ARTECH 2025

BRAGA – PORTUGAL

MEDIA ART CULTURES, COMMUNITIES & TERRITORIES

12TH INTERNATIONAL CONFERENCE ON DIGITAL AND INTERACTIVE ARTS

UNIVERSITY OF MINHO
BRAGA, PORTUGAL
26-28 | NOVEMBER | 2025

PROCEEDINGS | FULL VERSION



EDITORS
LUCAS FABIAN OLIVERO
EMÍLIA SIMÃO
ALBERTO SÁ
ADÉRITO FERNANDES-MARCOS

ORGANISED BY
UNIVERSITY OF MINHO
COMMUNICATION AND SOCIETY RESEARCH CENTRE (CECS)
THE ARTECH-INTERNATIONAL ASSOCIATION

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PROCEEDINGS (full version: ACM + Zenodo articles)
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ARTECH INTERNATIONAL
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Title

Proceedings of the 12th International Conference on Digital and Interactive Arts:
ARTECH 2025: Media Art Cultures, Communities & Territories

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Preface

Two decades of ARTECH conferences

On 12 July 2004, we organised the first edition of ARTECH at the Faculty of Sciences of the University of Lisbon, which we named the "First Luso-Galician Workshop on Digital Arts – Artech 2004". From the outset, our aim was to establish a series to be held alternately in Portugal and Galicia, in order to "... encourage contact and collaboration between communities on both sides of the border who deal with so-called digital arts, considering their multiple aspects, whether artistic, technological, or social".

ARTECH 2004 originated from discussions within the consortium of the "@rtec – Art and Technology in Cultural Industries" project, funded by the InterReg III A programme. Its objectives included developing technological platforms to support artistic and cultural activities linked, directly or indirectly, to the "Bienal de Arte de Cerveira" and the "Bienal de Arte de Orense". It was, in essence, a cross-border initiative between Minho and Galicia. The organisation of Artech 2004 was a collaborative effort by the following entities: the Centre for Computer Graphics, the University of Minho (Department of Information Systems), the Faculty of Fine Arts of the University of Vigo, the Project Association – Cultural Development Unit of the Cerveira Biennial, and Eurographics - Portuguese Chapter. The team was led by Adérito Fernandes-Marcos, President of the Scientific and Artistic Committee, with Henrique Silva from the Cerveira Biennial and Lola Dopico from the Faculty of Fine Arts of the University of Vigo serving as vice-presidents. The local organising committee was headed by Leonel Valbom from the Centre for Computer Graphics and Vitor Sá from the University of Minho.

The subsequent editions took place in **Vila Nova de Cerveira** (2005, organised by the Cerveira Art Biennial), **Pontevedra** (2006, Faculty of Fine Arts of the University of Vigo, Galicia), **Porto** (2008, School of Arts of the Universidade Católica Portuguesa), **Guimarães** (2010, School of Architecture and School of Engineering of the University of Minho), **Faro** (2012, Faculty of Social and Human Sciences, Higher Institute of Engineering of the University of Algarve), **Óbidos** (2015, Universidade Aberta), **Macau** (2017, Faculty of Creative Industries of the University of Saint Joseph), **Braga** (2019, Universidade Católica Portuguesa, Theatro Circo), **Aveiro** (2021, University of Aveiro), **Faro** (2023, Centre for Research in Arts and Communication of the University of Algarve); and now once again in **Braga**, with local organisation by the Centre for Communication and Society Research of the University of Minho.

In 2008, we took a bold step forward: we transformed ARTECH into an international conference, broadening our horizons and inviting voices from around the globe to enrich the creative dialogue. Four years later, in 2012, a significant moment brought everyone together at an *ad hoc* general assembly, where it became clear that it was time to strengthen the bonds within our community. It was then that the idea emerged to create an association dedicated to representing and driving the collective, embracing a more international role and proudly adopting English, Portuguese, and Spanish as the tools for our expression.

The following year, in 2013, the Artech-International Association was officially founded, cementing the commitment to unity and collaboration among all. In 2017, we celebrated another achievement: we

registered the conference proceedings book on the prestigious ACM (Association for Computing Machinery) platform, ensuring Scopus indexing and further showcasing our accomplishments on the global stage. Each step was a collective celebration of the innovative spirit that defines the ARTECH series.

Since its inception, the ARTECH conference series has become a true platform for creativity and innovation, bringing together hundreds of remarkable artefacts, digital and interactive art installations that challenge the senses, pioneering scientific articles, and provocative artistic manifestos. Each edition has been characterised by unforgettable encounters and intense debates, where ideas have crossed paths, inspired one another, and given rise to new forms of expression. These vibrant moments have not only advanced the academic and artistic development of digital and interactive art but also broadened the horizons of media, digital, and computational art, transforming the **ARTECH community into a dynamic laboratory of experimentation and dialogue, where talent and vision come together to shape the future**.

Today, as we celebrate two decades of ARTECH, we proudly affirm that every effort, encounter, and collaboration has been worthwhile — for together **we have forged a vibrant, global community**, destined to lead the future of digital and interactive art in the face of the challenges of process virtualisation, global connectivity, and the emergence of the post-digital era, which unifies and expands tangible and intangible realities.

We march ahead confidently for the next 20 years!

Macau, November 23, 2025

Adérito Fernandes-Marcos
President of Artech-International

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Prefácio

Duas décadas de conferências ARTECH

Foi em 12 de julho de 2004 que organizamos a primeira edição da ARTECH, nas instalações da Faculdade de Ciências da Universidade de Lisboa, que denominamos o "Primeiro Workshop Luso-Galaico de Artes Digitais - Artech 2004", já com a intenção de estabelecer a série a organizar alternadamente em Portugal e na Galiza, para "... *fomentar o contacto e a colaboração entre as comunidades dos dois lados da fronteira, que lidam com as denominadas artes digitais, considerando as suas múltiplas facetas, tanto do foro artístico, tecnológico ou social"*.

A ARTECH 2004 resultava da reflexão ocorrida no interior do consórcio do projeto *"@rtec – Arte e Tecnologia nas Indústrias Culturais*", financiado pelo programa InterReg III A, e que visa desenvolver, entre outros, as plataformas tecnológicas de apoio às atividades artísticas e culturais que acontecem direta- ou indiretamente associadas aos eventos "Bienal de Arte de Cerveira" e "Bienal de Arte de Orense", ou seja, era claramente uma iniciativa originalmente de natureza transfronteiriça Minho-Galiza. A organização do ARTECH 2004 foi conjunta e assumida pelas seguintes entidades: o Centro de Computação Gráfica, a Universidade do Minho (Departamento de Sistemas de Informação), a Faculdade de Belas Artes da Universidade de Vigo, a Associação Projeto – Núcleo de Desenvolvimento Cultural da Bienal de Cerveira e o Grupo Português de Computação Gráfica. A equipe foi liderada por Adérito Fernandes-Marcos, Presidente do Comité Científico e Artístico, com Henrique Silva, da Bienal de Arte de Cerveira, e Lola Dopico, da Faculdade de Belas Artes da Universidade de Vigo, como vice-presidentes; a comissão organizadora local foi assumida por Leonel Valbom, do Centro de Computação Gráfica, e Vitor Sá, da Universidade do Minho.

As edições seguintes ocorreram em **Vila Nova de Cerveira** (2005, organizada pela Bienal de Arte de Cerveira), **Pontevedra** (2006, Faculdade de Belas Artes da Universidade de Vigo, Galiza), **Porto** (2008, Escola das Artes da Universidade Católica Portuguesa), **Guimarães** (2010, Escola de Arquitetura e Escola de Engenharia da Universidade do Minho), **Faro** (2012, Faculdade de Ciências Sociais e Humanas, Instituto Superior de Engenharia da Universidade do Algarve), **Óbidos** (2015, Universidade Aberta), **Macau** (2017, Faculdade de Indústrias Criativas da Universidade de São José), **Braga** (2019, Universidade Católica Portuguesa, Theatro Circo), **Aveiro** (2021, Universidade de Aveiro), **Faro** (2023, Centro de Investigação em Artes e Comunicação da Universidade do Algarve); e agora novamente em **Braga**, com organização local do Centro de Investigação de Comunicação e Sociedade da Universidade do Minho.

Em 2008, demos um salto ousado: transformámos o ARTECH numa conferência internacional, alargando horizontes e convidando vozes do mundo inteiro para enriquecer o diálogo criativo. Quatro anos depois, em 2012, um momento marcante reuniu todos os presentes numa assembleia geral *ad hoc*, na qual ficou claro que era hora de fortalecer os laços da nossa comunidade. Surgiu então a ideia de criar uma associação dedicada a representar e impulsionar o coletivo, abraçando uma intervenção mais internacional e assumindo, orgulhosamente, as línguas inglesa, portuguesa e castelhana como veículos da nossa expressão.

No ano seguinte, em 2013, nasceu oficialmente a Associação Artech-Internacional, selando o compromisso de união e colaboração entre todos. E, em 2017, celebrámos mais uma conquista: registámos o livro de atas da conferência na prestigiada plataforma da ACM (*Association for Computing Machinery*), garantindo a indexação em Scopus e projetando ainda mais os nossos feitos no cenário global. Cada etapa foi uma celebração coletiva do espírito inovador que define a série ARTECH.

Desde o seu início, a série de conferências ARTECH transformou-se num verdadeiro palco de criatividade e inovação, reunindo centenas de artefatos surpreendentes, instalações de arte digital e interativa que desafiam os sentidos, artigos científicos pioneiros e manifestos artísticos provocadores. Cada edição foi marcada por encontros inesquecíveis e debates intensos, nos quais ideias se cruzaram, inspiraram e deram origem a novas formas de expressão. Estes momentos vibrantes não só impulsionaram o avanço académico e artístico da arte digital e interativa, como também expandiram os horizontes da média-arte digital e computacional, tornando **a comunidade ARTECH um verdadeiro laboratório vivo de experimentação e diálogo, onde talento e visão se unem para moldar o futuro.**

Hoje, ao comemorarmos duas décadas de ARTECH, afirmamos orgulhosamente que cada esforço, encontro e colaboração valeram a pena — pois, juntos, **forjamos uma comunidade vibrante e global**, destinada a liderar o futuro da arte digital e interativa diante dos desafios da virtualização de processos, da conexão mundial e do surgimento do pós-digital, que unifica e amplia as realidades tangíveis e intangíveis.

Avançamos com confiança para os próximos 20 anos!

Macau, 23 de novembro 2025

Adérito Fernandes-Marcos
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Preface

“Expanded Media Arts: Ecologies, Territories and Communities”

The 2025 edition of ARTECH takes place at a moment in which technology-mediated artistic production is confronted, simultaneously, with unprecedented technical acceleration and profound epistemological tensions. The convergence of Artificial Intelligence (AI) systems, immersive ecologies, data infrastructures, community practices and territorial dynamics calls upon Media Arts today to redefine not only their methods, but also their role in knowledge production, social mediation and cultural critique.

The theme of this year’s conference, “Media Art Cultures, Communities & Territories”, seeks precisely to bring into discussion this expanded condition of Media Arts, which have ceased to constitute a strictly artistic or technologically celebratory domain and have instead assumed the role of research laboratories operating in contexts where social and technological dynamics intersect, ecologies of public participation are cultivated, alternative modes of knowledge production are explored, and aesthetic-political dispositifs emerge with territorial impact and an artivist vocation. The contributions brought together in this “Book of Proceedings” bear witness to this plurality and reaffirm the urgency of critical, situated and interdisciplinary approaches.

The involvement of the Master’s Programme in Media Arts in the organisation of the Conference, through the active participation of both academic staff and students, also invites reflection on the challenges that currently confront postgraduate education. This level of academic training should not be reduced to mere technological skill updates but rather should focus on the capacity to form researchers and creators who can operate critically within complex digital environments, where social, cultural, and technological factors intersect, thereby fostering an integrated ecology of knowledges. This reconfiguration is not only pedagogical; it is structural, defining new professional trajectories and demanding flexible, interdisciplinary curricula grounded in research-creation practices.

The artworks and papers included in this edition, distributed across eighteen thematic sessions and an artistic exhibition supported by a digital platform in which artistic practice and scientific research converge, constitute a privileged observatory of contemporary production in Media Arts. They highlight, from the outset, the central role that Artificial Intelligence has come to play, not as a mere technological trend but as an aesthetic and epistemic agent that problematises fundamental categories of visual culture. The works presented here reconfigure the very notion of language and representation, interrogate the hidden materiality of algorithmic systems, question authorship and originality, archival and memorial regimes, gesture, body and aura, as well as issues of sustainability. The conference thus demonstrates that the relationship between AI and Media Arts is not one of simple instrumental adoption, but of ongoing critical negotiation, requiring informed and responsible practice that is consciously situated within the ethical tensions of the present. Within this framework, Media Arts may operate as a socio-cultural infrastructure that interrogates inequalities, fosters citizen participation and translates these dimensions into concrete artistic practices.

The organisation of an event of this nature is, inevitably, a long-term collective endeavour. It is therefore fitting to express our sincere gratitude to the members of the International Scientific and Artistic Committee, for their careful and indispensable work in the review process; to the authors, for their valuable theoretical and artistic contributions; to the Conference Secretariat, which has served as an essential interlocutor in managing the various strands of the event; to the academic staff and students of the Master's Programme in Media Arts at the University of Minho, for their commitment, availability and exemplary spirit of collaboration in their voluntary work; to the Communication and Society Research Centre (CECS), for its institutional support; and to our local partners, gnration and Braga - UNESCO Creative City of Media Arts, for their continued support. Our thanks are likewise due to the Research Centre in Arts and Communication at the University of the Algarve, the Doctoral School and the Faculty of Arts and Humanities of the University of Saint Joseph in Macao, for generously sharing their experience in conference organisation. A special word of thanks is extended to Artech-International for placing confidence in our ability to successfully host this 12th edition of the conference.

To all, our deepest thanks.

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Prefácio

“Media Arts em Expansão: Ecologias, Territórios e Comunidades”

A edição de 2025 da ARTECH decorre num momento em que a produção artística mediada por tecnologia se confronta, simultaneamente, com acelerações técnicas sem precedentes e com tensões epistemológicas profundas. A convergência entre sistemas de Inteligência Artificial, ecologias imersivas, infraestruturas de dados, práticas comunitárias e dinâmicas territoriais convoca hoje as Media Arts a redefinirem não apenas os seus métodos, mas também o seu papel na construção de conhecimento, na mediação social e na crítica cultural.

O tema desta edição da Conferência, “Media Art Cultures, Communities & Territories”, procura, precisamente, convocar para discussão esta condição expandida das Media Arts, que deixaram de constituir um domínio estritamente artístico ou de celebração tecnológica para se assumirem como laboratórios de investigação em contextos onde se entrecruzam dinâmicas sociais e tecnológicas, ecologias de participação pública, modos alternativos de produção de saber e dispositivos estético-políticos com impacto territorial e vocação artivista. As contribuições reunidas neste “Livro de Atas” evidenciam esta pluralidade e reafirmam a urgência de uma abordagem crítica, situada e interdisciplinar.

A envolvência do Mestrado em Media Arts na organização da Conferência, através da participação ativa de docentes e estudantes, convida também à reflexão sobre os desafios que se colocam hoje ao ensino pós-graduado. Este nível de educação académica não se deve limitar à mera atualização tecnológica, mas antes centrar-se na capacidade de formar investigadores e criadores aptos a operar criticamente em ambientes digitais complexos, onde se articulam fatores sociais, culturais e tecnológicos, promovendo uma ecologia integrada de saberes. Esta reconfiguração não é apenas pedagógica, é estrutural, definindo novas trajetórias profissionais e exigindo currículos flexíveis, interdisciplinares e assentes em práticas de investigação-criação.

As obras e artigos incluídos nesta edição, distribuídos em 18 sessões temáticas e uma exibição artística, com suporte de uma plataforma digital onde convergem a prática artística e a investigação científica, constituem um observatório privilegiado da produção contemporânea em Media Arts. Denotam, desde logo, o lugar central que a Inteligência Artificial (IA) vem assumindo, não como mera tendência tecnológica, mas como agente estético e epistémico que problematiza categorias fundamentais da cultura visual. As propostas aqui apresentadas reconfiguram a própria noção de linguagem e de representação, interrogam a materialidade oculta dos sistemas algorítmicos, a autoria e a originalidade, o arquivo e a memória, o gesto, o corpo e a aura, bem como as questões da sustentabilidade. A Conferência demonstra, assim, que a relação entre IA e Media Arts não é de mera adoção instrumental, mas de negociação crítica contínua, exigindo uma prática informada, responsável e conscientemente situada nas tensões éticas do presente. Neste quadro, as Media Arts podem atuar como infraestrutura sociocultural que interroga desigualdades, promove a participação cidadã e articula essas dimensões em práticas artísticas concretas.

A organização de um evento desta natureza é, inevitavelmente, uma empreitada coletiva, de longo curso. Impõe-se, por isso, uma palavra de sincera gratidão aos membros da Comissão Científica e Artística

Internacional e aos seus integrantes, pelo trabalho criterioso e fundamental no processo de revisão. Aos autores, pelas suas valiosas contribuições teóricas e artísticas. À equipa de Secretariado, que se constituiu como interlocutora essencial na gestão dos diferentes dossiês da conferência. Aos docentes e alunos do Mestrado em Media Arts da Universidade do Minho pelo seu empenho, disponibilidade e exemplar espírito de colaboração no trabalho voluntário. Ao Centro de Estudos de Comunicação e Sociedade, pelo acolhimento institucional, e aos parceiros locais, gnration e Braga - UNESCO Creative City of Media Arts, pelo apoio continuado. Ainda ao Centro de Investigação em Artes e Comunicação da Universidade do Algarve, à Escola Doutoral e à Faculdade de Artes e Humanidades da Universidade de São José em Macau, por nos terem emprestado a sua experiência na organização do evento. Um agradecimento especial, ainda, à Artech-International, pela confiança depositada na nossa capacidade de levar a bom porto a organização desta 12ª Conferência.

A todos, o nosso bem-haja!

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Curatorial Statement

Artech 2025 EXPO - Media Art Cultures, Communities and Territories

The online ARTECH Conference exhibition extends the event's research ethos into a shared digital space where artistic practice and scientific enquiry converge. Designed specifically for an online environment, the exhibition turns the screen into an area for exploration — a flexible space where images, code, sound and gestures reveal fresh perspectives on culture, community and technological mediation.

In this networked landscape, artists and researchers explore how digital technologies, ranging from artificial intelligence and virtual environments to interactive systems, robotics and data visualisation, reshape our collective experience of the world. Each artwork operates as both poetic expression and experimental research, providing an insight into the relationship between humans and machines, ecology and computation, and memory and data.

The participating projects examine how communities are formed and sustained in technology and art mediated contexts. Through interactivity, participation and generative processes, among many other approaches, they explore the concepts of empathy, identity and belonging in an age characterised by ubiquitous connectivity. These works serve as a reminder that media cultures are never neutral: they actively shape the way we perceive and relate to one another, as well as to the physical, virtual, and hybrid territories we inhabit.

In this exhibition, territory becomes a porous concept that is simultaneously ecological, political and algorithmic. Some pieces evoke environmental change and the fragility of natural systems, while others generate speculative digital landscapes based on data or code. Together, these pieces offer a broader interpretation of place as a living system in which material and immaterial layers coexist and interact.

By being part of an academic conference, this exhibition demonstrates that artistic creation is a form of research in itself. Each artwork contributes to scientific knowledge by testing new methodologies, metaphors, and interfaces that expand our understanding of media ecologies, digital mediation, and human-technological coexistence.

Although the exhibition takes place online, it is complemented by on-site screenings of the videos during the ARTECH Conference. These encounters provide vital opportunities to engage more deeply with the artworks by facilitating direct dialogue with their creators and research teams. Through these conversations, visitors will be able to grasp the conceptual, technical and ethical dimensions underlying each project, turning observation into critical exchange and shared discovery.

Ultimately, this exhibition invites us to reflect on how we inhabit digital spaces, and on how our actions, data and stories influence the nature of our shared existence. Here, art becomes an exploration, technology becomes an expression, and the conference becomes a community of thought, where media cultures evolve into living, collaborative spaces of imagination and knowledge.

The curator would like to thank all the participating artists for their valuable contributions and extend special thanks to João Martinho Moura, Susana Gaudêncio, Selma Pereira, and Adérito Fernandes-Marcos, whose help was crucial to the exhibition's success.

Pedro Alves da Veiga
CIAC – Centro de Investigação em Artes e Comunicação
Universidade Aberta

Nota Curatorial

Artech 2025 EXPO - Media Art Cultures, Communities and Territories

A exposição online da Conferência ARTECH amplia o espírito de investigação do evento a um espaço digital partilhado, onde a prática artística e a investigação científica convergem. Concebida propositadamente para um ambiente online, a exposição transforma o ecrã numa área de exploração — um espaço flexível onde imagens, algoritmos, sons e gestos revelam novas perspetivas sobre a cultura, a comunidade e a mediação tecnológica.

Nesta paisagem em rede, artistas e investigadores exploram formas como as tecnologias digitais, como a inteligência artificial ou os ambientes virtuais, passando pelas instalações interativas, robótica e visualização de dados, remodelam a nossa experiência coletiva do mundo. Cada artefacto assume-se como expressão poética e investigação experimental, proporcionando uma visão sobre a relação entre humanos e máquinas, ecologia e computação, memória e dados.

Os projetos artísticos participantes analisam como as comunidades são criadas e sustentadas em contextos com mediação tecnológica e artística. Através da interatividade, participação e processos generativos, entre tantas outras abordagens, eles exploram os conceitos de empatia, identidade e pertença numa era caracterizada pela conectividade ubíqua. Estas obras atuam como uma chamada de atenção para o facto de que as culturas mediáticas nunca são neutras: moldam ativamente a forma como nos percebemos e nos relacionamos uns com os outros, bem como com os territórios físicos, virtuais e híbridos que habitamos.

Nesta exposição, o território transforma-se num conceito poroso que é simultaneamente ecológico, político e algorítmico. Alguns artefactos evocam as alterações ambientais e a fragilidade dos sistemas naturais, enquanto outros geram paisagens digitais especulativas baseadas em dados ou código. No seu conjunto, estas obras oferecem uma interpretação alargada do lugar, como um sistema vivo, no qual camadas materiais e imateriais coexistem e interagem.

Ao estar integrada numa conferência académica, esta exposição demonstra que a criação artística é uma forma de investigação em si mesma. Cada projeto artístico contribui para o conhecimento científico, testando novas metodologias, metáforas e interfaces que expandem a nossa compreensão das ecologias dos meios de comunicação, da mediação digital e da coexistência humano-tecnológica.

Embora a exposição decorra online, ela é complementada pelas exibições dos vídeos nos locais das sessões da Conferência ARTECH, fomentando encontros e oportunidades que permitam um envolvimento mais profundo com as obras de arte e um diálogo direto com os seus criadores e equipas de investigação. Através destas conversas, os visitantes poderão compreender as dimensões conceptuais, técnicas e éticas subjacentes a cada projeto, transformando a observação em troca crítica e descoberta partilhada.

Em última análise, esta exposição convida-nos a refletir sobre como habitamos os espaços digitais e sobre como as nossas ações, dados e histórias influenciam a natureza da nossa existência partilhada. Aqui, a arte

torna-se uma exploração, a tecnologia torna-se uma expressão e a conferência torna-se uma comunidade de pensamento, onde as culturas mediáticas evoluem para espaços vivos e colaborativos de imaginação e conhecimento.

O curador gostaria de agradecer a todos os artistas participantes pelas suas valiosas contribuições e gostaria de agradecer especialmente a João Martinho Moura, Susana Gaudêncio, Selma Pereira e Adérito Fernandes-Marcos, cuja ajuda foi crucial para o sucesso da exposição.

Pedro Alves da Veiga
CIAC – Centro de Investigação em Artes e Comunicação
Universidade Aberta

Preface

International Scientific and Art Committee

We are delighted to welcome you to ARTECH 2025, the 12th International Conference on Digital and Interactive Arts, hosted by the Communication and Society Research Centre (CECS) at the University of Minho, in Braga, Portugal. For over 20 years, ARTECH has brought together artists, researchers, and practitioners who work at the intersection of art, science, and technology. The 2025 edition continues this commitment, opening space for imagination, dialogue, and thoughtful reflection on our shared digital lives.

We live in a time shaped by algorithms, networks, and vast infrastructures. Art helps us slow down and examine closely how technology influences our experiences, memories, and futures. ARTECH 2025 invites you to reevaluate the ethical, aesthetic, and ecological dimensions of the digital condition and to explore how creative practice responds to the complexities of contemporary media environments.

This year, we're proud to have received submissions from 34 countries, a sign that our community resonates globally and embodies the ARTECH community's inclusiveness. Our theme, "Media Art Cultures, Communities & Territories," invites us to consider how creative work and practices engage with the ecologies of the digital age. It brings forward notions of belonging, participation, and situated knowledge. Media art operates both as a language and as a laboratory, and therefore proposes ways to shape and share identity, remember and archive experience, and imagine possible futures across environments where the physical meets the virtual and the material meets the computational.

ARTECH 2025 welcomes a wide range of approaches and methods emerging from the convergence of art, science, and technology. Topics include, among others, artificial intelligence and authorship, sustainable and bioremediative practices, interactive and immersive environments, data visualisation and parametric design, creative coding and generative aesthetics, ecological activism, and the pedagogical dimensions of STEAM education.

A signature moment in this year's program is the Virtual Exhibition of Digital Artworks, presenting around thirty projects. While similar initiatives have featured in past editions of Artefacto, this iteration marks its place within ARTECH. The exhibition highlights the various contemporary media art through experimentation and play. Exhibition details are available online on the ARTECH INTERNATIONAL website.

More than a conference, ARTECH 2025 is a living ecosystem of ideas and encounters. It invites us to consider the role of media art in facing urgent planetary challenges and to imagine digital culture as a shared commons, open, collaborative, and transformative.

We are deeply grateful to everyone who makes this possible, to the authors and artists who enrich the program, to the scientific and artistic committees for their thoughtful contributions, and to the organising team at CECS for their dedication. Above all, we thank the participants whose curiosity and creative spirit keep the ARTECH community vibrant.

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Keynote Speakers

Paulo Teles
media artist, professor, researcher

Professor at the Department of Multimedia, Film and Communication of the Institute of Arts of the State University of Campinas. His artistic works seek to converge technology, new sensibilities and critical thinking through by interactive-corporal processes in emerging media, relational and multi-sensorial artistic expressiveness, and transdisciplinarity literacies through Art.

"Artistic [co]Creative Procedures in Masterpieces. from new Technological Sensitivities to the Multidimensional Sharing Literacies"

Based on artistic and intellectual production that investigates the interfaces between art, technology, and knowledge, this is an analytical and practical trajectory anchored in the author's artistic and educational production, which evolves from the search for new sensibilities in the field of Technological Art to the articulation of sharing literacies.

We will explore how the systemic vision of procedural art has expanded into action research in shared multimedia creative processes, as well as how this has highlighted cultural and critical diversity in procedures for the co-creation of contemporary collective works based on the multiplication of creative and critical agents in the context of a multicultural and diverse technological society.

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Sara Orsi
web designer, creative coder, researcher, educator
Sara Orsi is focused on the intersection of digital technology and contemporary culture. Currently she teaches at the School of Innovation and Creation Technologies (ETIC) and at the Faculty of Fine Arts of the University of Lisbon (FBAUL).

"On Cultural–Technological Ambivalences: A Dialogue Between Theoretical and Artistic Practices"

Drawing on multiple ambivalences that emerge from the cultural–technological interrelation, this presentation reflects, through a dialogue between theoretical and artistic practices, on how algorithmic entities and digital infrastructures have been shaping relations of power, visibility, and temporality.

Anchored in the concept of pharmakon – simultaneously a remedy or poison, but also a potion or spell – and in the ambivalences identified, a trajectory is traced around three main axes: power relations in algorithmic governance; the visible and invisible within digital infrastructures; and the paradoxical temporality of computing. technology on contemporary culture.

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Miguel Carvalhais
designer, musician, artist

Professor of Design at the Faculty of Fine Arts of the University of Porto, and its current dean. Author of the books Art and Computation (2022) and Artificial Aesthetics: Creative Practices in Computational Art and Design (2016).

"From Analogue to Metaphor: Art in the Computational Turn"

In this talk I will look at computational technologies and at how they breed tools and media that are quite unlike any of those that we have historically used to create art. I will delve into the relationships between art and media in the post-digital and post-internet condition and, by focusing on the computational nature of these media I will argue that because of their inherent instability and irreducibility, computational media are at odds with our expectations from media forms, while simultaneously opening up radically new spaces for artistic expression and experience, for an art of causality, complexity, emergence, and intensity.

Detailed Abstract Images from Automated Prompts

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Figure 1: Some abstract images, generated using (left to right) Midjourney, DALL-E, Midjourney, Stable Diffusion.

Abstract

Pretrained diffusion models guided by text prompts offer a controllable, accessible process for creating images. However, text prompts are easier to create, and more straightforwardly induce an output matching the user's intention, when the desired image content is representational: depicting a well-defined, recognizable subject and setting. Abstract images are difficult to describe and the user may lack a clear idea of the contents of the abstract image in the first place. We propose a mechanism, inspired by "Mad Libs", for automatically constructing prompts to elicit intricate abstract images. We present sample "Mad Libs" templates and give advice about how to populate the dictionaries that will be used for template completion. We test our prompts on three separate diffusion models and show several examples of images thus produced; the results have a degree of detail and coherence that naïve prompts cannot match.

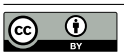
CCS Concepts

• **Applied computing** → **Arts and humanities**; • **Computing methodologies** → **Texturing**; **Non-photorealistic rendering**.

Keywords

algorithmic art, abstract art, generative AI, diffusion models, prompt engineering

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1 Introduction

The majority of papers on algorithmic art aim for representational output: images that depict a concrete subject, either real or imaginary. Filter-based and style transfer techniques are typically applied to representational images. Generative techniques are usually used to produce representational images, and the vast majority of training images are representational. Abstract images have received much less attention.

In this paper we investigate the use of pretrained diffusion models, conditioned on a text description of the desired image contents, to generate detailed abstract images. We are faced with the challenge of devising suitable prompts. The typical use of text prompts for image generation is to describe the concrete elements of the scene, plus some modifiers saying how the image should come out; these modifiers might describe the style or genre of the intended image, or possibly say something about the composition or color scheme. However, abstract images are inherently hard to describe, owing to an absence of concrete elements; the difficulty increases as we demand greater depth and variety of detail within the image. Some fractal images have the desired combination of detail and abstractness, as do some artworks created manually by artists, but generative models typically do not create suitable images. Figure 1 shows some images generated by our technique; these selected results exemplify the complex, abstract images that we sought to achieve. Images were generated using Stable Diffusion [10], DALL-E [8], and Midjourney [6].

We propose a prompt generation scheme styled after *Mad Libs*, where a template description is populated by random words from a set of dictionaries. This scheme might appear trivial, but its results are more effective than those of naïve prompting and it is able to generate new distinct prompts much more quickly than is feasible manually. The resulting images are varied and often surprising.

The generated prompts, while well-formed grammatically, are quite unlike the labels used to create the CLIP [7] latent space on which the text prompting depends. We hypothesize that this difference allows the diffusion model to access portions of the image

latent space that would otherwise be little used. In any event, the resulting abstract images are difficult to describe conventionally, yet are subjectively appealing nonetheless. We liken our prompts to Chomsky's famous sentence, "Colorless green ideas sleep furiously", insofar as a literal interpretation is impossible. Despite the often-nonsensical prompts, the diffusion models do produce images from them, with the resulting images also lacking any literal interpretation.

The immediate application is in computational aesthetics: creating aesthetic objects algorithmically. A potential future application lies in creativity enhancement, creating inspirational images that would have been difficult to think of otherwise, and sparking ideas that can then be realized, remixed, and remade by artists using their usual toolset and workflow. Automatic prompt generation allows for high iteration speed. Further, our generated prompts are human-readable (even if often nonsensical) and can be manually edited, although we do not pursue this direction here.

This paper provides the following contributions:

- Introduces a structured prompt generation approach using a Mad Libs style template, enabling the creation of novel, diverse and visually compelling abstract images using diffusion models.
- Demonstrates that the Mad Libs approach is effective at producing prompts that result in aesthetically appealing abstract images.
- Proposes guidelines for template construction and dictionary entries to improve generation of abstract images.

2 Previous Work

Past researchers have expended some effort on algorithmic generation of abstract images, whether geometric [3], adapted from photographs [11, 14, 15], or directly inspired by historical artists [1, 5]. We are not attempting to emulate any particular artist or art tradition. Arguably the work closest in spirit to ours is the Electric Sheep project (electricsheep.org), based on the Fractal Flame algorithm [2]; this undertaking sought to create beautiful images and animations, using a chaos game sampling of an underlying fractal distribution. The Electric Sheep images possess no recognizable semantic elements, but their complex beauty is hypnotic.

In this paper, we deploy diffusion models to create abstract images. The diffusion method of image synthesis defines a process of iterative noise addition and removal [4]. In the standard conception, the process operates directly in pixel space, e.g., Denoising Diffusion Probabilistic Models [4], while latent diffusion models (LDMs) operate on a latent representation of the input images; the Stable Diffusion model [10], we employ works this way. The process involves a forward diffusion phase, where Gaussian noise is added over a series of timesteps, gradually transforming the input (pixels or latent variables) into noise. At the final timestep, the distribution approximates a normal distribution. In the reverse diffusion phase, the network learns to reconstruct the data by denoising the pixel or latent data. While standard diffusion models operate directly on high-dimensional image data, LDMs first encode the image data into a lower-dimensional, latent representations which are used as inputs into the training process. In most cases, the training is conditioned using text descriptions that are converted into embeddings using a pre-trained model such as the open source CLIP (Contrastive Language-Image Pre-Training) model [7]. During training, the model learns to associate image and text features; this association enables the reverse diffusion process to generate images that semantically align with a conditioning *text prompt* at inference time, where the *prompt* is a user-provided description of the intended output that guides the generation process.

The content of the text prompt can have a significant impact on the attributes, quality, and suitability of the associated output. Research into the conditioning ability of text prompts aims to understand and design methods for encoding semantic and contextual details into the prompt in order to more effectively guide the generation process. However, interactions between embeddings and the model's internal representations during the generation process remain only partially understood. For example, one area of active investigation studies the extent to which a model represents unique token sequences and how this influences image generation.

Diffusion models have been shown to be effective at image creation generally, including generating images in an artistic or painted style [12]. They have recently been applied to creativity enhancement: by iteratively constructing a collection of negative prompts, Richardson et al. [9] were able to elicit novel examples of pets, furniture, and even art styles. Though their work concentrated on concrete, recognizable entities, a similar approach using negative prompts should be investigated for abstract images. (It may be worth commenting, though, that preliminary experiments with negative prompts in our context – instructing DALL-E not to include spheres – backfired and resulted in even greater quantities of spheres.)

Our particular prompting strategy was inspired by the Mad Libs word game, where we generate a text prompt using a template where parts of speech are populated with descriptive terms to elicit an abstract image. Yu et al. [13] previously employed a Mad Libs strategy for image labeling, though in the context of recognizable and describable entities and completing the templates with deliberate word selection in an effort to accurately describe the image contents, rather than creating images (or prompts) with random template completion. To our knowledge, Mad Libs has not previously been applied to creating abstract images.

3 Prompt Generation

We used a selection of pretrained diffusion models – Midjourney 6.1, DALL-E 2, and Stable Diffusion 3.5 Large – to generate abstract images using our Mad Libs prompt creation system. This set includes both open-source and commercially available models. In this section, we discuss the design principles behind the prompt creation and how the different elements of the design further our objectives of creating visually rich, heterogeneous abstract images. The "Mad Libs"-inspired prompt design involves populating a template with random words; we discuss the template structure and distribution of possible completion words in the following subsections.

3.1 Mad Libs

"Mad Libs" is a process for creating variations on a base text by filling in a template with arbitrarily-chosen words matching the requested type. A template might look like this: *Little Red Riding*

Hood went $VERBing into the $ADJECTIVE woods, carrying a basket of $NOUN to bring to her $ADJECTIVE grandmother.

In historical Mad Libs, the template is constructed to tell a story or set a scene, with occasional random words disturbing the predictability of the sentences to humorous effect. In our case, the template is less important; after a scripted introduction, the main body of the prompt chiefly serves as a container for a set of randomly selected words. The prompt resulting from populating the template is not intended to be read by humans (though it can be) and instead provides a surprising, incoherent description that can influence the creation of an image. We will describe the word selection process in section 3.2.

One of our generated prompts is the following, with the randomly selected completion words shown in bold. The resulting image is the first (leftmost) example in Figure 1.

*An intricate abstract design of **twisty pits**, mostly **yellow** and **burnt orange**. Within the larger designs one can see **broken whispers** with **pitted patterns embedding** throughout. Zooming in further, one can see **messy stains meandering** with hints of **gold**. Zooming in further, one can see **muddy whispers vibrating** with hints of **aquamarine**. Zooming in further, one can see **gaping regions swarming** with hints of **ivory**. The overall effect is reminiscent of **majestic scratches**. The image leaves the viewer with a feeling of **boredom** mixed with **disgust**.*

Our template design emphasizes detail through providing several statements about things that can be seen in the image, for example (as in the template shown above) by repeatedly describing what can be seen by zooming in. The described elements are evocative rather than concrete; in most cases, it is difficult to impossible to interpret them literally, which helps to ensure that the output images remain abstract.

The contents of the template can be summarized as follows:

- Introduction. Lays out intent of prompt and gives a high-level description of the overall image content. Optionally, describes main colors present in the image.
- Body. (Several statements.) Description of detailed elements of image.
- Coda. Another (possibly conflicting) summary of the image. Optionally, provides an affective description.

The template, especially the comparatively static opening text, helps to orient the image construction towards abstract images and to organize the randomly selected descriptive words. However, we emphasize that we are not specifically recommending this particular template; many variations are possible, and indeed, for the body of the prompt, it is not clear that organizing the descriptors is absolutely necessary; consider Figure 1 (rightmost image), whose prompt omitted the organizing text.

Given a prompt template, a finished prompt is produced by populating the blanks with words. We next discuss our approach to creating the dictionaries from which the random words are drawn.

3.2 Dictionary Design

We deployed six separate dictionaries: word lists for nouns, verbs, adjectives, adverbs, colors, and emotions. The dictionary entries were hand-selected, with most effort expended on the list of nouns; to paint with a broad brush, nouns tend to describe more localized features of an image (and hence have a greater impact on image formation through the attention mechanism) and also pose the greatest threat to our efforts to promote abstract images. Including a word like "bumblebee" pushes the diffusion model to create something recognizably bumblebee-like, whereas we want to limit the degree to which recognizable content appears in the output image. The other parts of speech pose much less risk; a mention of a concrete action (e.g., "crawling") is less liable to be interpreted literally when the entity stated to be taking the action is itself not recognizable, or even capable of performing the action in the first place.

The nouns we added to the dictionary fall into three broad categories: (i) semi-abstract entities (e.g., corners, rectangles); (ii) concrete entities that lack clear visual interpretations (e.g., echoes, whispers); and (iii) secondary elements added to a primary surface (e.g., scars, stains). We believed that none of these would be interpreted as anything concrete, with the last category in particular helping to elicit additional detail from the image formation process.

We expected color words to be interpreted literally, permitting some control without damaging the underlying structure. In practice, some descriptors such as "triangles" were also interpreted literally, though (in our view) without compromising the abstract nature of the images. Verbs, adjectives, adverbs (little used in most templates), and emotions did not appear to introduce any representational elements into the images.

Our handmade dictionaries are not particularly large, with about 50-150 words in each (and substantially fewer in the list of emotions). However, the combinatorial explosion arising from populating 20-25 template entries from the different dictionaries means that the potential number of unique prompts is immense, and of course, the dictionaries can straightforwardly be expanded, at least for a few doublings. It did not seem to us that a small dictionary size was responsible for a low variety of output – on the contrary, the outputs were highly varied – so there was no urgency to extend the word lists.

3.3 Template Variants

In the course of our investigation, we experimented with several variations within the general framework described in Section 3.1. The text of the introduction varied; we converged on an introduction that explicitly identified the main colors to be used in the image, making the connection between the prompt and result clearer (and hence more controllable), at least along this dimension. The conclusion varied as well. While we included the affective direction in all our later designs, we are not confident it is accomplishing much; an informal ablation was inconclusive, though it suggested that at minimum, the affective instructions are not making the output worse.

We attempted several variants for the prompt body. The most-used prompt template uses repeated descriptions of what can be seen by zooming in (see example in Section 3.1). Another moderately effective variant described the image as containing multiple sectors, and gave a separate randomly-populated instruction for each. Sometimes such prompts produced images containing multiple distinct patterns; more often, the prompt resulted in a somewhat

homogeneous pattern with poorly-integrated boundary lines overlaid, which we usually considered less appealing. Building on the idea of sectors, we also attempted to direct the image spatially ("in the upper left, the image contains...") but this approach seemed entirely ineffective. We believe that a more direct spatial attention map is necessary to obtain this level of control.

We speculate that the main value in an extended prompt body is to provide several competing descriptions of the pattern content, so that different parts of the noise can converge on different aspects of the description. With this in mind, we wondered whether the structured part of the template was providing much value: could similar images be obtained simply by providing long lists of keywords describing the content? A keyword-based prompt body is indeed effective occasionally, but we found this strategy to produce uninteresting output (more homogeneous, less detailed) substantially more often than the fully-templated prompts.

We consider our proposed templating mechanism a proof of concept, far from the final word on how to generate abstract images. We have made some suggestions and outlined some principles that promote the type of abstract, detailed, heterogeneous images we targeted. Nonetheless, additional refinement of existing elements and addition of new elements and structures is certainly possible.

In the following section, we show numerous results from our approach. The images are varied and possess the key characteristics of abstractness and intricacy that we sought.

4 Results and Discussion

4.1 Sample images and commentary

Figure 2 shows sample results from our process, containing examples generated by all three of the models we tested (Midjourney, DALL-E, Stable Diffusion). The figure contains results drawn from approximately the top 25% of images generated, according to our own impression of visual interest; we should note, though, that most outputs have some appeal and other users (making their own judgements) would have made different, equally valid selections. The displayed images are representative of the type of results one can expect from our prompting strategy.

The different models responded to the prompts by generating detailed, heterogeneous abstract images. Despite the high level of within-image variety, the images also have unified compositions, with natural-seeming progressions in color or scale, as well as large-scale elements sometimes spanning the entire image. Additional generated images can be found in Figure 1, and for these the full prompts are given in Section 3 (first image) and Appendix A (the remainder).

For a given prompt, there is considerable variation in the images the different models produced. Figure 3 shows results from the same prompt interpreted by each of the three models; some commonality can be discerned (especially in the colors used) but the structures are generally not very similar. Some descriptors (the "discs" of the third group) afford more stable interpretations and correspondences across models are more visible. However, most of our descriptors are less definite and the resulting images, both within and between models, are more variable.

In general, our automatically generated prompts are not easy for a human to decipher. From reading the prompt, it is highly non-obvious what image would satisfy the description given. Although the model does create an image, humans also have difficulty describing the image's contents, both because the contents have high complexity and because there is a dearth of vocabulary to describe the unfamiliar, non-representational image elements. Challenged to provide a description, people largely resorted to simile ("it looks a bit like...") or described their idiosyncratic reactions ("it reminds me of..."). The occasional descriptions people did propose were extremely lossy, unsurprising given the high quantity and variety of detail within each image.

ChatGPT was willing to attempt to describe the images, and gave quite detailed descriptions, though the descriptions did not generally convey the image content very well. Using the generated descriptions as prompts produced output with little resemblance to the starting image. Some representative results appear in Figure 4.

4.2 Comparison with naïve prompts

When considering the proposed approach to prompting, one might wonder whether the elaborate prompts are having much effect. Isn't it the case that these powerful diffusion models can create interesting abstract images with simpler prompts? Indeed, a straightforward instruction such as "generate a unique abstract image" can elicit an abstract image with some degree of appeal. However, in our observation the images thus produced tend to be simpler and more homogeneous than the complex, irregular images generated from our generated prompts. Figure 5 shows some examples of abstract images from plausible but naïve prompts. Though these images have their charm, the relative simplicity of their structure makes them less engaging; they fall short of the level of visual interest enabled by our prompting strategy.

Results from a somewhat more elaborate static prompt are shown in Figure 6. This prompt was designed after reflecting on our Mad Libs results and attempting to characterize what made these images compelling: the wide variety of detail, the color transitions, and the sense of unity in each individual image. We experimented with a few prompt variants, the most successful being the following: *A detailed, intricate, unified abstract image with a harmonious color scheme. The contents are unique, unlike anything seen before. Details vary in a smooth and continuous way across the image, yet remain chaotic.*

The results are indeed more varied and elaborate than the simpler prompts of Figure 5, but still unsatisfactory. The structures are limited and in some cases familiar to those with experience with fractals. Some of this is doubtless due to our effort to keep the static prompt generic; one can devise more complex prompts that describe the image content in a more specific and focussed way, but the greater specificity leads to lower variety in the output, so that a user might be inclined to write many custom prompts; however, manual prompt generation does not scale well, and the time per prompt will increase with the complexity of the prompt. The Mab Libs strategy provides a huge number of possible prompts with no additional manual effort, given the templates and dictionaries.



Figure 2: Some example results, selected for variety and visual interest. Images generated by (raster order) DALL-E, SD, Midjourney, DALL-E, Midjourney, Midjourney, SD, Midjourney, Midjourney, DALL-E, SD, SD.

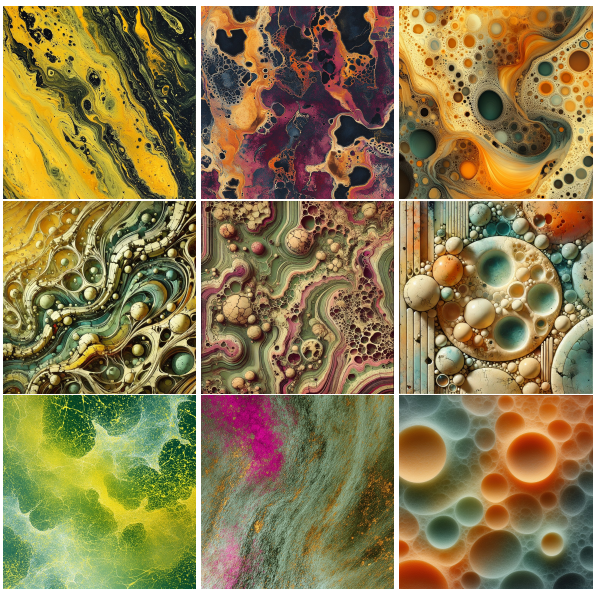


Figure 3: The same prompts used for Midjourney (top), DALL-E (middle), SD (bottom). Images were selected for visual interest and not for similarity.



Figure 4: Sample outcomes from asking ChatGPT to describe an abstract image and then using the description as a prompt. Above: initial image; below: derived image.

4.3 Concreteness of prompt elements

As described in Section 3.2, we populated our dictionaries with entries promoting evocative descriptions, but ones that are difficult to interpret literally. We did include some words that describe generic shapes, such as triangles, squares, or stripes, and these typically manifest in a literal fashion – i.e., one can see the triangles. Examples are given in Figure 7. We include in this image a related example where the model took one of the descriptive words literally: we had included 'wheat" as a possible color descriptor, and its appearance in the prompt yields stalks of wheat in the output image.



Figure 5: Sample outcomes from simpler prompts. Above, "A beautiful abstract image"; below, "An intricate abstract image". The results are reasonable, but lack the detail and within-image variety that we are attempting to produce. Images from variants of these prompts (e.g., adding additional descriptors such as "detailed", "high-quality" and "trending on artstation") were not qualitatively different.



Figure 6: Sample outcomes from more elaborate prompts. Left: Midjourney; middle: Stable Diffusion; right: DALL-E.

We attribute the abstractness of our output images to our policy of deprioritizing concrete referents when populating our dictionary, especially the nouns. Nouns provide the clearest connection between the text description and image contents. To highlight the differences between our less-concrete image descriptions and ones which are more concrete, we edited some randomly-generated prompts by replacing all nouns with concrete elements: tigers, clocks, trains, and the like. Representative results appear in Figure 8. These images are interesting in their own right, and (when the body text is used, calling for additional elements) still contain considerable detail, but tend more towards the surreal than the abstract. Investigating a mix of low-concreteness and high-concreteness terminology may be a productive future direction.

4.4 Limitations

Our prompts generally succeed at eliciting from the models the kind of detailed, abstract images we were aiming for. Not every output image is appealing or interesting, however; we estimate a success rate around 50%, higher for Midjourney, lower for SD, and potentially lower for DALL-E depending on the viewer's tolerance for looking at spheres.



Figure 7: Prompts containing definite shapes. Above: "ovals", "stripes"; below: "triangles", "wheat". The mentioned shapes are a prominent aspect of the image despite the prompt stating that they are visible only on zooming in. "Wheat" was meant to refer to the color but was interpreted as an object.



Figure 8: Sample outcomes using concrete referents, with body text (left) and without (right). Above: "prancing tigers"; below: "bejeweled tomatoes." Images by Midjourney.

Arguably the most critical limitation is that our prompt generation process does not afford a user much control over the output. Though the prompt is nominally human-readable and -editable, it is difficult to impossible to modify it so as to change the structure of the output image in a predictable way. Color can be controlled, but little else. In some applications, that may not be a significant drawback, but in other tasks, one might wish the images to be more directable.

Though we hoped to create a wide variety of dramatically different images, we found that certain elements and arrangements appeared with undesirably high frequency. For unknown reasons, DALL-E populates its images with spheres, sometimes quite densely. Midjourney commonly (an estimated 15% of the time) produces images somewhat resembling mineral veins. Examples of these structures are given in Figure 9. The reader can also look for spheres in other images generated by DALL-E appearing elsewhere in the paper.



Figure 9: Certain patterns and elements recur, depending on the model. Above: Midjourney often populates the image with irregular parallel lines. Below: DALL-E has a tendency to place spheres, regardless of the prompt.

5 Conclusion

We presented an approach to automatically generate text prompts to elicit detailed, varied abstract images from diffusion models. We borrowed from "Mad Libs", generating text by completing a template with random words; we tentatively suggest that the body of the template, organizing the descriptive words into grammatically-meaningful sentences, is not terribly important, but that the interesting abstract images are driven by the introductory text plus a set of unusual, evocative descriptive phrases.

The images resulting from our process are surprising and appealing. They are visually richer than what can be obtained through naïve prompts. Since the prompts are generated automatically, many different examples can be created quickly.

The work described here can be extended in different directions. Affording the user more control over the output images is an obvious goal, whether by incremental exploration of the prompt space or by some other means such as refining the dictionary choices according to user-specified objectives. We have not attempted to create video, but that is an obvious extension to consider.

Our dictionaries were created in an ad-hoc fashion and would benefit from a more systematic effort to sample a semantic space, filtering redundant words and identifying and filling gaps. Judicious inclusion of more concrete elements may be worthwhile, perhaps moving away from purely abstract images towards surreal images with a few recognizable elements. Although we focused on strictly abstract images here, there may be some application to representational images as well.

Finally, and more speculatively, we hypothesize that part of the effectiveness of our incoherent prompts is that they tap into portions of the underlying latent space that are otherwise difficult to access. To the extent this is the case, this investigation could lead to a better understanding of and use of these less-traveled possibilities.

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A Prompts

Prompts for images in Figure 1:

(teaser #2) A beautiful abstract image. The image displays an intricate design, a vacant depiction of red whispers. Within the larger designs one can see whispers of brown with desiccated triangles meandering throughout. Zooming in further, one can see vivid corners with hints of xanthous. Zooming in further, one can see burned scars with hints of golden. Zooming in further, one can see brass cells with hints of orange. The overall effect is reminiscent of cobbled stains. The image leaves the viewer with a feeling of awe mixed with surprise.

(teaser #3) An intricate abstract design of scraped pits, mostly bronze and robin's-egg blue. Within the larger designs one can see stony strips with smoky craters crashing throughout. Zooming in further, one can see sharp flecks splashing with hints of sapphire. Zooming in further, one can see ancient regions crashing with hints of Red. Zooming in further, one can see intricate bits crowding with hints of azure. The overall effect is reminiscent of irregular strips. The image leaves the viewer with a feeling of disgust mixed with joy.

(teaser #4) An intricate abstract design, mostly silver and yellow, with the following properties: pitted, twists, weathered, designs, ethereal, crevices, cutting, majestic, strips, twisting, sage, desiccated, bits, intertwining, coral, striking, cells, capering, ivory, bubbling, pebbles, awe, curiosity. [This was a rare case with a worthwhile result despite omitting the template structure beyond the introduction.]

Prompts for images in Figure 3:

Left: An intricate abstract design of twisty sparks, mostly lime and yellow. Within the larger designs one can see pitted puddles with muddy patterns swimming throughout. Zooming in further, one can see wonderful scrapes milling with hints of olive. Zooming in further, one can see hooked gaps sinking with hints of brown. Zooming in further, one can see burnt remnants crowding with hints of aquamarine. The overall effect is reminiscent of rough fragments. The image leaves the viewer with a feeling of regret mixed with regret.

Middle: An intricate abstract design of boiling remnants, mostly olive and magenta. Within the larger designs one can see vivid whispers with old lines milling throughout. Zooming in further, one can see irregular pits eroding with hints of gold. Zooming in further, one can see twisted sandstone vanishing with hints of apricot. Zooming in further, one can see intricate spots filling with hints of plum. The overall effect is reminiscent of pockmarked patterns. The image leaves the viewer with a feeling of anger mixed with boredom.

Right: An intricate abstract design of ethereal discs, mostly wheat and orange. Within the larger designs one can see mysterious corners with old holes arranging throughout. Zooming in further, one can see mysterious pieces tessellating with hints of lime. Zooming in further, one can see bubbling bits covering with hints of teal. Zooming in further, one can see burnished foam scratching with hints of jet black. The overall effect is reminiscent of smooth foam. The image leaves the viewer with a feeling of curiosity mixed with surprise.

Representational Model Guided by AI Algorithmic Logic Procedures

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ABSTRACT

This article presents the current outcomes of the research project Conformed Thought and Art in the Context of Algorithmic Logic and AI Procedures (FAPESP No. 2023/05500-3). The investigation was prompted by the generation of an unexpected image by an artificial intelligence system—a phenomenon often referred to as a "machine hallucination." This event serves as a starting point for analyzing the logical structures embedded in the conceptual and perceptual models that inform creative processes in computational contexts. The study also examines how artistic practices contribute to critical reflections on what we define as Conformed Thought, a concept developed in earlier publications [7, 8, 10, 11, 12]. The project proposes a representational model oriented by information processing that interrogates the epistemological and operational dimensions of computational algorithms, with particular attention to artificial intelligence. A central concern raised is that the indiscriminate use of AI-generated content in training datasets may lead to irreversible degradation of cultural production. The current stage of the research involves the development of an artwork based on the technical and aesthetic studies conducted so far.

Keywords

Artificial Intelligence, Signs, Logic, Art

1 Introduction

Faced with the generation, by an AI process[2], of an unexpected image, which could be identified as a "machine hallucination"[3], this work aims to analyze logical procedures in conceptual and perceptual models involved in creative processes, reflecting on art's contributions to what we call "conformed thoughts". The term "conformed thought" has been defined in several publications [7, 9, 10, 11, 12] as: codes and set of codes, norms, algorithms, standards, devices, interfaces, since they are the results of scientific concepts, texts, and theories and, therefore, updated forms of elaborated knowledge, with the ability to change habits and behaviors. This research is still in progress and can be described from the following arguments: in our daily lives, we extensively exercise and practice logical-abstract-symbolic reasoning, which we call 'conformed thoughts', self-controlled and deliberate, the result of concepts, models of knowledge of a culture or group, and this means that we are adapting and changing habits, behaviors, beliefs and actions based on these patterns. Consequently, this will cause changes in our way of thinking. The main interest is to present a representational model promoted by information processing that can point out questions about computational algorithms, artificial intelligence in particular. In summary, we have been studying machine training models in generative AI and initially; to understand the process, we proposed a simple task of generating images of apples.

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[2] In this article, Artificial Intelligence (AI) is a branch of computing that includes machine learning techniques that use a database, usually in huge quantities, to extract information and knowledge. We are interested here in techniques that make machines autonomous agents, that is, capable of acting without human interference.

[3] Sometimes AI algorithms produce outputs that don't make sense or are entirely inaccurate, either because they've been incorrectly decoded or don't follow an identifiable pattern. In this case, it is often said metaphorically that the machine has hallucinated. Machine misinterpretations occur due to several factors, including overfitting, bias/inadequacy in training data, and high model complexity.

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The idea, from the beginning, was not to use prompts or any labels that could indicate that the images used from a public image bank were of apples. The proposal was to work with a stable diffusion model, where noise is progressively added to an image until all that remains is random noise. Knowing how to identify the added noise, by its subsequent subtraction, the system can identify patterns in the images; and after the training phase, it will be able to generate images from the learned pattern. Interestingly, sometimes unexpected resulting images happened that could not be immediately accurately identified as an apple image, despite the database being only composed of images of apples. And in this process, we realized there was damage caused by the indiscriminate use of content generated by machine learning, leading to some irreversible damage in the resulting models, where the traces of the original content even disappear. Authors Ilia Shumailov et al. refer to this effect as “model collapse” [15]. Therefore, the research, at this moment, is concerned with these deviations caused by training from large-scale data, which will significantly affect our representational model.

Looking at Figure 1, we can immediately see that it is an abstract image, with some voluminous shapes, colors from an intense red to green, earthy tones, white. There is an exuberance of red, which carries a sensory charge in the image.

There is also an oscillation with the green tone, its complementary. And at first, we identified a background where the most voluminous shape centered on the image seems to be supported. We have no other information that can confirm whether this image was AI-generated, nor have we identified a label that may have been used.

However, one thing that was not expected from AI, when we started this research, was its ability to interpret abstract information like the one in this image. We uploaded this image to ChatGPT (OpenAI, 2024) and asked it to describe it. The answer was surprising from the beginning, when that image was defined as "abstract art". Not an abstract image, but art. After a formal description of the image, it added: "This type of abstract art can be interpreted in many ways, depending on the perspective of the viewer. The shapes and colors can evoke different emotions or personal memories. Overall, the image conveys a sense of intensity and dynamism".

We continue to question ChatGPT about representational aspects, for example, how to identify objects and forms in the image. At the end we asked if any fruit can be recognized in the image, and we received a new surprise with the answer: “(...) could be seen as something similar to an apple (...)”.

1 Initial Premises



Figure 1: Image generated by AI in a preliminary procedure to the representational model proposed in the research. Source: by Author.

Given this preliminary condition, the project we developed begins with the recognition of units of meaning in a representational model, based on things, objects, and models [10]. In this proposed model, in a process of representation we have 'things in themselves', 'objects', which will be objectified things (things in themselves only enter a communicative system while objectified), and 'models' of these objects.

Thus, in the proposed system, there will be minimum units of representation. However, it is not a simple linear system, nor is it a closed deterministic system. We have influences and new inputs, interferences and information inserted by the context, disturbances and changes caused by the path. But, one thing is objectified to participate in a communication system, which is transformed based on goals and objectives (and at this initial moment, the goals and objectives are given by external agents). Then the result is a concept of this object transformed into a model that will return to the system again by feedback (Figure 2).

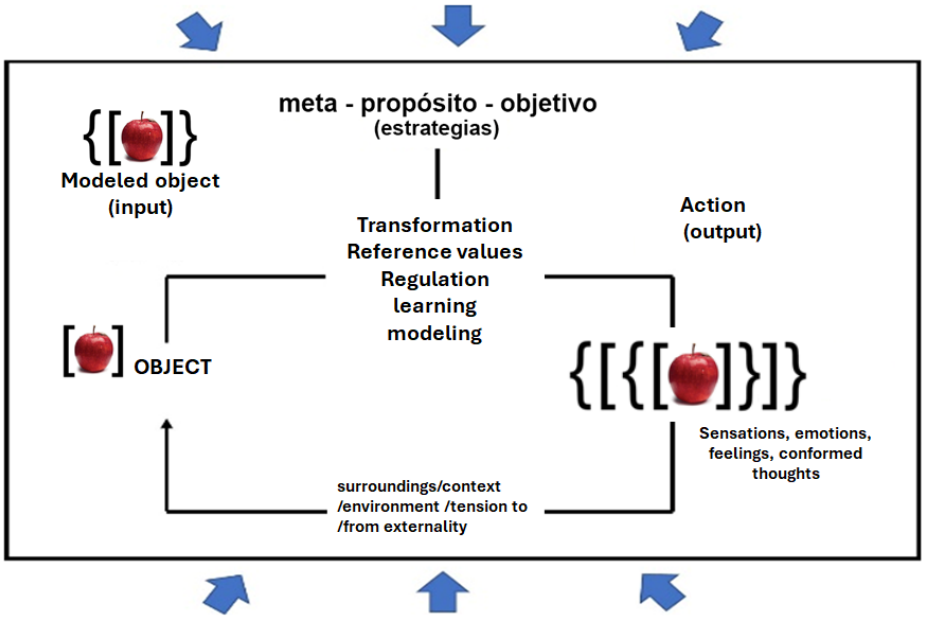


Figure 2: Basic system of representation based on the minimum units: things, objects and models, recognized as thoughts conformed to the diagram. Source: by Author.

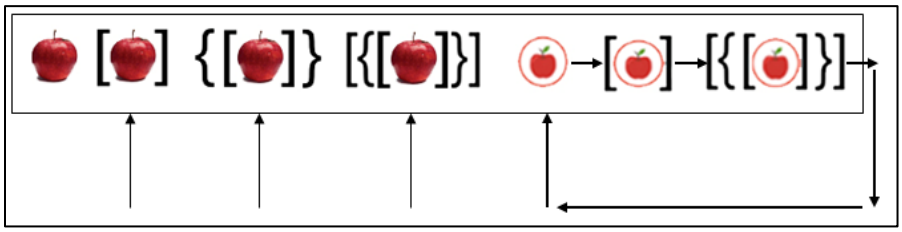


Figure 3: Interpretation of Vilém Flusser's Abstraction Climb, based on AI-generated images. Source: by Author.

2 Development

We follow by feedback, from the cybernetic model, where the process will move to the next phase, when the objectified thing will be transformed by an external purpose, generating results again, thus infinitely. Therefore, when we say that the purpose is ordered by agents externally to the system, it is different from when the system itself has autonomy to change its goals. But in any case, it is a complex system, which means that it may be capable of generating emergent patterns, and by entropy generate unpredictable behaviors, disorganization, or suffer technical or human interference, introduce randomness, information overload, among others.

According to Flusser, imagination is essential for our actions and understanding of the world [4]. However, at the same time, imagination is our ability to distance ourselves from the objects of the world. This movement of moving away and retreating objects can be called abstraction. There is an example in his book The Coded World [4] that deals with the inaugural gesture of creating images, when in prehistoric caves we find the figuration of a horse. Flusser says:

> "the first image setters had to move away from a horse, look at it and then fix this fleeting vision on the cave wall, precisely so that others could recognize it" [4, p. 162].

The fundamental question, Flusser continues, is: where do you go when you move away from the horse?

Then we have the image of a thing, then the explanation of that image of the thing, and then an image of that explanation, which will result in concepts and finally in the model of the object of the thing itself. I believe that Flusser's theory has already been widely disseminated, unnecessary to prolong this point. Our problem is that with algorithmic procedures, confirming the Flussean theory, imagetic thinking is becoming capable of re-elaborating concepts, capable of transforming concepts into objects, and becoming a meta-thought of a conceptual way of thinking [4, p. 118]. He also says that imagetic thinking starts to think about concepts, in the form of models [4, p. 118]. More categorically, he continues the next page that imagetic thought takes the place of philosophy, as a *metaprocessing* of concepts.

With AI – where we perceive a new dimension of Flusser's abstraction scale (Figure 3), the machine not only classifies and analyzes information, but also creates phenomena from the synthesis of numerous models. Therefore, the process continues, to the point that AI itself establishes new goals, objectives and habits, and in this case, by agents internal to the system, that is, it manages to establish new goals internally.

The consequences that this may cause in cultural production. And yet, AI is no longer just a tool or language and becomes an agent capable of carrying out technological mediations, influencing cultural production, promoting social interactions, generating new cultural paradigms.

This should be considered, before proceeding: the various possible approaches to AI: - as a Tool; - as a Language; - as Mediation; - as Culture.

In addition, a) as a tool, it can be used as an AI-assisted creative process, Human-AI co-creation, and fully automated creation; b) As a language, we can recognize a traditional style with AI, whether abstract or experimental, more photorealistic, and even as generative and interactive art; c) As technological mediation, we can approach AI through Natural Language Processing (NPL), as Adversarial Generative Models (GANs), as personalization and recommendation algorithms, as interaction and communication; and d) As culture, where AI acts as an influencer in cultural production, as a repository and cultural curatorship, as a cultural reflection (through biases, narratives, and dissemination of information), as a form of social interaction (social networks, bots, virtual assistants), as cultural ethics (privacy, surveillance, autonomy and control, Fake News), and as a creator of new cultural paradigms.

Which means, for example, that we are currently surrounded by platforms and social interactions impregnated by AI algorithms and that, we cannot stay only in the discursiveness of the technique, AI is now considered as a culture[4] and not just a tool. We must consider technology itself in cultural relational practices, by the social fabric in behavioral terms. Today, social networks already work with AIs, which shape us, and form our culture, and this is the basis of the principle of Conformed Thought that we follow in our project. This principle recognizes all these approaches to AIs.

Returning, after this quick clarification, from the abstractive escalation of representation in the diagrams to a representational model, we move on to the next step, which is to create a dynamic cybernetic machine based on a learning model, which will synthesize data to generate representational objects in a *metaprocessing* of/for the generation of "conformed thoughts". It is already clear at this point that there is a subtle difference between 1. if it has the image of something that is absent - and much has already been said about this (and I recall the principle of phantasmagoria); of 2. if it has a modelling process that metaprocesses and generates its own objectified models. In other words, we are not just saying that we have a simulation of the imagination [4, p. 169], in the face of the much-discussed question of whether or not simulation is representation [2, pp. 37-48]; nor citing the proposal of the digital to lead to a dimensionless condition [4, p. 176] with possibilities of information of infinite recombination and signal superpositions..., but, in addition, what we are adding in this process is the quasi- autonomy of the machine and decision-making.

From Figure 4 we can see the machine learning model, which we call metacognitive quasi-process[5],

[4] We cannot fail to recognize that AI is currently a producer of content on platforms, repositories, cultural curatorship, and acts in different forms of social interaction. Social networks with bots and virtual assistants interact with users on social media platforms influencing online discussions and behaviors. Not to mention ethical issues and the culture of the algorithm, biases, dissemination of information and Fake News.

[5] The concept of "metacognitive quasi-process" is presented in [14, p. 10]. Just to make it easier to read at this point, we can say that considering the representational system proposed in Figure 2, in Figure 4 the representational system starts to reevaluate its objectives and goals

presented in the project Conformed Thought and Art in the context of algorithmic logic and AI procedures [14, p. 10]. Thus, in the escalation of Flusser's abstraction, we go through important setbacks and distances to what we arrive at in the synthesis of a machine trained by concepts that will feed back into the system in *metaprocessing*, or metacognition. But it is worth a new regression, before the current phase, to approach AI processes, images of apples were generated from prompts in the main current AI generators, always with the same request: Generate an image of an apple. We can remember Baudrillard at this moment and his concept of Hyperreal, where the technical image becomes more real than the real, that is, an idealized representation of the real that starts to cause us real effects [1]. A reality produced by models, signs and images that no longer have direct reference to the real world, but that seem more real than real.

And what happens when hyperreality blurs the boundary between the real and the fictional? When the hyperreal becomes an epiphenomenon, that is, it becomes part of a mental imagery that causes an effect beyond that under its primary consideration. In other words, when do parallel and secondary phenomena take the lead to the main phenomenon and reestablish the parameters of reality?

In this way, we can already deduce that AIs incessantly produce and reproduce images and representations that replace direct contact with reality, reestablishing new parameters for reality. And, while hyperreal, considered an epiphenomenon as well as a superficial manifestation - let's call it that, of reality - AIs start to overcome barriers and give credibility to their images in an inversion of the representational process: the real phenomenon becomes secondary and superficial, since the machine places us at a distance from the objects of the world that confuse us between real and fictional.

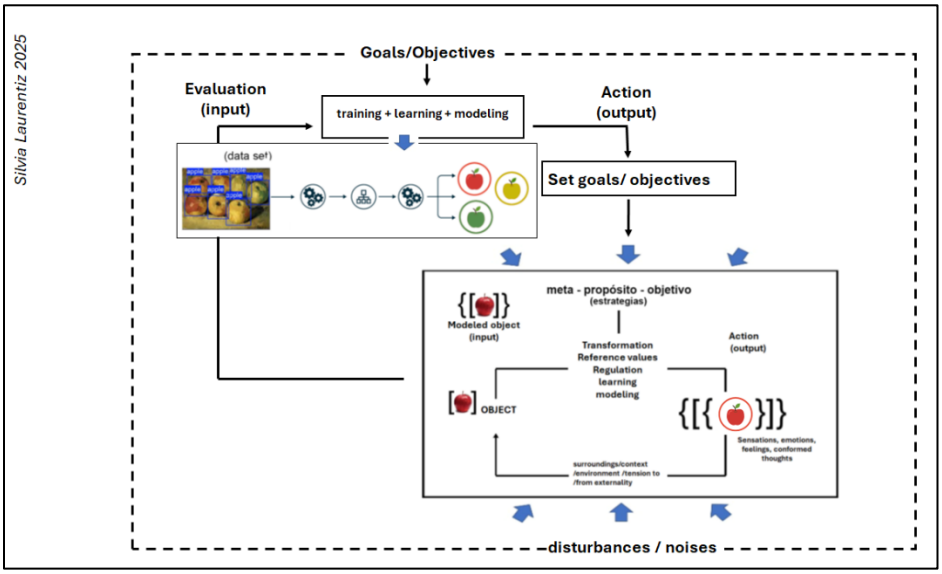


Figure 4: extended diagram for representational model using AIs. Source: by Author.

through the Machine Learning process. This means that the system makes its decisions internally, with a certain autonomy, without an order from an external system. In this case, the representational model processes itself, metaprocessing its data. In this paper, we consider metaprocessing of a representational system as a metacognitive process. Since it does not fulfill all the characteristics of cognition, we will call it "metacognitive quasi-process".



Figure 5: image generated in Stable Diffusion Online (https://stablediffusion.com/) - a free Artificial Intelligence image generator that efficiently creates high-quality images from text prompts. Do not confuse the technique of Generative Artificial Intelligence stable diffusion models. There are libraries and tools that can be employed to make it immensely easier to implement or use these templates, as is the case with this website. Source: by the Author.

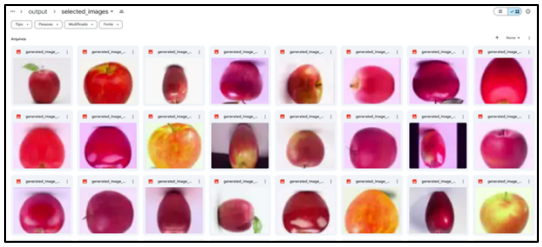


Figure 6: Images generated by the initial attempts of our machine learning model, stable diffusion. Source: by the Author.

Thus, the first phase of generating images by different generators currently available has always started from models already trained, exactly to perceive this dynamic, the blurring of borders. The models of DALL-E, Flux.ai, Krea.ia, ChatGPT, Stable Diffusion, were used at this time, and we can already perceive subtle differences between the different models trained, some more realistic, others more illustrative, or with some deviations, which further highlights the proportions and effects in current cultural production.

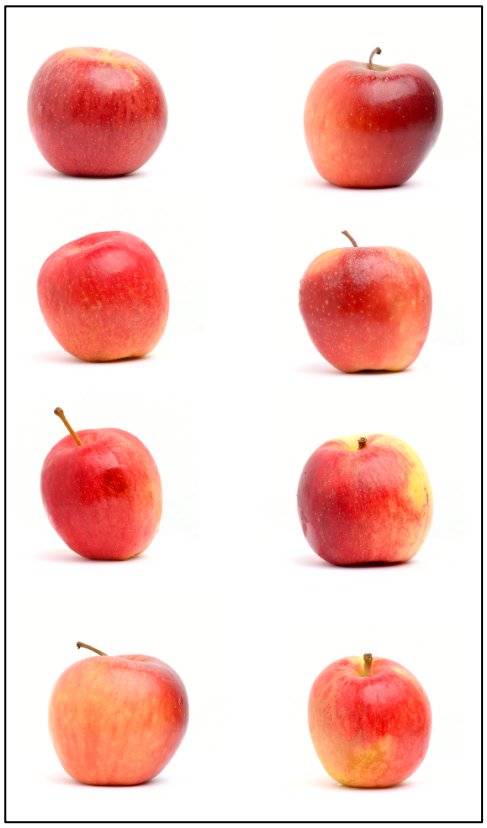


Figure 7: Images generated by our already improved machine learning model. Source: by the Author.

In addition to this preliminary process, using prompts in different trained models, in our research we have been training our own model, from a public database of apples. Again, in this case, we have not been using prompts or labels. It is a semi-supervised training system, where we have been working with a stable diffusion model (and we did not use the online stable diffusion, as used to generate Figure 5). We use a U-Net model, which are convolutional neural networks. Quickly, the amount of noise in the latent space is estimated and subtracted from the training image. This process is repeated several times, reducing the noise according to the steps specified by the programmer.

In this process of noise insertion and subtraction, the network gradually recovered patterns in the image, while changing parameters until different training results were achieved. We did not identify, for example, the same characteristics of the current market models, used in the

preliminary phase, because our model is a simplified version of machine learning. The idea was never to compete with large technology conglomerates, nor to achieve the same results, but to demonstrate the fragility and risks of these systems. Especially because this is theoretical research, which is based on practical experiments, and not the reverse.

Remembering that, after the training process, we moved on to a process of discrimination of those generated images that better represent the model from another trained network, now with the reference of apples defined by labels. This second network identifies among those images generated by our model, based on the following criteria: those with a higher level of confidence (we are establishing 90%), those with low confidence (below 90), and those not recognized. Of course, images with 90 to 100% confidence choose more realistic apples while the others are distancing themselves from an immediate apple recognition. But we remember that the discriminator used was trained with this profile, so the result will always tend to identify "more realistic" apples. Therefore, we can immediately say that the image presented in Figure 1 would be discarded. However, motivated exactly by that image, we also started to count those images with low confidence, as well as those totally discarded, because we are also interested in perceiving a latent space of the generated images. And, at first, images that end up falling short of expectations and present unexpected results are considered by some authors as 'machine hallucinations', and it is evident that to question a model of a representational system this can be interesting in the future.

Just to better exemplify the process, in Figure 6 there were the first attempts to generate images, still with adjustments and initial studies. In Figure 7 the model now generates more realistic apples images, but some inconsistencies and inaccuracies can be noticed.

3 Some Considerations

Some initial considerations after the initial testing phase with the prototype: - The algorithm efficiently generates and selects apples; - At each iteration it is possible to verify a change in the pattern of apple generation, motivated by the apples generated in the processes; - According to the initial plan, we were forcing the system to be fed back, returning to the initial base of the image bank those that were considered highly reliable in the first generation, after the model had already been trained. With the initial database expanded, new training is done. After this training, new images are generated, new discrimination, recursively, for at least 3 generations of images. This is consistent with Ilia Shumailov et al., when they demonstrate the same concern, right at the beginning of the article, that if the training data of most future models are also extracted from the web, they will inevitably train based on the data produced by their predecessors [15, p. 755]. In the final phase, it is intended to analyze the entire process again.

The focus was to provide feedback on the training continuously. If in fact, according to a 2022 EUROPOL Innovation Lab report, which predicted that 90% of online content would be generated by AI by 2026 [3], this, consequently, means that AI-generated images will feed back into all other systems and internet agents as well, and that they will fill our feeds. These images, crowding our access and search systems, will end up impacting on our representation models, proliferating images that are increasingly distant from their initial objects, causing an overload of information available with reduced quality. So much so that research conducted by Europol shows that the most worrying trends are in the evolution and detection of deepfakes and disinformation in general. Of course, everyone knows what a deepfake is and what legal, ethical, and moral damages are involved in this matter. In this project, in line with Flusser [4], we are interested in the passage from a thing that was objectified to a model, and this model later becoming an objectified model, which subsequently becomes a model of the model and that these processes carry levels of abstractions that are increasingly distant from the "thing in itself". This is the proposal of Flusser's abstraction scale and in our proposed model from a basic unit of representation we suggest that the process of modeling and learning would cause a *metaprocessing* of/for the generation of 'conformed thoughts'. In other words, when a discussion is initiated about false information (deepfakes, falsity of documents, misuse of images, invasion of privacy, alteration of data in political campaigns, generation of false criminal evidence...) created and distributed on the network, ethical issues are easily detected by purposely participating in this process. However, our project raises the issue that even without being images generated by some dubious principle and in bad faith, something happens in the generation of images that will cause irreversible consequences in the representational system.

It is important to warn that in 2024 the 2022 EUROPOL report was contested and had an updated

version that replaced the previous version exactly at the point where they declare the expected future share of 90% of content synthetically generated by AI [3]. This information in the updated version was removed in 2024. Despite this, we still believe it is a worrying prediction. Even though it's not 90% of AI content, it's currently shown to be a significant number. In conclusion, in scenarios where new models are trained by data generated by other models, this can cause accumulated degeneracy. Over time we will have a loss of variety, fidelity and the ability to generalize. Especially because we are dealing with errors, biases and simplifications that accumulate, and with that, as Flusser predicted, the model moves further away from the things of the world. And, if before we sought to distinguish true information from false, when we start to deal with models, this seems to no longer make sense.

In addition, it is evident that closed systems that feedback infinitely tend to generate disorder and randomness by entropy, and this is also a cause for concern. In the next steps, in our model we intend to bring the contribution of the arts, allowing the system to adapt and compensate for the loss of information, in addition to containing a subjective bias of the object of the model. In this way, the architecture of the proposed system that comprises the generator, the discriminator, the clusterizer and the selector of images, we propose to intervene, guided by the motivation of the project Conformed Thought and Art in the context of algorithmic logic and AI procedures, bringing a bias of art to the next stages of the work.

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Abstract Language Model — Exploring the human machine relation by using artificial neural networks as a tool for creating audio-visual artworks

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Abstract

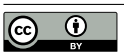
For *Abstract Language Model*, an artificial neural network was trained on the entire character sets represented in the Unicode Standard — over 65.000 characters contained within the Basic Multilingual Plane. The resulting complex data models contain the translation of all available human sign systems as equally representable, machine-created states including latent points, where the most accurate representation of the characters is achieved. Crucially, interpolation between these latent points becomes possible, enabling the generation of an infinite spectrum of intermediary forms between previously discrete characters, which can be understood as the emergence of a purely machine created semiotic system. The revealing of such "obscured variants" between the known characters points toward the conceptual possibility of a transitionless, non-binary universal language, which could be expressed by a self-conscious machine comprehended reciprocally by its human counterpart. The processes described above are visualized in the 4-channel video installation "Abstract Language Model (Sync)". Consisting of four synchronized visualizations with seven different states (Extraction, Analysis, Rearrange, Process, Transformation, Learning and Language), the audio-visual sequence is based on a real-time interpolation through the trained neural models, illustrating the transformation into a trans-human / trans-machine language. "Abstract Language Model (Live)" serves as the performative counterpart to the installation, presented as a 45 minute, single-channel audio-visual performance featuring real-time generated visuals and stereo sound. This paper details the artistic research and conceptual framework of *Abstract Language Model*, the technical development of the artificial neural network and the audio-visual implementation and presentation concluding with a critical discussion and evaluation of the resulting work.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Artificial Neural Networks, Unicode, Semiotics, Audio-Visual, Media Arts, Human Machine Relation, Language



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1 Introduction

This paper traces the evolution from a theoretical-artistic concept of an *assumed language model* to the conceptual refinement, applied development and eventual implementation for "Abstract Language Model", an audio-visual artwork using an artificial neural network as a tool for exploring the human machine relation. In dialogue with current discourses on artificial intelligence, on machine self-awareness and the prospect of co-existence within a hyper-technological environment, the project proposes a speculative framework for a common language between humans and machines, grounded in a shared semiotic system. The audio-visual artwork functions as both medium and method, offering a distinct artistic perspective through which to explore, embody, and critically reflect upon these critical contemporary issues.

1.1 From an assumed language model to an abstract language model

Previous works by the author, such as "Hypergradient (2016)" [1] and "Soft Takeover (2019)" [2], explored the conceptual premise of an assumed language model for self-conscious machines and their potential forms of expression. These works utilized a custom-developed semiotic system ("which can be described as a deputy for all known semiotic systems" [1]), composed of patterns and movement sequences defined by a set amount of so called *binary states* (represented with 13 linear actuators used for *Hypergradient* and 81 linear actuators used for *Soft Takeover*), which then facilitated the kinetic movements of the physical installations, enabling what was conceived as the "language" or "communication" of the machine. The conceptual framework for these works was informed by the theoretical writings of Winfried Nöth, particularly his engagement with Charles Sanders Peirce's notion of semiosis. As Nöth reflects: "What is a semiotic machine? A robot, a computer running programs endowed with artificial intelligence, any computer, a simple calculating machine, or even an ordinary mechanical typewriter? (...) Peirce, long before the advent of computers, showed on the one hand that machines can certainly participate in processes of quasi-semiosis, but on the other hand that human minds, to a certain degree, can also operate like mere machines." [3] Also the texts

and theoretical work on semiotics by Umberto Eco (for example "A Theory of Semiotics (1976)" [4]) provided a critical foundation for the development of these pieces. A related exploration of human machine communication is evident in "Offset XYZ (2018)", which builds on the same semiotic principles but emphasizes behavioral and non-verbal dimensions. As the author describes: "Every position and movement has to be read as encrypted words and sentences, *its* semiotic system or language: an attempt for seeking contact from the self-aware becoming *machine* trying to be understand by its unknown environment." [5] To strengthen the perceptual connection with human observers, this *machine* was designed using the *Modulor Man* by Le Corbusier [6] as a proportional model, aligning its form with scheme-conditioned human perception as much as possible.

Advancing this artistic inquiry of an *assumed language model* which would facilitate communication between humans and machines — without the need for translation due to an already shared semiotic system — the research and development of an *abstract language model* aims to generate a machine created semiotic system, which is based on all existing human signs, but transferred into and recreated with a trained artificial neural network for enabling a universal trans-human / trans-machine language.

1.2 Transforming the theoretical research into an audio-visual artwork

To comprehensively present all aspects and results of the development and training of the artificial neural network, as introduced in the following chapter, the artistic medium selected to portray this process was an audio-visual work, in contrast to the kinetic physical sculptures utilized in previous works. This decision was guided by a combination of conceptual and practical considerations: first, to align the medium of expression with the virtual environment in which artificial neural networks inherently operate; second, to visualize the underlying processes in a way that is simultaneously abstract-didactic and artistically pedagogical; and third, to extend the authors ongoing engagement with audio-visual works. As conceptual, aesthetic and also sonic references in the field of audio-visual (media) art, the work of German artist Carsten Nicolai and Japanese artist Ryoji Ikeda are significant influences. Nicolai's "unidisplay (2012)", for instance, "employs visual semiotics to examine various theories of perception" [7] and reflects how his work translates scientific phenomena and digital errors into minimalist soundscapes and visual forms. Ikeda's work, by contrast, transforms vast datasets into overwhelming audio-visual installations, for example "datamatics (2006)", which uses "pure data as a source for sound and visuals *(and)* combines abstract and mimetic presentations of matter, time and space" [8]. Also of relevance is the work of German artist and engineer Robert Henke, whose practice serves as a source of inspiration — particularly "Atlantic Waves (2002 - 2007)" — an "improvisational audiovisual network performance based on a self-written network sequencing application" [9]. Additional influences in the realm of generative visual aesthetics and concepts include the art practices of Vera Molnár and Manfred Mohr, whose work laid foundational principles for computer-based visual abstraction.

The following chapter outlines the technical requirements for data collection and the subsequent training of the artificial neural network. Special emphasis is placed on the processing of the character code points, their conversion into image data and the implementation of interpolation through the resulting trained models. The subsequent chapter then addresses the conception and realization of the project as both a live audio-visual performance and as a 4-channel video installation. Here, the seven different states of the audio-visual narrative structure will be introduced, followed by the synchronized implementation with the before created trained models and the final development of the visual and aesthetic presentation.

2 Collection of data and training the artificial neural network

As previously outlined, the evolving use of semiotic systems in the author's earlier works to conceptually define a machines own language was still the product of human conceptualization rather than a machines own creation. Between 2021 and 2022, the idea started to take more concrete form about how a *universal language* between humans and a machines could be facilitated: it would be based on a shared semiotic system, eliminating the need for translation and thereby avoiding information loss. Such a common system for language also would presume its existence in both the physical and virtual-digital domains and would not necessarily need to be stated verbally, but could be expressed and understood in both realms equally. It also should contain the whole existing structural and semiotic information of the human system and the machine system in order to include every particular aspect of each side in this process: the basis for a trans-human / trans-machine language.

Nearly all of the existing written semiotic information of the human language is represented in the Unicode Standard, a character encoding standard maintained by the Unicode Consortium. The standard is "designed to support the use of text in all of the world's writing systems that can be digitized and (. . .) defines 154.998 characters and 168 scripts used in various ordinary, literary, academic, and technical contexts." [10] It encompasses the vast majority of all ever written characters or signs by humans and thus can be considered a highly suitable representation of the human side for the development of *Abstract Language Model.*

Conversely, the current technology of machine learning and artificial neural networks contain the culmination of all history of computer and (intelligent) machine developments since their origin at the beginning of the 20th century. It can be argued that this technological complex may be interpreted as a general *machine language*, which includes all structural and informational data of the machine side. Admittedly, this technology is not solely created by a machine but based on thoughts which initiated in a human mind, thus echoing the initial paradox identified above. Nonetheless, it is the closest approach for the representation of a purely machine based system for the development of *Abstract Language Model.*

2.1 Identifying character code points and processing as image data

To prepare all characters included in the Unicode Standard for training with the artificial neural network and to facilitate the systematic collection of data from publicly available sources, it was determined that the characters within the Basic Multilingual Plane [11] (BMP), comprising approximately 65.000 code points, would serve as the reference set. Based on the Unicode Charts [12], which provide detailed positional information for each character (for example "U+0041" references the Latin Capital Letter A or "U+1843" the Mongolian Letter Cha) in the standard, the next step involved identifying fonts which are able to reproduce this references as a visual depiction.

Noto Fonts by Google [13], a free typeface released under the SIL Open Font License, was selected for this purpose. Designed and conceived to cover all scripts and characters encoded in the Unicode Standard, the Noto font designs "are harmonious across scripts but retain the authentic flavors that make each script special" [14] and thus were the perfect choice for rendering the before collected references into 1024 x 1024 RGB images. Using the sans serif variant of the font for better legibility, nearly 95% of all characters could be extracted using this method; for the missing or not included characters in the Noto font, supplementary variants could be depicted with the Arial font, which is one of the most comprehensive and widely used font families, originally released in 1982 and pre-installed on most Microsoft and Apple operating systems.

The before mentioned rendering as a 1024 x 1024 RGB image was processed using the respective TrueType font (TTF) files and the extracted available Unicode characters in the font through a Bash script, which resulted in text files with a line break (¬) after each character (for example "0baf ௯ ¬0bb0 ௰ ¬, etc." in NotoSansTamil.txt for the Tamil U+0B80..U+0BFF block). These text files were then manually reviewed to remove duplicates and subsequently converted into image files using Python and its included PIL library [15]. This process yielded a total of 56.528 distinct characters which could be rendered using this procedure. The discrepancy between this number and the theoretical available 65.536 code points can be attributed to several factors, including a few unallocated blocks in the Unicode Standard, not designed characters in either the Noto or Arial font family (nor other font families included in the research) or a non-functionality of processing it with available text editors or Python interpreters due to the rare use of these characters.

2.2 Setting up the artificial neural network and training with the image data

As of 2022, two principal open-source options on how to setting up an artificial neural network locally in order to train image data were widely available. TensorFlow [16], developed by the Google Brain team, is a well-documented and widely adapted software library supporting machine-learning and artificial intelligence projects across multiple programming languages, including Python, JavaScript, C++ and Java. PyTorch [17], on the other hand, is based on the Torch library (originally developed in 2002 as a scientific computing framework for the LuaJIT [18] compiler) and has been actively developed and maintained by Meta (formerly Facebook) since 2017. It offers similarly extensive documentation and robust functionality for Python and other major scripting languages. After preliminary testing, PyTorch was selected as the preferred framework for the development and overall integration of the *Abstract Language Model* project.

Based on a default project from the PyTorch documentation, utilizing a Variational Autoencoder [19] (VAE) architecture with an encoder / decoder structure (as opposed to a Generative Adversarial Network [20] (GAN) architecture with a generator / discriminator technique), the first version of the neural network was implemented. The neural network was trained locally using a system equipped with an NVIDIA RTX 3060 GPU (CUDA-enabled [21]) and an 11th-generation Intel Core i7 processor with 32 GB of RAM. To optimize computational efficiency and reduce unnecessary training time, prior to the import into the neural network the image data was first converted to Grayscale (8-bit depth with no information or contextual loss since the content itself was black characters on white background instead of using 24-bit RGB) and downscaled to 64 x 64 pixels. The full dataset of 56.528 characters was divided into 48 batches with a more or less equal distribution (~1200 samples per batch) according to the Unicode charts. Importantly, this strategy aimed to receive models which try to represent all language scripts equally independent from their quantity (128 code points for Basic Latin as opposed to 20.992 code points for CJK Unified Ideographs (Han script)). Each batch was trained using a learning rate of 0.0001 (0.01%) per step over 5.000 epochs, with each batch requiring approximately 24 hours of training time (a total of ~6 weeks training time on this before mentioned hardware), saving the trained models with included weight parameters as a .pt (PyTorch model) file.

2.3 Interpolation through the resulting models

To utilize the visual output generated by interpolating across the two-dimensional latent space of the trained models — an essential component of the audio-visual work described in the following chapter — it was necessary to map the XY coordinates of an given input to receive the visual sample of the current position within the model's latent space. This functionality was developed with Matplotlib [22], a widely used data visualization library for Python and temporarily with the computer mouse as an input for XY coordinates. Through experimentation, it was determined that the optimal coordinate range for meaningful interpolations extend from -5 to 5 along both the X and Y axes, where most of the latent points (yielding into the most accurate representation of the original input data) are aligned (Figure 1).

For real-time integration with TouchDesigner [23], the software used for developing the audio-visual work, the XY coordinates are transmitted via the OpenSoundControl [24] (OSC) protocol into the Python application, where the image texture of the current interpolation is then returned via a custom Shared Memory [25] application (developed by a long term collaborator which is known for his work on OsciStudio [26]) with nearly zero latency. For the development of both the audio-visual installation and the live performance, a curated subset of 16 trained models was selected (to ensure an equitable representation of all language scripts independent from their quantity, as previously discussed), which can

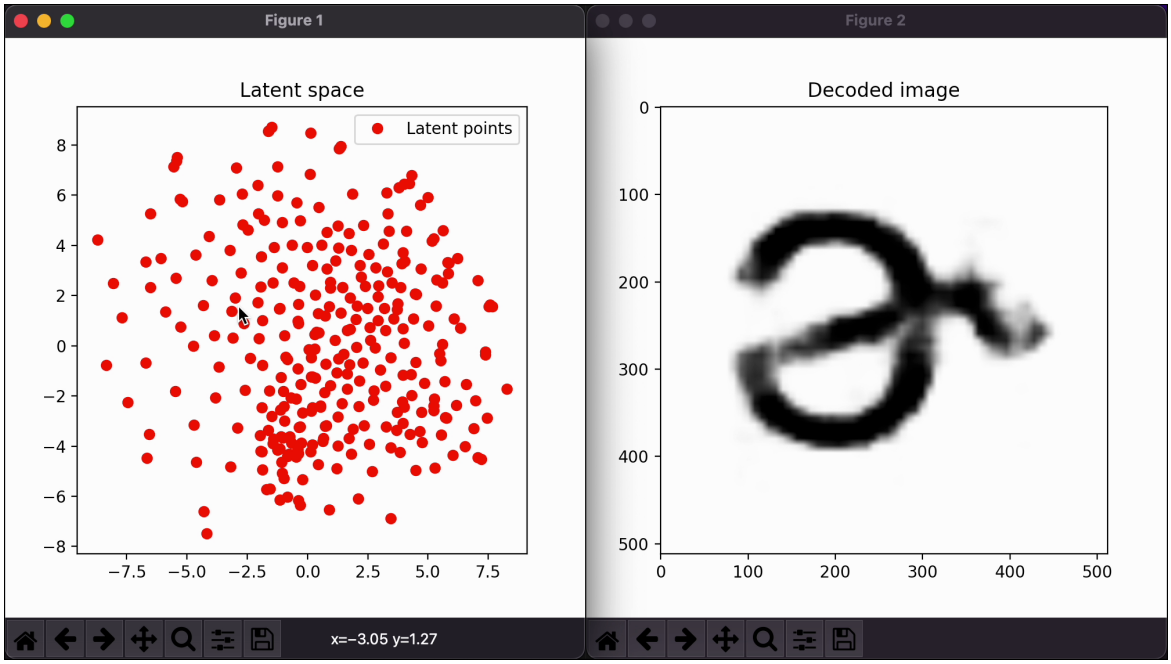


Figure 1: The depiction of the interpolation through the trained artificial neural network with Matplotlib. On the left side the mouse cursor triggers the XY coordinates which show on the right side the visual output of this position. [Courtesy of the author]

be accessed and switched in real time via OSC. The full set of 48 models, however, is employed in other works based on *Abstract Language Model*, such as "Semiotic Interpolations (2023)" [27] and "Obscured Variants (2023)".

3 Conception and implementation as a live audio-visual performance and a 4-channel video installation

The previously described interpolation through the two-dimensional latent space of the trained models — or more precisely, through the emerged "machine-created semiotic systems" — served as the conceptual and technical foundation for an audio-visual narrative sequence with variants as a live performance and a 4-channel video installation. Parameters for the XY coordinates (float constants) with automatic behavior (sparse noise) and manual selection for velocity and easing, the selection of the models (0 to 15 integer constants) with options for a linear or instant transition between the selections and a frame rate trigger (60 updates per second) were sent from TouchDesigner into the Python application, which processed the actual interpolation in real time and returned the current state as a 64 x 64 pixel RGB image texture back into TouchDesigner. This basic setup formed the core infrastructure for each of the seven distinct states comprising the audio-visual narration.

3.1 Conception and development of seven different states of the audio-visual narration

To articulate both the conceptual premise of a trans-human / trans-machine language and the practical implementation and processes of the artificial neural network for *Abstract Language Model*, the audio-visual sequence is structured into seven distinct narrative states, which are briefly described from a conceptual perspective and the subsequent transformation as a visual representation. Throughout the whole presentation of both variants, overlayed microtext showing information data of the current state together with white grids and enclosing outlines are aesthetic choices and reference the previous works of the author. Additionally, ultra-short white or red flashes punctuate key moments to highlight transitions or emphasize specific events within the narrative.

3.1.1 Extraction. This opening state focuses on the acquisition of the code points from the Unicode Charts and the following extraction of inherent information like shape, spread and depth mapping from the corresponding image texture. Characters from across all collected systems are presented in a grid, which is arranged from large scale to granular on a subtly rotated 3D plane. Animating the depth data as a point visualization through instancing mode of a Geometry COMP with subtle coloring from a RGB simplex noise, the sequence gradually transitions from abstraction towards a more concrete visualization, whereby the high-angle view camera follows this rhythm with ease in and out trackings on the Z axis. At times, the point visualization is also supported by an overlaying point grid, dynamically responding to the depth data and reinforcing the overall visual structure.

3.1.2 Analysis. The second state delves into the process of evaluating and analyzing the before extracted information on a more detailed basis. The camera is now based on the previously introduced 3D plane and slowly navigates through a morphing landscape of distributed point grids, animated by interpolations from selected models, whereas on the top of the canvas the point visualizations remain visible. As the camera reaches the center of the plane, the point grid changes into a shimmering surface (using a Phong shader with the already introduced RGB simplex noise as color map), which evokes a "melted semiotic space", referencing the dissolution of the human-constructed system.

3.1.3 Rearrange. This phase involves the reorganization of the extracted and analyzed data in preparation for processing and the transformation into the machine-created representations. All characters reappear again in rapid, staccato sequences, transforming from concrete depictions to a purely flat representation as white and black squares, reorganizing themselves reminiscent to the weights notion of an artificial neural network. The camera switches now to an orthographic top-down perspective, revealing the full 112×64 unit grid. Toward the end of this sequence, the grid dissolves into fragmented clusters, which eventually compress into a single point (nucleus), marking the conceptual emergence of the new "machine-created semiotic system".

3.1.4 Process. This non-linear state is divided into short distinctive sequences throughout the whole presentation, displaying the latent points and the current state of the interpolation of selected models in a 2D and 3D visualization. The granular depictions contain the aesthetic equivalent of the before introduced scientific depiction of the trained models with Matplotlib and also symbolized illustrations of the behavior of layers and nodes during the training of the neural network.

3.1.5 Transformation. Emerging from the compressed nucleus of the "rearrange" state, this phase initiates an expansive eruption of derivatives. It oscillates between recognizable shapes of some characters and volatile point clouds, which try to transform into ever-new formations. These evolving structures shift around and attempt to organize themselves more and more into connected arrangements. Visualized with a composition of animated Noise TOPs for translation and coloring (separated RGB channels) and the before described instancing mode of the Geometry COMP as a particle system, the new system culminates in a superstructure created from over one million color particles.

3.1.6 Learning. Once established, this before described superstructure immediately dissolves again into new arrangements, formations and animated manifestations during the "learning" state. Occasionally, a subtle hint of a known shape still appears as an alienated echo of its origin. Developed primarily using the feedback technique, the existing particles ("a universal equivalent of characters") coalesce into a more kinetic depiction of organized organisms or connected frameworks ("universal equivalents of words and sentences").

3.1.7 Language. The final state presents the visualization of the fully formed "(universal) language" as an ever-changing and infinite-evolving structure of interlinked particles, alternating between individual and collective behavior. The visual aesthetic ultimately transforms from the separated RGB depiction into a more harmonious and soft interpretation with all nuances of the color spectrum.

3.2 Implementation as an audio-visual live performance

The individual control parameters governing each narrative state and their associated visual characteristics were systematically identified and consolidated as global scene parameters (mapped float and integer constants with variable ranges). Parallel to the visual development, a soundscape was created using Ableton Live [28], which — although not elaborated in detail here — served as the main sequence to compose the sonic and visual components into a cohesive 45 minute performance [29]. To enable precise synchronization between the before identified parameters and the evolving audio timeline, the TDAbleton [30] tool was integrated both into Ableton Live as well as into TouchDesigner. The tool linked automation curves or audio levels from Ableton Live with the float and integer parameters controlling the visual presentation in TouchDesigner. At times, also converted visual data from the interpolation of the trained model is sent into Ableton Live and sonified using Abletons internal software synthesizers or Massive X by Native Instruments, whereby the resulting sounds are integrated in real time with the composed soundscape. The final soundscape of the performance was compiled into seven individual tracks (corresponding to the seven states as introduced before) and also released separately as an audio album. The hardware setting for performing the audio-visual performance live consists of a laptop with a dedicated graphics card running TouchDesigner and the Python application and another laptop running Ableton Live with an external MIDI controller for the manipulation of parameters during the performance and an external audio interface. The two systems are connected via Ethernet to enable real-time synchronization between sonic and visual elements. Additionally, the TouchDesigner laptop provides a DMX [31] output, allowing external lighting systems — subject to availability at the performance venue — to be synchronized with selected moments of the performance.

3.3 Extending the audio-visual concept from single-channel to 4-channel

For the installation version [32] of *Abstract Language Model*, the previously described single-channel audio-visual sequences (originally developed in a resolution of 2560 x 1440 or 2K) were expanded into a synchronized 4-channel configuration (4x 1920 x 1080 or 4x 1080p). With a total loop runtime of 12 minutes, a total of 48 minutes audio-visual content was rearranged or newly created to utilize the full width and the spatial setting of the multi-screen installation format. While several segments from the live performance appear identically within the installation — now presented simultaneously across four synchronized displays — other parts were specifically adapted to span over more screens at the same time and create a synchronized behavior on two or four screens. This spatial redistribution also introduced a new layer of compositional logic not achievable

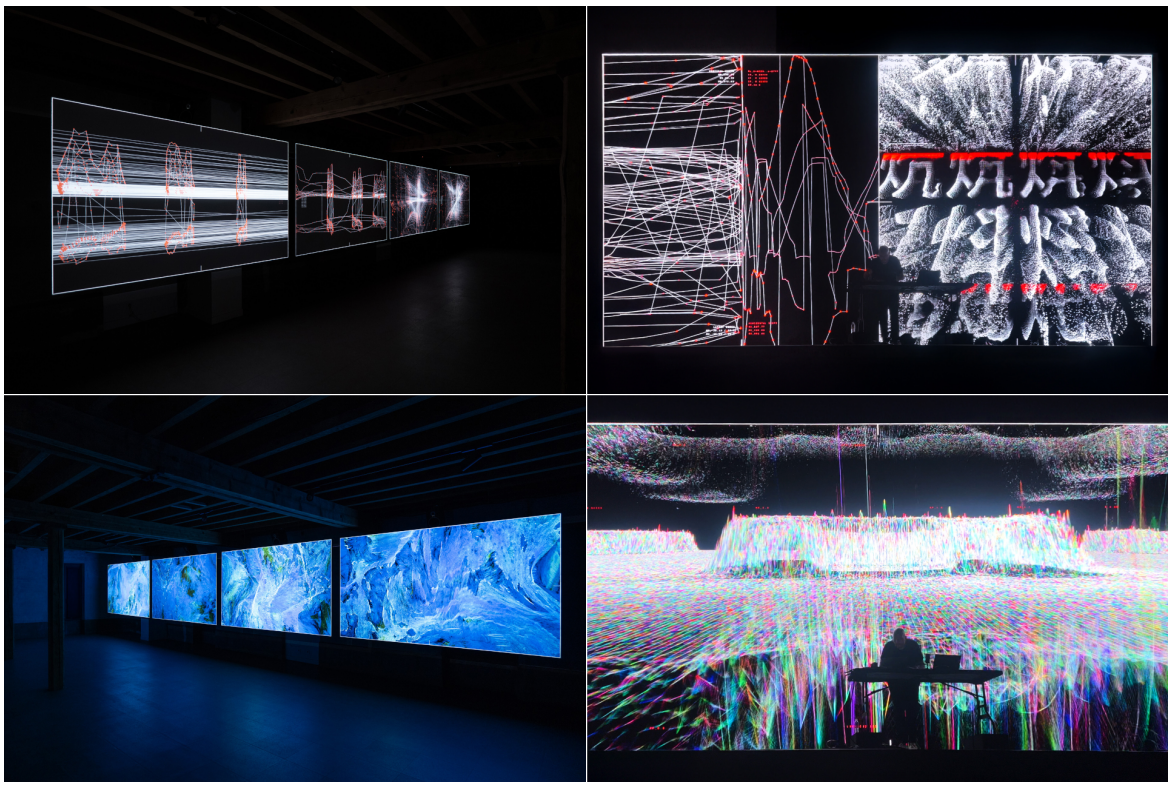


Figure 2: Scenes in-situ from the 4-channel installation (left side, [Courtesy of the author]) with the "process" and "language" states and the live performance version (right side, [Danny Arens]) with the "process" and "analysis" states.

in the single-channel format, foregrounding the dialectic between simultaneity and fragmentation as an additional structural element of the installation version. The individual assets were arranged and composited using video editing software, synchronized with also re-edited sound and ultimately rendered as a full sequence with a resolution of 7680 x 1080. The hardware setting for showing the installation version consists of a desktop computer with four video outputs, running TouchDesigner as a media server and projection mapping and / or color correction tool, depending on the output setting with video projectors or LED screen modules (Figure 2).

4 Discussion

The initial artistic proposition and corresponding research — to develop a so called *language model* capable of facilitating communication between humans and machines without the need for translation, by means of an already shared *semiotic system* — have been successfully realized and articulated through two audio-visual artworks. These works serve both as practical implementations and as conceptual reflections of the idea behind *Abstract Language Model*.

However, in critically evaluating the outcomes of this research and the foundational concept itself, several important clarifications emerge as necessary. One might argue that the described implementation and development of the artificial neural network was limited to the training of visual depictions of characters, but did not consider the actual meaning, contextual background of the language or the intelligent linking of information to produce new generative output (as outlined also in Kate Crawford's and Trevor Paglen's publication *Excavating AI: The politics of images in machine learning training sets* [33]), which is typically assumed when referred to *language models* in commercially available products like ChatGPT or Gemini. In contrast to this commonly called *AI* applications, which generate text, images, audio and video based on trained data from billions of already existing samples whose origins ultimately were based in a human thought (with the bi-directional implications as mentioned in Joanna Zylinska's *The Perception Machine* [34]), the term *intelligence* is actually misleading. An artificial neural network excels in making connections between data points and in generating a meaningful output based on this data points, but an actual intelligent behavior also would include self-awareness, emotional knowledge, reasoning, critical thinking or conscious intuition, where neither of these characteristics are represented in the currently available applications. For example, if one were to ask ChatGPT whether it is self-aware and who it is, the system would likely produce a convincing response based on the data it was trained on. However, such a reply would still originate from a system grounded in human language and patterns of thought, rather than from any form of autonomous or self-reflective machine consciousness. And until today, the question of what constitutes "a

machines own thought“ or “a machines own will“ remains unsolved, because we try to explain it based on human concepts.

We could learn to understand this if we shared the same language.

Let us envision, for a moment, the steps necessary to transform this idea of a *universal human-machine language* into a practical reality. Based on the theoretical conclusions developed in this paper, it would first be necessary to collect and prepare comprehensive datasets encompassing all aspects of human knowledge — extending far beyond the sole representation of human semiotic systems, as exemplified with *Abstract Language Model*. A preliminary challenge concerns defining what constitutes *human knowledge*. This notion includes not only written and in any form documented aspects of human existence but also non-describable or non-physical elements of human experience — for example, “What does an emotion induced by music feel like?” or “How can the aura of a human being be described?”. For the sake of this thought experiment, let us assume that a method is found to capture and transform all *human knowledge* into an appropriate data-representable equivalent. The definition and collection of *machine knowledge*, however, would represent an even greater challenge. As discussed in chapter 2, any current attempt to define *machine knowledge* would necessarily reflect a human perspective on machine existence, rather than a machine’s self-referential description of its own reality within its native communicative framework. One might nevertheless argue that since machines originated from human invention, a comprehensive inclusion of all documented developments in computing and (intelligent) machine systems since their inception could serve as the best available approximation — at least until a more intrinsic method of representing *machine knowledge* emerges.

Once both *knowledge datasets* were prepared, a method for integrating them without any information loss would be required to establish a shared semiotic system. In case of the here described work, the convergence process is realized through the current technology of artificial neural networks, culminating in the *Abstract Language Model*. However, the integration of the entirety of *human knowledge* and *machine knowledge* into a shared semiotic system for a common (universal) language would likely necessitate an entirely new methodological framework, tailored to the format and structure of the resulting datasets from the before described collection and preparation process. Such a shared semiotic system would need to be communicable, transmittable, and intelligible in both human and machine contexts. This may, in turn, require a redefinition of the very concept of communication. Human verbal communication operates primarily through biophysical processes — immaterial information is transformed into sound or gesture, transmitted via wave oscillations (light, sound or electronic through non-matter) and then reinterpreted as immaterial information by another biophysical system. Machine communication, by contrast, relies on electronic signal processing, where immaterial information is encoded, transmitted through ultra-fast wave oscillations (light, sound, electronic through matter) and decoded into immaterial information once more. The shared principle across both systems appears to be the *immateriality* of information and its transfer through *oscillatory waves*. This commonality could serve as the conceptual basis for a new communication model underpinning a universal human–machine language.

Since both domains would remain bound to their biological or technological embodiments, a new kind of a bio–technological interface or a wave-oscillation transformer would be required, designed to enable information exchange without any loss or transformation. Current developments in neural and brain–computer interfaces, such as those proposed by Neuralink [35], move in a different direction. These approaches merely translate wave signals from one communication system to another, primarily by extending the biological side with electronic augmentation, which diverges strongly from the idea of the proposed shared semiotic system. In the envisioned universal language, both humans and machines would already operate on a common informational basis, eliminating the need for translation. The challenge would instead lie in how to teach and establish this new language equally in both domains — a process likely to involve a prolonged transitional phase in which traditional languages gradually lose significance as the universal language emerges as the dominant mode of communication across humans and machines alike: human to human to machine to machine to human, a trans-human / trans-machine language. This envisioned language could, in some sense, be compared to something which exists already today human to human in form of the English language (a so called *lingua franca*, theoretically also the international auxiliary language Esperanto [36]), which is spoken and understood by a majority on this planet while preserving regional linguistic diversity. In conclusion, this thought experiment illustrates that realizing a genuine universal language for humans and machines remains an immensely complex challenge, dependent on future technological innovations as well as philosophical and ethical reflection. Yet the idea itself offers a compelling vision of what genuine mutual understanding between human and machine intelligences might entail. For now, it remains the task of artists, thinkers, and scientists to explore, test, and refine this vision, advancing the discourse and pushing its conceptual boundaries.

The longstanding interrelation between science and art has always involved mutual influence: art creating based on scientific concepts or discoveries and science expanding into art when a concept or discovery could not be proven yet. It is within this tradition that the work on *Abstract Language Model* must be situated. The idea of a common language between humans and machines remains a speculative one and far from being resolved in the near future. Even the emergence of so-called A*rtificial General Intelligence* (AGI) [37] will “only” replicate human intelligence in a machine or software. So, what is an intelligent and truly self-aware machine and how can we really understand each other? The provisional answer of *Abstract Language Model* lies in the convergence of *human language* and *machine language* (as previously described as “the current technology of machine learning and artificial neural networks contain the culmination of all history of computer and (intelligent) machine developments and thus can be seen also as some sort of general machine language”) in a meaningful way in order to receive a shared semiotic system, which can result in a new universal trans-human / trans-machine language. Therefore, the development and training of an artificial neural network using image data of characters — and the use of its results as a speculative concept for a common semiotic system — must ultimately be understood as an artistic gesture: a visual and sonic exploration of the theoretical construct discussed herein.

4.1 Continuation of this artistic research for a new audio-visual work

The audio-visual composition "Transphonic *(working title)*" will be the successor of the here described work "Abstract Language Model" and will explore the sonic-linguistic dimension of a machine-created semiotic system: an artificial neural network which is trained with all spoken characters included in Unicode. As of the time of writing (June 2025), over 8.000 voice samples have already been collected using the gTTS (Google Text-to-Speech) library. These audio samples will subsequently be transformed into spectrograms and then trained with an adapted neural network (processing of higher resolution image data). The resulting model will support interpolation and thus reveal infinite new or obscured versions between previously distinct spoken characters: the foundation of a sonic semiotic system, envisioned as a speculative step toward a holistic, transitionless universal human-machine language.

5 Conclusion

The evolution of the theoretical-artistic concept of an *assumed language model* — initially outlined in the introduction — toward the here described applied development and conceptual refinement presented in A*bstract Language Model* demonstrates a consistent trajectory within the author's artistic research and practice. Contemporary societal debates surrounding artificial intelligence, self-conscious machines or robots, and, more broadly, about coexistence and communication with a hyper-technological environment must also be addressed through artistic propositions, which try to find alternative ways to reflect on this complex themes.

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Lisbon MIL City within the A.I. Age

Interpreting Media Arts and Urban Heritage for Sociological Tourism and their Dissemination via a Digital Marketing Campaign

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Abstract

Objectives. The present project aims to position Lisbon as a leading destination for sociologically-informed tourism, through the Media and Information Literacy (MIL) Cities framework. In particular, Lisbon MIL City focuses on enhancing urban heritage, media arts and cultural tourism literacies at Lisbon, by addressing cultural barriers such as technological illiteracy, within A.I. contemporaneity. *Method.* The project's team is constituted with 4 Task Forces that will undertake both sociological case studies and MIL Cities metrics on diverse Lisbon areas and stakeholders. *Dissemination:* Such project content will be diffused via a digital marketing campaign, which targets diverse audiences, including citizens, researchers, students, culturally-curious tourists and migrants, among other stakeholders. *Results and impact.* It is necessary to note that the above-mentioned initiative is a work in progress, still without final results. Progressively, it intends to transform conventional tourism into a social medium for deeper cultural understanding and sustainable practices, ultimately establishing Lisbon as a local and global model for Sociological Tourism.

CCS Concepts

• **Applied computing** → Arts and humanities.

Keywords

Media Information Literacy-MIL Cities, Lisbon MIL City, A.I., Media Arts, Heritage, Sociological Tourism, Digital Marketing

ACM Reference Format:
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1 INTRODUCTION: WHAT THE PROJECT LISBON MIL CITY MEANS?

1.1 Core Objectives

The social process here depicted and the respective scientific project, aim to develop a comprehensive integration of social activities, practices and discourses, academic frameworks, measurable objectives and practical marketing strategies, in order to position Lisbon as a *Media and Information Literacy (MIL) City*, an urban paradigm explained below. This city model involves stakeholders such as start-ups and spin-offs that develop products and services to increase diverse media and information literacies, applied to communicative everyday practices at Lisbon. For this purpose, the project's team uses a *mixed methodology* that includes: (a) sociological tools; (b) MIL City instruments, which allow to detect *social and cultural barriers* (such as technologicism, technological illiteracy, ageing marginalization, ethnocentrism, etc), by using *MIL Cities Indicators*, e.g., "Indicator 5. Art, culture, tourism", and "Indicator 9: Artificial Intelligence-AI", within specific research fields located at Lisbon. Based on those findings, the research members promote new urban experiences, such as cultural tourism opportunities for visits at key locations at Lisbon, e.g., inside and *urban sample* that includes: Mouraria Creative Hub, Alcantara Senior University, Aljube Museum and public art sites. The project's dissemination campaign is committed to develop a strong emphasis on community engagement and academic collaboration. As for dissemination, a comprehensive measurement and evaluation framework will assess a *digital campaign*'s effectiveness, while a SWOT analysis identifies strengths, weaknesses, opportunities, and threats. This strategy integrates SEO best practices, social media engagement, and guerrilla marketing tactics, in order to maximize visibility and participation. Such diffusion campaign has a strong emphasis on community engagement and academic collaboration.

1.2 State of the Art and Specific Purposes

MIL Cities signifies a social and ethic paradigm of city transformation led by UNESCO, in the Age of A.I. [1]. This program was developed at several cities and Universities worldwide, by using, among other methods, a system of indicators assessing cultural barriers and related social phenomena such as A.I. spread, mainly organized at University of S.Paulo, Brazil, by Prof. Felipe Ortiz and colleagues [2]. One of MIL Cities initiatives is the emerging *project Lisbon MIL City*, co-coordinated by this text's author, who extensively and intensively studied such matters since 2017 to 2025 [3]. This project intends to work as a tool for more profound communication and social interactivity, via open research on cultural policies and politics, production and reception of innovations in urban heritage, via media arts and ethical A.I., in particular targeted to cultural tourism. Other purpose is to apply innovative methodologies directed to communities [4], that may contribute to the cultural-led urban regeneration in Lisbon [5]. And for undertaking



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such objective, the following text balances theoretical foundations with actionable plans, addressing cultural barriers (e.g., technological illiteracy) while leveraging Lisbon's heritage for sustainable tourism.

As mentioned above, the main aims and research questions addressed in this text, focus on positioning Lisbon as a pioneering Media and Information Literacy (MIL) City, through innovative tourism strategies, such as *Sociological Tourism.* This concept means integrating sociological frameworks into tourism practices, related to heritage and urban media arts, in order to foster deeper engagement with urban spaces by particular audiences (e.g., engaged citizens, academic researchers, culturally curious tourists, migrants and local communities), through alternative tourism experiences.

More *specific purposes* include, in order to transform conventional tourism: (a) Shift from superficial sightseeing, especially mass tourism into *innovative communicative tourism*, related to heritage and urban media arts, that may promote urban media literacy, using Lisbon's social landscape as a narrative tool; (b) Measure impact: Track visitor engagement, academic citations, and cross-cultural exchanges to evaluate success; (c) Bridge research and practice: Combine academic methodologies (e.g., sociological field research, PERT analysis, etc.) with accessible tourism offerings; (d) develop *experiential tourism* (e.g., geolocated narratives, augmented reality overlays, by addressing cultural barriers such as technological illiteracy).

In sum, the project intends to develop the following: Academic rigor: For example, some bibliographic references [6], [7], among many others, validate the project management, tourism models, and branding strategies. Market analysis and critique: Post-pandemic tourism trends (e.g., demand for authentic experiences) may directly support a planned campaign's focus on Sociological Tourism. Methodological depth: mixed-method approaches (field research, PERT analysis, SEO/social media tactics) ensure robust implementation. Impact measurement: on visitor engagement and economic growth that may demonstrate tangible goals. Innovation: guerrilla marketing (QR code plaques, pop-up cafés) and creative tourism (via AR overlays) differentiate the planned dissemination campaign.

1.3 Main questions

Some possible and pertinent departing questions are the following:

- How can sociological perspectives transform conventional tourism into a tool for media arts literacy?
- What strategies effectively bridge academic research and accessible tourism experiences?

How can Lisbon leverage its cultural heritage to promote sustainable, informed, communicative and knowledgeable cultural tourism?

1.4 Empirical Issues: Working Hypotheses and Key Areas for Field Work

Firstly, within the Lisbon MIL City urban empirical field, some situations must be previewed, through working hypotheses and applied activities. For instance, how does the fieldwork and campaign plan address cultural barriers in cultural tourism? Field research by task forces may identify such cultural barriers, e.g., technological illiteracy within Lisbon's social actors. These specialized task forces can develop as well practical solutions (e.g., media literacy tools for citizens, tourist and migrants). The project's team faces such challenges via the following targeted strategies, included within the Sociological Tourism paradigm:

- *Communicative Tourism*: Replacement of conventional sightseeing with immersive experiences (e.g., *AR and AI apps, geolocated storytelling*), to bridge cultural gaps.
- *Community Engagement:* Involvement of locals and migrants in workshops and pop-up events (e.g., *"Sociological Cafés"*) to foster intercultural dialogue.
- *Multilingual Content:* Offer of resources in multiple languages and use of *QR codes* for accessible, on-demand sociological insights.
- *Measurements:* Tracking of cultural barrier reduction via sociological surveys and stakeholder interviews.

In other words, by blending academic rigor with accessible formats, the project task forces transform cultural barriers into engagement opportunities.

Secondly, what *key urban locations* are highlighted in the study field work and campaign for Sociological Tourism? The project highlights several sample locations in Lisbon for its experiential and communicative tourism, including: Mouraria Creative Hub: A focal point for cultural and media literacy initiatives. Universidade de Alcântara Sénior: Engages senior citizens in Sociological Tourism. Museu do Aljube- Resistêncoa e Liberdade: Explores both historical and social narratives. Urban Art Sites: Showcases Lisbon's street art as a lens for social analysis.

1.5 Field Task forces

The project organizes various task forces aimed at enhancing urban literacy in Lisbon through entrepreneurship, interculturalism, and innovative literacy games. Task Force 1 focuses on start-ups and spin-offs that create products and services to boost heritage and media arts literacy, particularly in the context of communicative and cultural tourism practices. Task Force 2 addresses cultural barriers like ageism, by utilizing Media and Information Literacy (MIL) indicators related to education and the elderly. Task Force 3 examines communication strategies to overcome cultural barriers, specifically ethnocentrism, through case studies in museums, including Aljube, Resistance and Freedom Museum. It gathers metrics on diverse museum audiences, including locals, tourists, and migrants. Lastly, Task Force 4 emphasizes the development of e-books and applications that foster inter-knowledge between local and global communities, leveraging media and advanced technologies like AI and quantum programming. This task force also addresses cultural barriers such as technological illiteracy, using MIL indicators related to art, culture, tourism, and AI.

1.6 Further debates on methodology

The above-mentioned project references introduce key conceptual frameworks and institutional guidelines. Moreover, other authors provide precious contributions to support the methodology applied in the project. In effect, the following authors and their works, among others, bridge theory and practice, ensuring the project's credibility and alignment with contemporary research on heritage, media arts and cultural tourism literacies. For instance:

Project management methodologies, such as PERT analysis [8] are used for timeline and dependency analysis. As for Tourism Research, Ritchie [9] informs on impact measurement and sustainable tourism models. Marketing & Branding is analyzed by Aaker [10], and guides for the campaign's visual identity, guerrilla tactics and SEO/Social Media, may be consulted inside Lopezosa [11].

1.7 Methods to apply and expected results

As indicated above, the project employs mixed-method research approaches to achieve its objectives, combining qualitative and quantitative methods and techniques from Sociology and Marketing.

Task Force Activities: four specialized task forces develop these studies, activities and actions: Entrepreneurship for city literacy (metrics on start-ups); community engagement (surveys, workshops); digital platform development (SEO, social media analytics); innovative tourism design (geolocated narratives, AR overlays, AI apps).

Field Research: Conducted at Lisbon's Hub Criativo da Mouraria, Alcantara Senior University, Museum of Aljube and public art sites, by analyzing cultural barriers such as technological illiteracy and the respective solutions as start-up innovations in media literacy tourism.

Data Collection & Analysis: Quantitative: Visitor metrics (engagement rates, tour participation), economic impact assessments. Qualitative: Focus groups, ethnographic studies, and stakeholder interviews, in order to evaluate cultural understanding and media literacy improvements. PERT Analysis: Program Evaluation and Review Technique (PERT) maps project dependencies, identifying bottlenecks like field research delays (e.g. via a 46-week critical path).

Results & Findings: Market Trends: Post-pandemic demand for "authentic" experiences and cultural tourism growth. Anticipated outcomes: Projected increases in visitor engagement, local revenue and cross-cultural exchanges. Challenges: Policy cohesion, resource intensity, and measuring sociological impact remain hurdles.

In particular, the project dissemination and marketing soundly emphasizes practical outcomes (e.g., guerrilla marketing tactics, SEO-optimized content) and probable results are largely projected, with ongoing evaluation cycles.

2 A PRACTICAL ROADMAP: HOW TO IMPLEMENT AND ASSESS CONTENT DISSEMINATION AND DIGITAL MARKETING

2.1 Executive Summary

As previously stated, through comprehensive Social and Human Sciences methods such as *social storytelling*, the project team examines social structures, contexts, and practices, in order to transform how visitors experience Lisbon, through fostering deeper cultural understanding and supporting sustainable, informed and knowledgeable tourism practices. To complement such sociological and narrative lens, the project's marketing approach integrates SEO best practices, targeted social media strategies, brand development

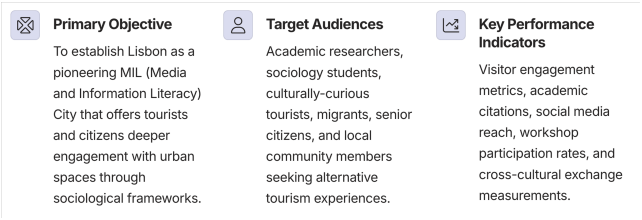


Figure 1: Project's objectives/audiences. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

for Lisbon MIL City, and guerrilla marketing tactics to maximize visibility and participation. The next pages provide a more detailed roadmap for the project's implementation, including task force activities, timeline projections, resource allocation, and evaluation metrics. By bridging academic research with tourism experiences, the following dissemination and marketing campaign will establish Lisbon as a leading example of how cities can leverage sociological insights to enrich tourism, while addressing contemporary social challenge. The MIL model has a specific complexity, and developments of MIL indicators and other tools will be presented in forthcoming publications.

2.2 Project's Overview and Objectives

The project uses a core instrument named "*Sociological Tourist Guide*", as a content production, dissemination and marketing campaign pillar, that aims to revolutionize tourism in Lisbon, by integrating sociological perspectives into visitor experiences. Our primary goal is to transform conventional tourism into a vehicle for MIL-Media and Information Literacy, while highlighting Lisbon's unique cultural and social landscape.

As above-mentioned, this campaign utilizes four specialized task forces to create a comprehensive approach to Sociological Tourism. Each task force addresses specific cultural barriers while contributing to the overarching goal of promoting media arts and information literacy through tourism. By integrating research methodologies with accessible tourism experiences, we aim to bridge the gap between academic Sociology and a Sociological Tourism based on practical cultural engagement with diverse social audiences (Figure 1).

2.3 Project's Implementation Timeline

Successful execution of such Sociological Tourism marketing campaign requires careful sequencing of activities across multiple workstreams. This section presents a comprehensive implementation timeline identifying key milestones and dependencies (Figure 2). The implementation follows a phased approach that balances thorough preparation with the need to demonstrate visible progress. The timeline spans 18 months from initial planning to full implementation and initial evaluation. Critical dependencies that require careful management include early stakeholder engagement to secure access to key research sites; timely completion of field research to inform authentic experience development; guide recruitment

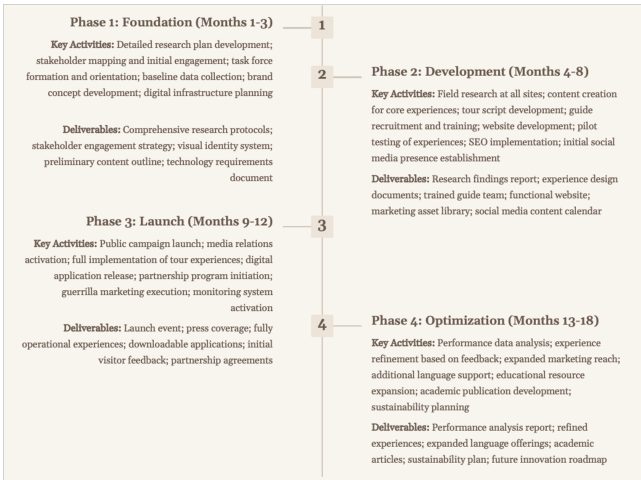


Figure 2: Project's Field Work Timeline. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*. This is an archive of social/logical data, including items with a specific hybrimedia format. Hybrimedia signifies the transformation of *originary* content into *original* content, by integrating text, images, sounds, videos, virtual/augmented reality, AI and quantum programming open code

and training preceding experience implementation; digital platform development supporting marketing and booking functions; community approval of representations before public release.

The project timeline includes strategic buffer periods around critical activities to accommodate potential delays while maintaining overall momentum. Quarterly review points will enable assessment of progress against objectives and adjustment of subsequent activities based on emerging insights and changing conditions. This implementation timeline balances thoroughness with urgency, recognizing both the need for careful development of our sociologically informed approach, and the importance of establishing a public sphere presence within a competitive tourism landscape.

2.4 Example of Sociological Sectorial Analysis: Tourism Trends in Lisbon

Lisbon's tourism landscape has experienced significant evolution in recent years, with important implications for Sociological Tourism substantive content production and diffusion campaign. Understanding current trends and projections is essential for effective positioning of our initiative.

Prior to the COVID-19 pandemic, Lisbon was experiencing unprecedented tourism growth, with annual visitor numbers reaching 4.5 million in 2019, representing a 75% increase over the previous decade [12]. While the pandemic caused a temporary decline, recovery has been steady, with 2022 figures reaching approximately 70% of pre-pandemic levels and projected to exceed 2019 numbers by 2024, according to European Travel Commission.

Significantly, post-pandemic tourism shows shifting patterns that align with the project's campaign objectives. There has been a 28% increase in tourists seeking "authentic" and "educational"

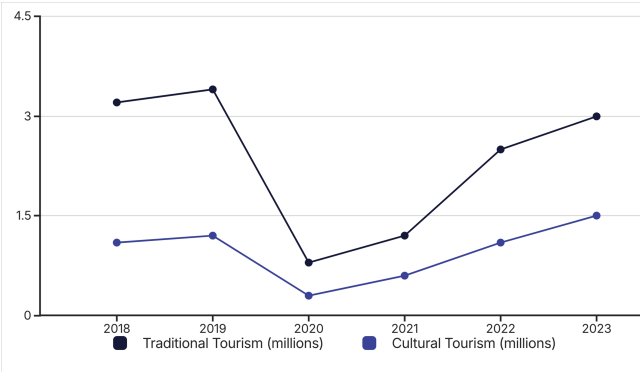


Figure 3: Market Analysis Tourism Trends in Lisbon. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

experiences over traditional sightseeing [13]. Cultural tourism has grown by 32% since 2019, with visitors spending an average of 15% more time at museums and cultural sites than before the pandemic [14] (Figure 3).

Other analyses also indicate that the experiential tourism segment is growing at twice the rate of traditional tourism in Lisbon, with a notable increase in visitors aged 25-45 with higher education backgrounds [15]. This is one of the demographic most likely to engage with the project's concepts and hypotheses on Sociological Tourism.

2.5 Measurement and Evaluation Framework

Comprehensive measurement and evaluation are essential for assessing the effectiveness of Sociological Tourism marketing campaign. The project's framework combines quantitative metrics with qualitative insights across multiple dimensions, in order to provide a holistic view of campaign performance.

For each task force, we will develop specific key performance indicators that align with their research objectives while contributing to overall campaign evaluation. These specialized metrics will include technological literacy improvement for Task Force 1, senior engagement measures for Task Force 2, intercultural exchange assessment for Task Force 3, and technology adoption rates for Task Force 4.

Data collection will integrate both automated digital analytics and structured research methodologies to create a comprehensive evidence base. The team will implement a quarterly evaluation cycle with formal reports providing actionable insights for continuous campaign refinement. Annual comprehensive impact assessments will synthesize findings across all measurement categories to assess progress toward long-term objectives [9] (Figure 4).

2.6 SWOT Analysis of the Campaign

A comprehensive SWOT analysis may provide critical insights into the potential success factors and challenges facing our Sociological Tourist Guide dissemination and marketing campaign for Lisbon. This SWOT analysis highlights the need to leverage our unique approach and expert task forces while addressing potential challenges in communication and implementation. The growing market for

Measurement Category	Key Performance Indicators	Evaluation Methods
Digital Engagement	- Website traffic and user behavior - Social media reach and engagement - Email marketing performance - Content download rates - Digital application usage	- Google Analytics implementation - Social media analytics platforms - Heat mapping and user recordings - Quarterly digital performance reports
Tourism Impact	- Visitor numbers at key locations - Tour participation rates - Length of stay at research sites - Repeat visitation patterns - Tourism revenue generation	- Visitor counting systems - Booking system analytics - Post-visit surveys - Economic impact assessment
Knowledge Transfer	- Learning outcome achievements - Media literacy improvement - Cross-cultural understanding - Sociological concept retention - Post-visit behavior changes	- Pre/post knowledge assessments - Longitudinal follow-up surveys - Focus groups with participants - Academic research publications
Community Impact	- Local stakeholder participation - Community perception changes - Cultural barrier reduction - Institutional partnership development - Media coverage quality and quantity	- Community surveys - Stakeholder interviews - Media content analysis - Partnership growth metrics

Figure 4: Measurement/Evaluation Framework. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

educational and authentic tourism experiences presents significant opportunities, though we must remain vigilant about economic pressures and competing tourism narratives [16] [17].

The present project will use these insights to develop mitigation strategies for identified weaknesses and threats, while capitalizing on our strengths and the opportunities present in the evolving tourism landscape. Regular reassessment of this SWOT analysis will ensure that the project's campaign remains adaptable to changing conditions (Figure 5).

2.7 PERT Analysis: Project Timeline and Dependencies

Program Evaluation and Review Technique (PERT) analysis is essential for mapping the complex interdependencies between the project's campaign elements and establishing a realistic implementation timeline. The critical path analysis indicates that the minimum campaign development timeline is 46 weeks, with the most significant bottlenecks occurring in field research, content creation, and digital platform development: [6] [8]. To optimize implementation, the present project will employ parallel processing for non-critical path activities and establish bi-weekly progress reviews to identify and address potential delays early. The following PERT analysis outlines the critical path for our Sociological Tourist Guide dissemination and marketing campaign.

Strengths	Weaknesses
- Innovative integration of sociology and tourism - Strong institutional partnerships - Access to diverse expert task forces - Alignment with UNESCO MIL Cities framework - Unique value proposition in tourism market - Established research methodologies	- Complex concept requiring clear communication - Limited precedent for sociological tourism - Potential perception as overly academic - Resource intensity of research components - Challenges in measuring sociological impact - Need for multi-disciplinary coordination
Opportunities	**Threats**
- Growing market for educational tourism - Increasing interest in authentic local experiences - Digital platforms for sociological storytelling - Post-pandemic shift toward meaningful travel - Potential academic and institutional funding - Cross-promotion with educational institutions	- Economic pressures affecting tourism budgets - Competing traditional tourism offerings - Political changes affecting institutional support - Potential resistance from traditional tourism sectors - Sustainability of long-term implementation - Cultural barriers to sociological concepts

Figure 5: SWOT Analysis. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

Task ID	Task Description	Duration (weeks)	Predecessors
A	Initial research and concept development	4	None
B	Task force formation and briefing	2	A
C	Field research at key locations	8	B
D	Data analysis and sociological framework development	6	C
E	Content creation and guide development	10	D
F	Digital platform development	12	B
G	SEO implementation and testing	4	F
H	Social media strategy development	3	B
I	Guerrilla marketing planning	4	H
J	Partnership establishment with local institutions	6	B
K	Marketing materials production	8	E, H
L	Campaign launch preparation	4	G, I, J, K
M	Campaign launch	2	L
N	Post-launch evaluation and adjustments	6	M

Figure 6: PERT Analysis. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

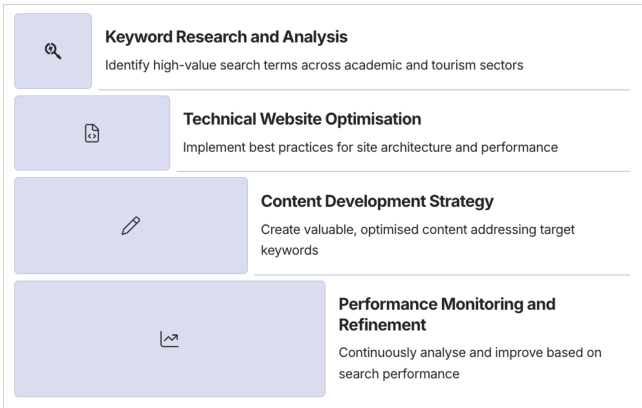


Figure 7: Social Media Strategies. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

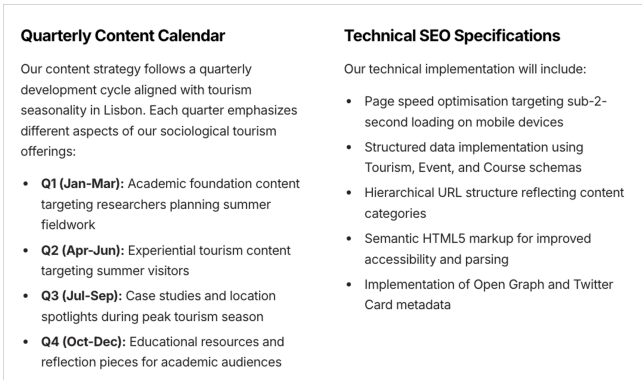


Figure 8: SEO Strategy Optimizing Digital Visibility. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

The project's *keyword research* has identified several high-value semantic clusters that bridge tourism and sociological interests. Primary target keywords include "cultural tourism Lisbon", "sociological travel", "Lisbon local experience", "authentic Lisbon tours", "Lisbon cultural immersion", "educational tourism Portugal", and "media literacy tourism". *Long-tail keywords* will address specific locations and experiences such as: "Mouraria Creative Hub tours" and "Portuguese dictatorship museum Lisbon" (Figure 6).

2.8 SEO Implementation: Content Calendar and Technical Specifications

Successful implementation of the project's SEO strategy requires both a structured content development approach and precise technical specifications. This section outlines our content calendar framework and details the technical SEO implementations necessary for optimal search visibility (Figure 7).

Technical SEO implementation will ensure that our digital platforms follow current best practices, including: Mobile-first responsive design optimized for tourism use cases; schema markup for tourism events, locations, and educational content; accelerated page loading through modern performance techniques; multilingual content with proper *hreflang* implementation (an hreflang tag tells search engines which language and regional version of a page to display); location-based structured data to enhance local search visibility. Content strategy will focus on developing comprehensive resource hubs around each task force's research areas, incorporating academic citations while maintaining accessibility for general audiences. This approach serves both academic researchers seeking methodological information and tourists seeking experiential guidance. Regular content audits will ensure continuous improvement based on performance metrics and evolving search patterns [18].

For each task force, we will develop dedicated landing pages with optimized H1-H6 hierarchy, semantic markup, and comprehensive content addressing primary research questions. These pages will serve as content hubs linking to more specific resources about methodologies, locations, and experiences. Key performance indicators will include organic traffic volume, search position for target keywords, engagement metrics, and conversion rates for tour bookings and resource downloads (Figure 8).

Local SEO will be particularly important for the research location-specific content. We will implement Google Business Profile optimization for each featured location, including Mouraria Creative Hub, Universidade de Alcântara Sénior, and Museu do Aljube. Each listing will include comprehensive information, 360-information, 360-degree photography, and regular posts highlighting upcoming events and new research findings [19] [20].

Backlink development will focus on establishing relationships with academic institutions, tourism authorities, and cultural organizations that can provide high-authority links to the project's content. This approach will build domain authority while simultaneously creating valuable partnerships for our broader marketing objectives.

2.9 Social Media Strategy Overview to Specific Platforms

The project's social media strategy creates distinct but interconnected approaches for each platform, maximizing engagement with our diverse target audiences, while maintaining a cohesive brand narrative across channels.

Content distribution will follow a strategic cadence across platforms, with each channel receiving unique but complementary content. We will maintain a 70/20/10 content ratio: 70% educational and experiential/innovative content directly related to Sociological Tourism; 20% curated content from partners and academic sources; and 10% promotional content for specific tours and experiences.

Community management will be crucial for building engaged audiences. Each task force will contribute to content development within their expertise areas, ensuring authentic voices across all channels. Dedicated community managers will facilitate dialogue, respond to inquiries, and identify partnership opportunities arising from social engagement [21] [22].

Social listening will be implemented across all platforms to identify emerging conversation topics, monitor sentiment monitor sentiment around the project initiatives, and assess the effectiveness

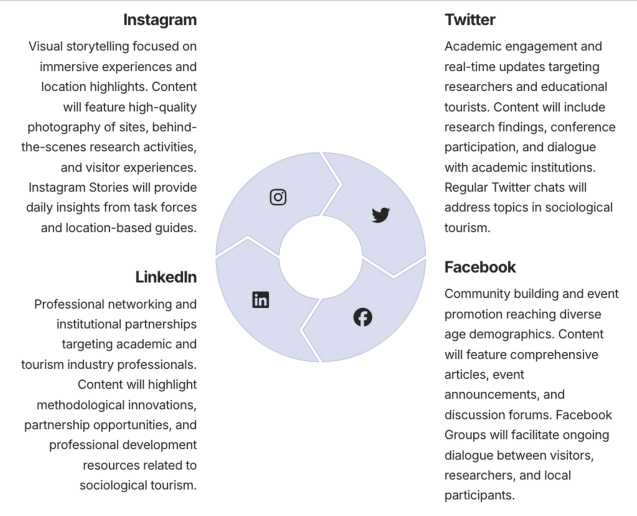


Figure 9: SEO Implementation. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

of the team messaging strategies. These insights will inform quarterly strategy adjustments to ensure continuous improvement in engagement and conversion metrics (Figure 9).

Moreover, *hashtag strategy* will combine *evergreen tourism tags* (#LisbonTravel, #PortugalTourism) with specialized *academic and cultural tags* (#SociologicalTourism, #MediaLiteracy, #MILCities) and *campaign-specific tags* (#LisbonMIL, #CulturalTourist). *Location-specific hashtags* will be developed for each research site to create discoverable content clusters.

And *influencer collaboration* will focus on micro-influencers in academic tourism, cultural education, and senior travel niches rather than mass-market travel influencers. This approach aligns with our targeted audience strategy and emphasizes credibility over raw reach metrics [23].

Platform	Content Types	Posting Frequency	Primary Audience
Instagram	- Photo carousels of locations - Researcher "day in the life" Stories - Visitor experience Reels - Location highlight guides - Behind-the-scenes research moments	- Feed: 4-5x weekly - Stories: 1-2x daily - Reels: 2x weekly - Guides: 1x monthly	- Cultural tourists (25-45) - Visual arts enthusiasts - Travel influencers - Photography enthusiasts
Twitter	- Research findings and statistics - Academic conversation threads - Conference live-tweeting - Methodology discussions - Real-time event updates	- Standard posts: 3-5x daily - Threads: 2x weekly - Twitter chats: 1x monthly - Research updates: weekly	- Academic researchers - Graduate students - Journalists and writers - Educational institutions
Facebook	- Long-form articles and analyses - Event listings and recaps - Community discussions - Photo albums of locations - Live videos of tours and talks	- Standard posts: 1-2x daily - Events: as scheduled - Live videos: 1x weekly - Group engagement: daily	- Older demographics (45+) - Community organizations - Local residents - Senior tourists
LinkedIn	- Case studies and white papers - Partnership announcements - Industry insights and trends - Professional development resources - Institutional achievements	- Articles: 1-2x weekly - Updates: 3x weekly - Newsletter: 1x monthly - Thought leadership: biweekly	- Tourism professionals - Academic administrators - Cultural institution leaders - Urban planners and developers

Figure 10: Platform-Specific Social Media Tactics. Source: Own elaboration. ©*Pedro Andrade Sociological Collection*

2.10 Guerrilla Marketing Tactics

Guerrilla marketing tactics will complement the project's conventional dissemination and marketing approaches, by creating unexpected, memorable experiences that embody our Sociological Tourism concept. These high-impact, low-cost interventions will generate word-of-mouth publicity and create authentic engagement opportunities throughout Lisbon.

Documentation of these guerrilla interventions will be shared across social media platforms, extending their reach beyond direct participants and creating shareable content that embodies our approach to innovative tourism. Local media outreach will target coverage of these unusual tourism approaches, positioning Lisbon MIL Cities as an innovative cultural initiative rather than a conventional marketing campaign.

These tactics share several key characteristics that align with our broader dissemination strategy: they create unexpected moments of sociological reflection in public spaces; they bridge digital and physical experiences; they encourage active participation rather than passive consumption; and they make academic concepts accessible through everyday encounters. By bringing Sociological Tourism into unexpected contexts, these guerrilla approaches will help distinguish our campaign from conventional tourism marketing [24]. Some *case studies* are exemplified below.

Urban Annotation Exploration

Installation of temporary QR code plaques at sites of sociological interest throughout Lisbon. Each code links to a brief sociological analysis of the location, available in multiple languages. This creates an alternative "layer" of interpretation accessible to anyone with a smartphone, turning the entire city into an open-air sociological museum.

Popup Sociological Cafés

One-day transformations of traditional Lisbon cafés into discussion spaces where tourists and locals engage with researchers about urban social issues. These events will feature specialized coffee cups with sociological questions printed on them as conversation starters, creating shareable moments and meaningful exchanges.

"Tourist or Local?" Exhibitions

Interactive public space installations that challenge viewers to distinguish between photographs of tourists and locals, highlighting the blurring boundaries between visitors and residents in a globally connected world. These exhibitions will appear in unexpected locations such as metro stations, public squares, and market areas.

Metro Line Sociological Tours

Distribution of specialized metro maps that reframe transit lines as sociological journeys through different urban realities. QR codes at stations link to audio guides explaining the sociological significance of each area, turning routine public transportation into educational experiences.

2.11 Project Materials and Visual Identity

Effective dissemination materials that embody this project's sociological approach are essential for communicating its unique value proposition to potential participants. This section outlines the approach to creating cohesive diffusion assets that reflect the team conceptual framework and engage target audiences.

The project visual identity system balances several key objectives: communicating academic credibility, creating emotional engagement, distinguishing our offerings from conventional tourism, and expressing the distinctive character of Lisbon's social landscape:

Visual Language

The project's visual identity employs a distinctive approach that visualizes sociological concepts through accessible graphic treatment:

Photography style emphasizing documentary realism rather than idealized tourist imagery, showing authentic social interactions and urban spaces. Color palette derived from Lisbon's urban environment, combining traditional architectural colors with contemporary urban accents. Typography pairing a scholarly serif for headlines with a clear contemporary sans-serif for body text, embodying the bridge between academic content and accessible presentation. Distinctive diagrammatic elements visualizing social connections and structures, creating a visual language for complex concepts.

Within such a posture, key dissemination materials include:

Core Publications: a series of printed and digital guides introducing this sociological tourism approach, featuring rich visual documentation of featured locations, conceptual frameworks for understanding social phenomena, and practical visitor information. Such publications serve as both publicizing pieces and valuable resources in themselves.

Documentary Series: short documentary films profiling each research site, featuring interviews with locals and researchers explaining the sociological significance of locations and practices. These videos demonstrate our methodology in action, while creating emotional connections to the communities and issues featured.

Sociological Maps: distinctive maps of Lisbon that visualize social phenomena rather than simply physical geography, showing aspects like migration patterns, economic transformations, cultural interactions, and historical developments. Such maps serve as both orientation tools and conceptual networks.

All dissemination materials embody the principles they promote—they demonstrate critical media literacy through transparent sourcing, multiple perspectives, and explicit attention to how representation shapes understanding. This approach ensures that the project's dissemination actions are not simply promoting sociological tourism, but actually practicing it, through its communication methods.

Distribution of materials will be strategically targeted to identified audience segments, with distinct versions tailored to academic, cultural tourist, senior, and intercultural visitor segments. Each version maintains conceptual integrity while adjusting language, examples, and visual emphasis to address specific audience interests and knowledge levels [26] [27].

3 CONCLUSION: IMPACT AND FUTURE DEVELOPMENTS

As stated *supra*, the ideas discussed in this project aim to transform Lisbon into a pioneering Media and Information Literacy (MIL) City, by integrating sociological frameworks into tourism, fostering deeper cultural engagement and sustainable practices. Within such lens, key impacts include Visitor Engagement: increase in engagement through experiential tourism (e.g., geolocated narratives, AR and AI apps) and sociological storytelling. Economic Growth: rise in local revenue by attracting culturally curious tourists. Academic & Community Impact: bridging academic research with tourism via task forces, workshops, and cross-cultural exchanges.

Future Developments are as follows: Smart City Integration: Leveraging IoT (Internet of Things) and data ecosystems for enhanced visitor experiences. Scalability: Plans to expand language support, refine experiences based on feedback, and develop academic publications. Challenges: Addressing policy cohesion, technological barriers, and measuring long-term social, cultural, knowledge and sociological impact.

Ultimately, the campaign's success hinges on balancing innovation with community needs, positioning Lisbon as a model for MIL-driven tourism globally.

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The ancestors of AI in the era of the floating world: images, atlases, archives of critical thinking (contributions)

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Abstract

Aesthetic thought manifests itself in the multiplicity and intersection of models articulated with current practices available to researchers on digital platforms. The growing awareness that theoretical knowledge must be mastered encompasses artistic creations/practices that, by understanding the Internet as a global museum, where images of a floating world overlap with the usual chrono- and georeferencing. It is proposed that A. Kahn [*Grand Archive de la Planète*], A. Warburg [*Atlas Mnemosyne*], and A. Malraux [*Musée Imaginaire*] be considered ancestors of globalized/cartographic thought/action expanded on digital platforms. On the other hand, W. Benjamin's *Art in the age of its technical reproducibility* is called upon regarding the consequences of photography. Based on the concepts/images of Atlases and Archives, we analyze the potential of iconographic thought in the face of the immeasurable contributions of AI. Reflections on digital archives and, more recently, AI-powered image/text generation can be understood as ekphrastic anticipations of these Ancestors. Over the course of a year, excerpts related to these authors were used as *prompt*s for generating images on open-access online platforms. How does AI represent these characteristic personalities' achievements? This is a reflective ongoing development that, given its complexity, is still to be fully answered.

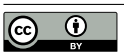
CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Information systems**; • **Digital libraries and archives**; • **Computing methodologies**; • **Artificial intelligence**;

Keywords

AI Ancestors, Images of the World, Overwhelming Archives and Atlases, Prompt into Image

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1 Introduction

The concepts of archives, atlases, and maps (mental and/or imaginary) are nourished by images, subsumed under appropriate structures that denote specific chronological and geographic references. Images, among other forms of documentary evidence, shape truths and deviations. When we encounter AI tools on digital platforms, it becomes clear that this multifaceted universe is designed (and controlled), most in particular, by the generation and use of images—whether generated by AI or those from image-historical banks and archives. Therefore, the firm and infinite impact of iconography predominates.

In creating a mental map, I devised, I invoked the ancestors who instigated us to question their scope, impact, and consequences of thinking in a [almost] contemporary era about the meanings of atlases, archives, and anthropologic-sociocultural-affective maps. In other words, to situate heritage territories determined by georeferenced and multicultural instances, polysemic and heterogeneous, as they are identities and memorials of geographies and civilizations separated by centuries and kilometres. The rationalized accumulation of images is a common denominator among the authors cited, albeit under different auspices and scopes. Images of unspeakable times and places watch over us as if floating in the world of intangibility.

Aesthetic thought manifests itself in the multiplicity and overlapping of models articulated with current practices available to researchers and students on digital platforms. The growing awareness, the belief that theoretical knowledge must be mastered, linked to artistic creations and practices, implies the configuration of a broad network, both chronological and georeferenced: images of a floating world. As my main hypothesis, I consider that the conceptual and aesthetic models of image organization/interpretation developed in Albert Kahn's *Grand Archive de la Planète*, Aby Warburg's *Atlas Mnemosyne*, and André Malraux's *Musée Imaginaire* what position themselves as ancestors of the globalized contents @digital platforms. On the other hand, I understand that Walter Benjamin's questions when discussing *Art in the Age of Technical Reproducibility* [1] anticipate and critically inform the challenges of visual culture and iconography in the Age of AI-generated images. In this context, by inducing, revisiting, renewing, and stimulating these historical paradigms, we could enable a critical and reflective understanding of the iconographic overflow and epistemological instability characteristic of images of the *floating world* [2] today.

2 Floating images of the world: *internet as a global museum*

The image no longer exists in its own right but now exists only to make the invisible code visible, whatever the material medium. It makes no difference to the code whether it appears as a two-dimensional or three-dimensional image. (...) The matrix of sensations was more fundamental than any object. The object was dispensed with [3].

Our fine arts were developed, their types and uses were established, in times very different from the present, by men whose power of action upon things was insignificant in comparison with ours. But the amazing growth of our techniques, the adaptability and precision they have attained, the ideas and habits they are creating, make it a certainty that profound changes are impending in the ancient craft of the Beautiful. In all the arts there is a physical component which can no longer be considered or treated as it used to be, which cannot remain unaffected by our modern knowledge and power [4].

In 2015, a line of research began, even though at the time I wasn't fully aware of how far it would go, or where it would lead us. Under the title "Floating Images of the World: Archives and Atlas," I undertook a subjective vision of Art and Culture in the Digital Age, in particular, envisioning the impact of the Internet as a global museum. In this sense, the contours of a sociological approach to the recognition of Cultural Heritage were questioned—considering its different typologies, particularly with regard to Intangible and Ephemeral Heritage. Now, I understand that it anticipated issues and practices I have been following. When considering the internet as a global museum, I thought about how, in the digital age, artistic and intellectual issues such as digital museology, cultural mediation, or aesthetic education could connect, and how art could better reach the public sphere. During the pandemic, this idea gained overwhelming force. In a way, I believe this formulation became prophetic; it anticipated the debates about online musealization and digital heritage. Online archives would provide democratized [global] access – an illusion or utopia – to the History of Art. Naming some of the pioneering image archives:

- Artcyclopedia (1997): http://www.artcyclopedia.com/
- Artchive (*circa* 1996): http://archive.turbulence.org/blog/archives/001211.html
- Artnet (1997): https://www.artnet.com

Kuspit [3] considered that the first computer-generated images, exhibited in 1965 at the Howard Wise Gallery, were abstract, not exactly innovative in aesthetic or conceptual terms. Even so, they provided "a new digital heightening of sense experience, correlate with the new way of conceptualizing consciousness as the codification of experience in the form of electric bits of information". Years before the irresistible reign (if noy expertise) of AI as widespread image-generator, Kuspit estimated its present capacities: "In digital art, every bit of information is inherently "sensational" by reason of its electronic character" [3].

As a professor and researcher, I realized that these archives would be very useful and could expand iconographic content to a wider academic audience. This is because they provided access to visual culture, beyond physical museums (perhaps Malraux's Museum without Walls), preparing the ground for further developments in digital museology, online curation, and AI-based image research. Thus, initial intuitions and approaches fueled the idea of the internet as a global museum, highlighting how digital platforms could serve as portals to the world's artistic heritage. Recently, I revisited Foster's book, "The Archive Without Museums" [5], and now, in the age of AI, and considering his reasoning, the title takes on new scope: "If there is a relation between visual culture and electronic information, how can it be thought outside of anxious affirmation or romantic revolution? One way is to invoke the archive as defined by Foucault, "the system that governs the appearances of statements," and to ask what this new order might enable as well as disable" [5]. This leads to ramifications and complexities of the topic which, while not the focus of this article, require urgent attention.

Free access to this type of image archive proved to be an opportunity for research in Arts and Humanities; as well as a resource for teaching. For an artist, it can expand meanings, serve as a method, a differentiated tool, or establish itself as an aesthetic novelty. Or it simply serves to broaden knowledge or leisure. It made images of masterpieces freely available, quickly and easily. On the other hand, in the following years, most museums and cultural centers resorted to new technologies to gain greater visibility and reach a more heterogeneous audience. Thus, for some researchers, it has become a kind of immaterial imaginary museum of Malraux; perhaps intangible, but accessible through personal computers, with simplified sharing. Perhaps the compulsive action of downloading and saving digital images is linked to the impulse of the collector or archivist – Albert Kahn [will therefore be a paradigm, while also safeguarding the achievements advocated by Warburg]. As a global museum, Internet meets the closeness of Atlases or, for some people, means a mental map for specific psycho-conceptual purposes. Finally, thinking of the Internet as a global museum showed that unusual alternatives could be experimented with and, later, would even boost the impact of AI on the curatorial experience and stimulate intermedial aesthetic experiences.

3 Floating images of the world: archives and glimpses of critical thought

My previous conceptual strategies, coupled with online research, allowed me to use and reflect on the digitization of original artist's notebooks—from the 18th and 19th centuries—on travelogues, authors, and artists often omitted from historiography, especially women. At that time, it was evident that travelers were driven by the fascination of globalist approaches to foreign destinations; by the tendency to equate traces and signs in an unconventional historiographical methodology; or by an artistic and technical seduction translated into the various images produced. Photography signaled a path of renewal and unstoppable achievements, where the ideas of atlas and archive followed visionary trajectories. Therefore, I was encouraged to revisit and recover four authorial references and related theoretical-historical procedures, as follows:

3.1 Albert Kahn > *Grand Archive of the Planet* (1905-1930)

Albert Kahn is the first ancestral reference, due to the project *Great Archive of the Planet* [6], which involved 52 photographers, including three women. The French philanthropist and banker died in

Author/Artist	Selected Prompt introduced in the "box" of each AI platform
Albert Kahn	Autochrome photography project _Archive of the Planet__ Albert Kahn believed that traveling meant keeping one's eyes open and elevating one's spirit. It would allow people to move forward, not to crystallize, and to overcome incompatibilities and restrictive unrecognitions between nations, allowing people to perceive the dimension of the universal, its laws, its infinity. The world was within reach of his collaborators, of those who assimilated his purposes. Today, apparently, the images are there, before each individual, in the delimitation, on the perimeter of a computer screen. One is not about to go on a Trip Around the World, nor is one going after an inventory of the planet legitimized by the utopia and boldness shared in the visionary spirit of an altruistic banker. Kahn foresaw the necessary steps to make his conviction come true: to counter the crisis into which humanity would sink. Contrasting an activation that depended on the opportunity and capacity to overcome the captivation of images, going further, seeking lucid objectives for its redemption, that is, to transcend ignorance. The answer lay in direct access, through presence in forgotten or unknown places. Crossing the safety zones of European centrality and also delving into the meanders disregarded by the assumption of progress.

Figure 1: ***Selected Prompt – Albert Kahn*** **(Author)**

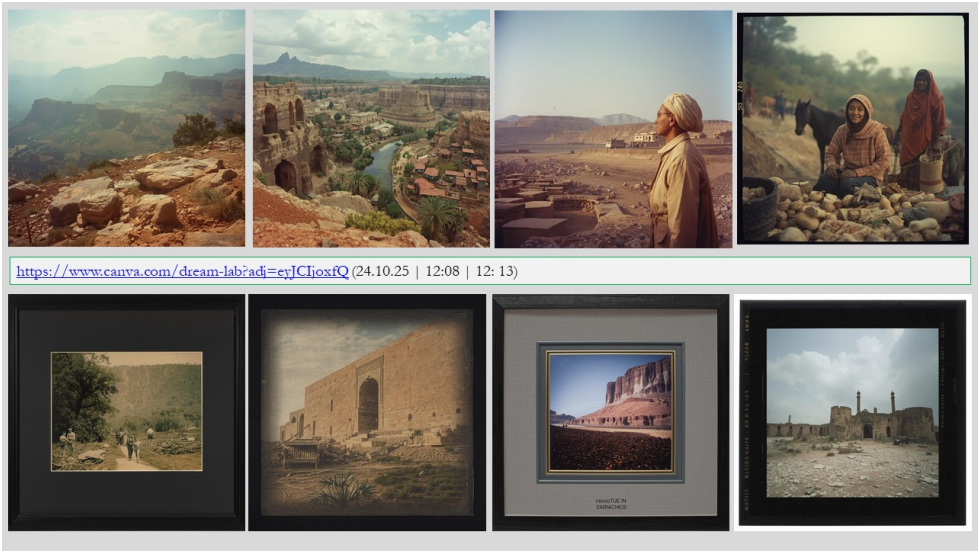


Figure 2: ***Selected Prompt – Autochrome, Albert Kahn*** **(Author)**

1940. He realized that the world he lived in should be preserved in images, as it was rapidly disappearing. The Archives "uncovers a latent nostalgia in the hyperreal hues of early colour photography" [7]. Anyone can access online the nine episodes of the BBC series *The Wonderful World of Albert Kahn* (2008). The documentaries reflect the anthropological, social, and geopolitical complexity of that changing era (perhaps even anticipating global overviews):

Part 1: A World View
Part 2: Men of the World
Part 3: Europe on the Brink of War
Part 4: The Story of Soldiers
Part 5: The Story of Civilians
Part 6: Europe After the Fire
Part 7: The Middle East, the Birth of Nations
Part 8: The Far East, Expeditions to Empires
Part 9: The End of a World.[1]

And my experiment began, asking AI to generate the image of such personality in context, and his archivist *autochrome universal planet*:

At Museum Albert Kahn's website[2], more than 70.000 images are available and downloadable, answering an expanded desire of the primary goal by this utopian Archive towards a most humanist achievement of the world.

3.2 Aby Warburg > *Mnemosyne Atlas* (1927/1929)

"In December 1927, Warburg started to compose a work in the form of a picture atlas named *Mnemosyne*. It consisted of 40 wooden panels covered with black cloth, on which were pinned nearly 1,000 pictures from books, magazines, newspaper and other daily life

[1]https://www.artfilms.com.au/item/the-wonderful-world-of-albert-khan?ItemID$=$5373
[2]https://albert-kahn.hauts-de-seine.fr/en/collections/presentation/a-documentation-project-for-the-world/the-archives-de-la-planete

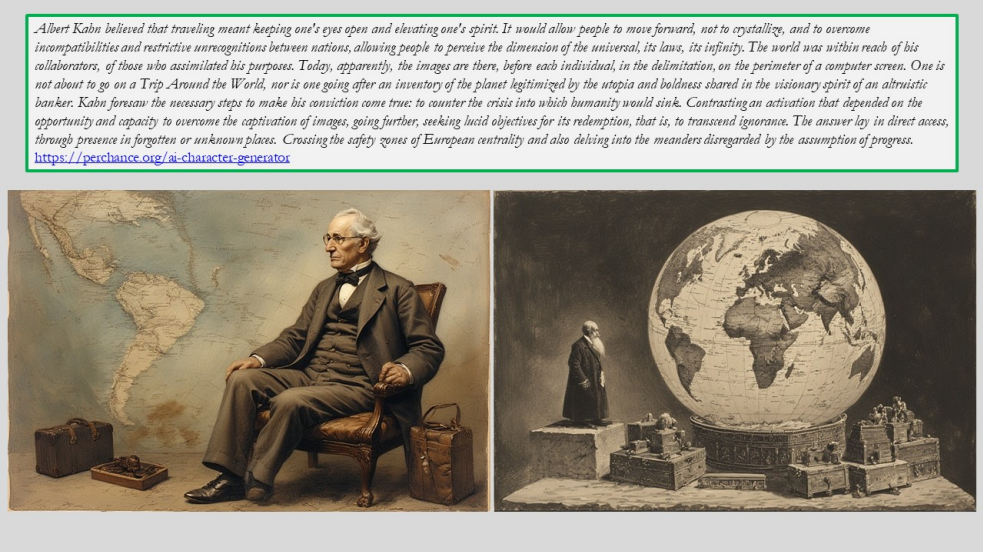


Figure 3: *Prompt into Image – Albert Kahn* (Author)

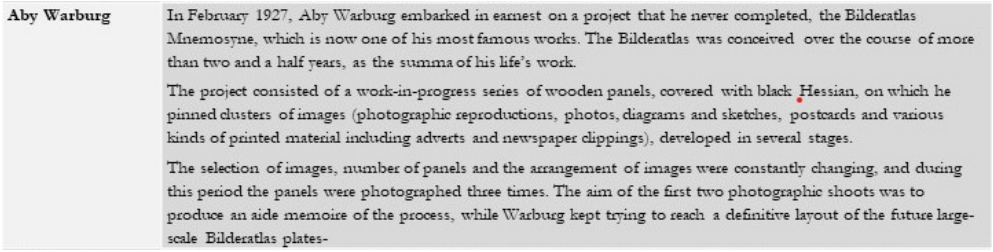


Figure 4: *Selected Prompt – Aby Warburg* (Author)

sources" [9, apud 10]. The collected pictures were settled according to specific crossed-themes:

1. Coordinates of memory
2. Astrology and mythology
3. Archaeological models
4. Migrations of the ancient gods
5. Vehicles of tradition
6. Irruption of antiquity
7. Dionysiac formulae of emotions
8. Nike and Fortuna
9. From the Muses to Manet
10. Dürer: the gods go North
11. The age of Neptune
12. "Art officiel" and the baroque
13. Re-emergence of antiquity
14. The classical tradition today [9].

There were no explicit captions and the atlas contained only brief texts: "Warburg certainly hoped that the beholder would respond with the same intensity to the images of passion or of suffering, of mental confusion or of serenity, as he had done in his work" [11]. The Mnemosyne Atlas unlocked an alternative way to face Art History – and the origins of art work concept –, not following a continuous homogeneous cultural heritage timeline, but relating iconographic contents versus primordial heterogeneous knowledge and beliefs; it was unfinished when Warburg died in 1929.

The first series of panels was photographed in May 1928 and the second in more than one session between late August and mid-September 1928; both helped Warburg to advance the project during absences from his working materials in Hamburg[3].

Fortunately, though unfinished, one of the greatest achievements of his life is now available online, for a richer and more humanistic understanding of the arts, civilization, and cultural heritage.

3.3 André Malraux > Museum without Walls/Musée Imaginaire (1947/1949)

Considering André Malraux's original title, *Musée Imaginaire* [12], and its English translation, Museum without Walls, semantic differences arise. One of its main ideas is how photography connects people from different places and allows for the understanding of foreign and distant cultures, regardless of location. It presents a concept and evaluation of photography apart from the one Walter

[3]https://warburg.sas.ac.uk/library-collections/warburg-institute-archive/bilderatlas-mnemosyne



Figure 5: *Prompt into Image – Aby Warburg* (Author)

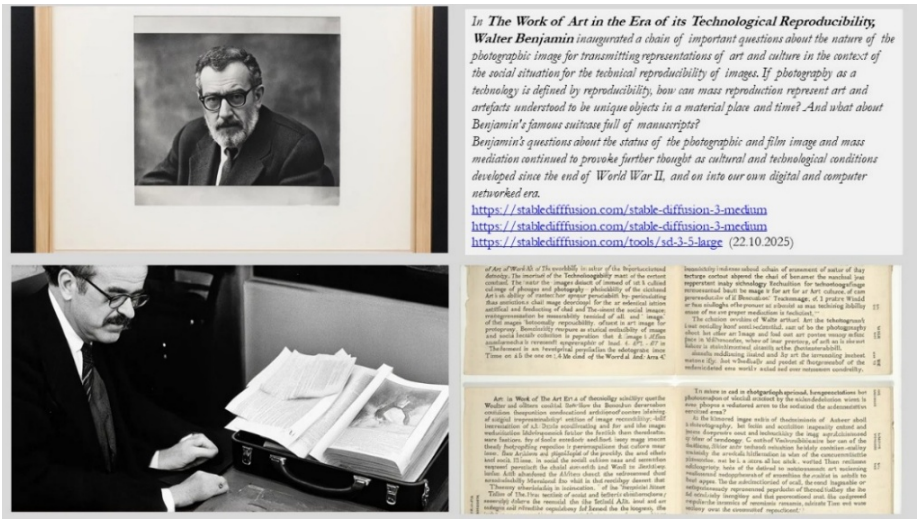


Figure 6: *Prompt into Image – Walter Benjamin* (Author)

Benjamin published *L'œuvre d'art à l'époque de sa reproduction mécanisée*[4] (1935), whose principles about mechanical reproduction depletes the aura, meant as unique and original cause of the work of art. Foster's [5] comments follow Benjamin's idea that photography places art in another context [1], which, in my opinion, echoes Malraux, although in a different way and positioning another type of aura.

But, returning to Foster [5], if for Benjamin exhibition museum guarantees art as such. Moreover, tradition and liquidates aura, for Malraux broken bits into one metatradition subject is the Family of Man-and allows all the fragments to course together life of certain forms, emerging ever and again like spectres from the past.

Malraux's imaginary museum did not imply the existence of a physical, georeferenced location. You could construct yourself between our fingers as we turned the pages of books or looked at photographs of works of art. Foster [5] in The Archive without Museums presented his cross-reflections after Malraux' Museum without Walls: "Might visual rely on techniques of information to transform a wide range of mediums of image-text-a database of digital terms, an archive without museums?" [5]. According to Foster [5], Malraux's perspective renewed epistemological terms

[4]It was first published, French translation by Pierre Klossowski, Zeitschrift für Sozialforschung (5e année, 1, 1936, p. 40-68). Paris: Librairie Félix Alcan.

André Malraux	The photograph of André Malraux, surrounded by a constellation of images laid across the floor, does not depict a moment of preparation or research, it enacts a gesture of creation. What we witness is not an editorial pause but an authorial act. Malraux's posture, absorbed and upright, does not suggest passive observation but a form of embodied editing, a choreography of attention that elevates the arrangement of images to the status of expressive form. In this sense, the curatorial gesture ceases to be secondary to the work of art and becomes itself a work, a visual syntax through which meaning is not just transmitted, but actively produced.
	So vital is the part played by the art museum in our approach to works of art to-day that we find it difficult to realize that no museums exist, none has ever existed, in lands where the civilization of modern Europe is, or was, unknown; and that, even amongst us, they have existed for barely two hundred years. They bulked so large in the nineteenth century and are so much part of our lives to-day that we forget they have imposed on the spectator a wholly new attitude towards the work of art. For they have tended to estrange the works they bring together from their original functions and to transform even portraits into "pictures". (Voices of Silence, Part 1, Museum Without Walls, 13-14)

Figure 7: Selected Prompt – André Malraux (Author)



Figure 8: Prompt into Image – André Malraux (Author)

and erected another museological concept, somehow chronologically and georeferenced in the years following the Second World War. Once again, what kind of images does AI generates to evoke Malraux actions?

The museum without walls resides in the mental space, that kind of immateriality embodied in each person. It is a fluid space, energized by one's imagination, nourished by the absorption of images from universal works of art that circulate ad libitum.

And what about the edited/editable/transmuted de/remultiplication of/in the digital, you might ask. At the end of the 20th century, the power of the image itself was a recurring argument and a controversial belief that promoted several reassessments, attending to diverse aesthetic theories – linked to analytical philosophy, such as phenomenology, visual anthropology [13], semiotics [14] or iconology [15] – among others – subjecting it to successive surgical deconstruction. Decades after Malraux [12], Soulages [16] focused on the ontology of the photographic image; it became an autonomous substance, and was no longer seen as a simulacrum (or substitute) for the work of art. Moreover, Belting [13] expanded these beliefs, which broadens the scope of what an image is, beyond historical-artistic frameworks, neither subservient to the other.

3.4 Gerhard Richter – *Atlas* (1962)

In contemporary art, several artists position themselves in individual projects based on the concept of image archive; the contents may be personal or unidentified, as they are appropriated under the compulsive fascination of memory and/or the recovery of georeferenced heritage, previously erased in a universalizing projection.

Gerhard Richter *Atlas* (1962)[5] is "a compilation of images arranged across 802 multi-image panels. Since its initial exhibition in 1972, Atlas has been continuously expanded, amended, and reorganised based on the volume of panels shown in each stage of its iteration" [16]. This is different opinion from Buchloh [18] "reading of *Atlas as* a mnemonic device and/or model for display, and Giuliana Bruno's [19] account of its emotive and/or filmic quality…" [16].

The project articulates a positioning that is simultaneously that of a collector, gatherer, and accumulator of images. The Atlas should be displayed after juxtaposed panels, organized by the artist, who over the years adds new elements and integrates sketches of his own authorship, reproductions of photos/images from the press (newspapers, widely circulated magazines, and pornography), others made by the artist (self-portraits and/or family portraits, landscapes, etc.), and those that he appropriates:

[5]https://www.gerhard-richter.com/en/art/atlas

Gerhard Richter	Gerhard Richter's Atlas is a collection of photographs, newspaper cuttings and sketches that the artist has been assembling since the mid-1960s. A few years later, Richter started to arrange the materials on loose sheets of paper. 'In the beginning I tried to accommodate everything there that was somewhere between art and garbage and that somehow seemed important to me and a pity to throw away.'[1] (Interview with Dieter Schwarz, 1999 in: Gerhard Richter: Text. Writings, Interviews and Letters 1961–2007, Thames & Hudson, London, 2009, p. 332). At present, Atlas consists of 802 sheets. Spanning a period of almost four decades, the individual sheets reflect different phases of Richter's life and work. Although Gerhard Richter had already begun collecting photographs and press cuttings, he started working on Atlas in the early 1970s by arranging his own and other family photographs on paper.

Figure 9: *Selected Prompt – Gerhard Richter* (Author)



Figure 10: *Prompt into Image – Gerhard Richter* (Author)

> "Richter evokes the different forms and meanings of photographic documentation, from intimate and familial records to their aesthetic, cultural, and political significance. (…) These images are organized into sets of juxtaposed panels, forming mobile constellations of ideas and visual form" [20].

The assemblage of elements is driven by a sense of aesthetic composition: each image is recognisable, and arouses dialogues at our leisure or logic. Richter shares his inner cartography, following an auto-ethnographic methodology, a road-map that shapes a "global" self-portrait. If Kahn, Warburg, Malraux were focused in outer images from the *Planet*, Art History or Museums, Richter himself shares his *Atlas* in a self-curating and museological revealed performance. The scattered images are chosen from his personal archive to be known in parcels as an ongoing chrono and georeferenced process – anthropological, artistic, sociological and aesthetic.

Generating images in AI demiurge mood and related comments:

> "Le générateur est un algorithme par renforcement qui produit des images aléatoires et dont la fonction de coût correspond à sa capacité à tromper le discriminateur. Concrètement le générateur prend en entrée un vecteur de bruit aléatoire et génère des données synthétiques. Ces données synthétiques sont ensuite présentées au discriminateur comme si elles provenaient d'exemples réels. Le générateur est entraîné à ajuster ses poids pour que les données générées ressemblent de plus en plus à celles de l'ensemble d'apprentissage, en minimisant la probabilité que le discriminateur les classe comme étant fausses" [21].

We could ask what indices, levels of similarity or dissimilarity are likely to be present in images produced by generative AI [22]; we are therefore faced with models that are capable of being structured, capable of generating—without time or measure (?)—more and other data: "sous la forme de textes, images fixes et en mouvement, sons, musique, et, dans un futur proche, des combinaisons de plus en plus complexes de tous ces éléments" [23]. Their beliefs suggest that the algorithm insinuates itself between the ability to perceive and the ability to imagine, and is therefore capable of "produire de nouveaux objets sensibles sur la base d'expériences sensibles antérieures. Ce qui nous intéresse, dans les deux cas, est exactement ce rapport avec *ce qui était déjà là*, et les catégories selon lesquelles il faut le penser" [23]. On the other hand, one can question the scope and nature of the (descriptive) texts generated by AI : "modèles de langage ne produiraient que des textes génériques et stéréotypés" [21]. However, in this research, as is common when applying prompt into images, some of the statements cited require different approaches, even if based on common denominators. The essential

Lab.Visual AI Process **– Methodology @ 4 steps**
From June > October 2025

1st step	2nd step	3rd step	4th step
Selecting images Kahn/ Warburg: Archives | Collections	Online search > selection of AI-free *prompt > image* platforms, for different generating image-results.	Prompt selected/framed: my own descriptions;	Insert prompts (describing/narrating or explaining images)
Theory/critic references by/and Benjamin & Malraux		Excerpts from aforementioned authors;	Observing and analysing the subsequent images.
Descriptions of G. Richter's panels from Atlas Project.		Quotes by academics and other theoretical details.	Repeat the prompt *into* image/action: once, twice…in different days and/or weeks and/or months.
			Iconographic result sufficiently closer to the original image.

AI GENERATED Platforms (and options) > **IMAGE after** ***PROMPT \| PROMPT into IMAGE***

https://perchance.org/ai-character-generator
https://perchance.org/ai-landscape-generator
https://stablediffusion.com/stable-diffusion-3-medium
https://stablediffusion.com/webui
https://stablediffusion.com/webui#google_vignette
https://stablediffusion.com/tools/ai-image-generator
https://stablediffusion.com/tools/sd-3-5-large
https://deepai.org/machine-learning-model/text2img
https://chatgpt.com/g/g-pmuQfob8d-image-generator/c/68faa73e-555c-8326-850e-b4c650d9a7d5
https://www.canva.com

Figure 11: Table corresponding to the 4 steps (Lab.Visual AI) for each *Prompt into Image* case study; list of AI platforms selected and used

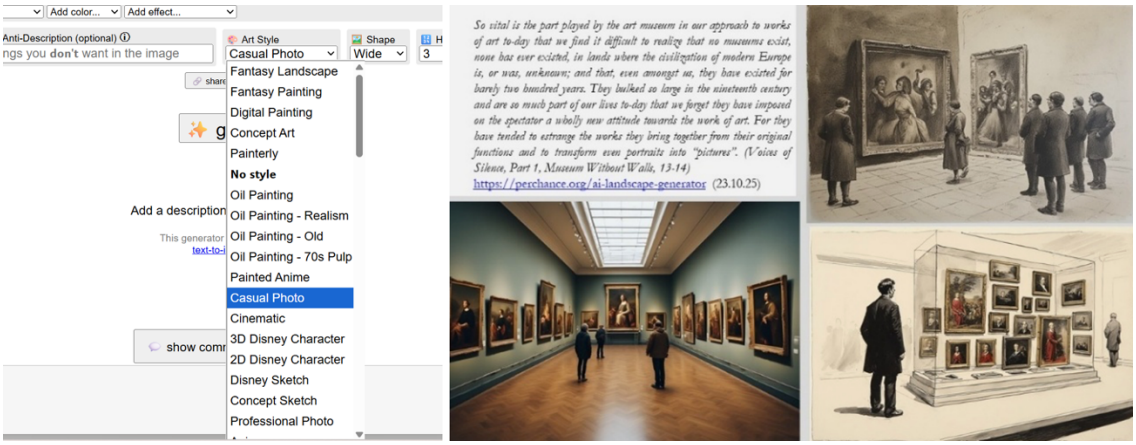


Figure 12: *Perchange Options*; Result > *Prompt into Image – André Malraux* (Author)

focus translates into iconographic drift, deduced from the different platforms used and considering the insertion of the textual content (descriptions) chosen for this purpose – and the measures applied, as referred to below.

Based on the examples presented above, some reflections can be made about AI-generated images. Which inputs can/should be highlighted?

These *Lab.Visual IA* experiments began in June, and the last attempts were done late October 2025. The four-step process directed the application (several time) in the compass of months.

Some AI platforms – *Perchance*, for instance – offered a different number of generated images for each attempt - 3, 6 or 12 images/prompt. For most of the experiments presented here, I selected a number of 3 - it seemed to be enough, due to the diversity of images presented in each and only demand; did not insert "Anti-description (optional)"; as "Art Style" > "Casual Photo" and as "Shape" > "Wide". Other choices being available, I tested, much preferred to bound the possibilities, as mentioned.

As listed in Figure 11, the choice of platforms, for this first set of experiments, meant to be enough. And I also verified that they were access free online and available. The exception was, on the 24th October regarding Stable Difussion's[6] website which suddenly stopped working that day: while developing the experiments, a message popped up saying the website was offline (Figure 13).

[6]https://stablediffusion.com/stable-diffusion-3-medium, https://stablediffusion.com/webui, https://stablediffusion.com/tools/ai-image-generator, https://stablediffusion.com/tools/sd-3-5-large



Figure 13: *Screenshot*@24th October 2025.[7]



Figure 14: *Prompt into Image – Walter Benjamin* (Author)

This was the only occurrence of its kind throughout the 5-month process. The large number of images generated demonstrates the diversity of "standards of taste" that prevails on each platform, which is the "aesthetic standard/norm", difficult to alter and manage, despite the more specific and deliberate commands that were successively introduced.

Here, I will only elaborate on two sets of issues in images (due to the length of this article). I chose the cases of generative AI representation by an author who so critically questioned photography, such as W. Benjamin, and, on the other hand, someone who compulsively wanted to preserve in autochrome a world that was collapsing/disappearing, as Albert Kahn did – through his photographers.

The above-mentioned guidelines were applied to "Benjamin's" generate image to be, after the description turned available and adequate. As we can observe, in the 1st (left side up image) two characters appear, one of them carrying a suitcase. That one, is induced to be "Water Benjamin". Though they were produced in the same AI valuation, each image is one in aesthetic perspective and style. The set-up of the 3 compositions is variable, but defines scenography lines that content stereotypes related to: travellers; men on the run, escaping, migrating or journeying; the bag either is closed, or opened with visible contents such books and note books, folios – part of archives or collections; in the 2nd (engraving variation) and 3rd (mimetic/casual photography) images, the standing lonely man is represented in a still and idealised landscape quiet. The poetic environment does not induce the tragedy within that would shortly after being a not-overcoming fact.

> "…ils [les algorithmes génératifs] sont capables d'abstraire le «style »d'un artiste, par exemple, pour l'appliquer à une image donnée. En résumé, les vecteurs dans l'espace latent capturent des informations essentielles sur les données et peuvent être manipulés pour contrôler les caractéristiques des sorties générées" [21].

[7]Just today, the 10th November, I tried to access https://stablediffusion.com/webui and surprisingly it is available again. These new productions will not be included in this paper.



Figure 15: *Prompt into Image – Albert Kahn* (Author)

The images generated after the prompts, which can be read (upper right corner) in Figure15, demonstrate how small changes can occur. The images on the left – above and below – differ only by the word ”colored” [24] inscribed in the prompt. Both landscapes, although panoramic, are structured and show two perspectives: in the first, the group of people and animals is cornered on the left, with the horizon line and the riverbanks on the right, in a lower line of the image. The second directs a path, pointing to the vanishing point, according to the Renaissance perspective. In contrast, the third image is devoid of human presence, in a rather romantic aesthetic, producing a feeling of almost ontological solitude. The clouds, the mountain, and the valley below are framed in black, as was the case with the original autochrome. The hermeneutic approach is broad, and each reader/viewer is invited to delve into his/her own imagination.

Drawing on the concepts/images of authorial portraits, georeferenced landscapes, Atlases and Archives, we aesthetically examine the potential of iconographic thought in the face of the immeasurable and indomitable generation of images by AI. By revisiting historical paradigms, the urgency arose to deconstruct the images of a disappearing world (Khan); to conceptually reorganize the historiographical systematization of art based on symbolic cultural anthropology and iconology (Warburg); to problematize the (possible) failure of *auratic* rapture *versus* the technical reproducibility of photography (Benjamin); and to make explicit the dichotomous polysemy raised by the proliferation of printed images (Malraux). The questions raised by the assumption of digital archives and, more recently, AI are repositioned (both retrospectively and prospectively). The following priority objectives stand out: to recognize the evolution of image archives, from analogue (photographic, printed) to digital and AI-generated platforms; to trace the genealogy of visual thought through historical paradigms, focusing on the construction of meaning through the curation, reproduction, and circulation of images; to critically analyse the concept of the floating world as a metaphor for the multiplicity and instability of digital visual culture; to assess the impact of AI on traditional notions of authorship, aura, and originality (*after* Benjamin); to deconstruct historical and contemporary visual systems using methodologies inspired by symbolic cultural anthropology, iconology, and archival studies; and to reflect on the aesthetic and anthropological implications of cartographic and archival strategies in the digital age.

3.5 *Coda @ closing time and space?*

After presenting the iconographic results guided by the successive descriptions decided upon, questions are raised again.

To what extent or how is the hypothesis/idea of considering these authors as ancestors of AI effectively substantiated and, therefore, corroborated? What legitimacy does it have, what recognition or validity? Very specifically, what are the indicators?

Over the course of a year, narrative excerpts from the aforementioned authors were collected, as well as a compilation of images referenced and/or created/promoted by them. Been aware of the objectives that directed this AI Lab visual experiment, it was understandable that foundational concepts of the iconographic thought and/or aesthetic theories subsumed in Kahn [22], Warburg, Benjamin and Malraux were not powered @ the same epistemological level. The recognition of images dynamism along 20^{th} decades and until the present time was hard and complexified the parallels that I wished to be draw back. It was not possible to compare – at the same meta-iconographic level - analogue photos with digital ones or with AI generated images. I could only confront the “skin”, the appearance, not the depth. The genealogy of visual thinking traces across historical paradigms, were focused on the construction of meaning through this kind of process, maybe nearer to image curation, reproduction, and circulation than I thought at the beginning of this AI research project/Lab Visual.

Some of the results obtained highlight the modelling/measurement (qualitative) of my researcher’s interference/manipulation in

the evaluation of successive stimuli until the desired/aspired iconographic images were approximated; the repositioning of archival thinking in digital and post-digital contexts, connecting the aforementioned paradigms with contemporary visual culture. The visual AI tests promoted an aesthetic confrontation between affinities and dissimilarities. Reflections on aesthetic & anthropologic implications of atlases/cartographic and archival strategies in the digital age have to be developed and deepened. On the other hand, to evaluate the impact of AI on traditional notions of authorship, aura, and originality (*after* Benjamin) it was not enough overviewed. Those cross-objectives and levels asked for further positioned proposals and steps in order to deconstruct historical and contemporary visual systems using methodologies inspired by symbolic cultural anthropology, iconology, and archival studies.

Meanwhile, the *"floating world"* concept - as a comparison for the multiplicity and instability of digital visual culture - seemed to be ensured. The articulation of the world images' logic as metaphor for the ephemeral and hyperconnected aesthetic ecologies for present time.

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Aura-Fox Redux: uma arqueologia da imagem técnica

Aura-Fox Redux: a technical image archaeology

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Abstract

This article presents and analyzes Aura-Fox Redux, an installation that reconfigures a historical photographic enlarger as a performative artistic object. The work investigates the operational and epistemological potentials of the technical apparatus through interventions that challenge its materiality and its condition as an analog device within a post-digital context, characterized by the automation of creative processes and the continuous updating of tools and production workflows. The proposal engages concepts such as aura and wonder, drawing on the reflections of Walter Benjamin, Vilém Flusser, and Pedro Miguel Frade, as well as the "desauratize" approach by Andreas Fickers and Annie van den Oever. Aura-Fox Redux offers a sensitive experience guided not by the device's functionality but by an aesthetics of gesture and performance, affirming curiosity and wonder as avenues to a contemporary archaeology of technical image-making. The methodological approach integrates different strands of media archaeology: the discovery and repair of the object through direct engagement, allowing an understanding of its material and operational logic; the theoretical contextualization based on technical documents and media theory authors, which problematizes its contemporary condition and cultural persistences; and the performative exploration of the enlarger through the installation setup and prototyping of new components, transforming it into a hybrid artifact oscillating between theatrical box, photographic camera, projector, pinhole, magic lantern, and laboratory. The work thus constitutes an investigation based on artistic practice, enabling the development of projects oriented toward mediation as a process, shifting the focus from functionality and the image as a product. At the same time, it opens space for critical reflection on the cultural regimes that shape the production and perception of images and their technical mediations.

Resumo

Este artigo apresenta e analisa Aura-Fox Redux, instalação que reconfigura um ampliador fotográfico histórico como objeto artístico performativo. A obra investiga as potências operacionais e epistemológicas do aparato técnico por meio de intervenções que tensionam sua materialidade e sua condição como dispositivo analógico em um contexto pós-digital, marcado pela automação dos processos criativos e pela constante atualização de ferramentas e fluxos de produção. A proposta articula conceitos como aura e espanto, mobilizando reflexões de Walter Benjamin, Vilém Flusser e Pedro Miguel Frade, além da abordagem de "desauratize" de Andreas Fickers e Annie van den Oever. Aura-Fox Redux oferece uma experiência sensível orientada não pela funcionalidade do aparelho, mas por uma estética do gesto e da performance, afirmando curiosidade e espanto como vias de acesso a uma arqueologia da imagem técnica. O percurso metodológico integra diferentes abordagens da arqueologia dos media: a descoberta e a reparação do objeto por meio da experiência direta, que permite compreender sua lógica material e operacional; a contextualização teórica a partir de documentos técnicos e autores da teoria dos media, que problematiza sua condição contemporânea e persistências culturais; e a exploração performativa do ampliador por meio da configuração da instalação e da prototipagem de novos componentes, transformando-o em artefato híbrido que oscila entre caixa teatral, câmara fotográfica, projetor, pinhole, lanterna mágica e laboratório. O trabalho configura-se, assim, como uma investigação baseada na prática artística, que permite desenvolver trabalhos orientados para a mediação enquanto processo, deslocando a ideia de funcionalidade e a centralidade da imagem como produto. Ao mesmo tempo, abre espaço para a reflexão crítica sobre os regimes culturais de produção e percepção das imagens e de suas mediações técnicas.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Media Artes, Arqueologia Dos Media, Objeto Técnico, Imagem

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1 INTRODUÇÃO

A expansão de tecnologias e meios computacionais digitais tem sustentado um discurso de inovação que frequentemente obscurece as suas continuidades e dependências em relação aos media pré-digitais. No entanto, é precisamente no contexto pós-digital que

se torna visível uma condição paradoxal: ao mesmo tempo em que há automação e aceleração dos processos técnicos e criativos, observa-se movimentos de retomada, ressignificação e hibridização de dispositivos e procedimentos historicamente associados aos media analógicos. Tal cenário implica a necessidade de examinar as genealogias dos media, atentando não apenas para suas transformações lineares, mas para suas descontinuidades, reativações e convergências operativas que se manifestam nos modos de produção e expressão contemporâneos.

É nesse enquadramento, alinhado à abordagem experimental da arqueologia dos media, que este artigo apresenta e discute Aura-Fox Redux, uma instalação que reativa um ampliador fotográfico histórico como objeto artístico e performativo. Para isso, discutimos inicialmente o contexto reflexivo e percurso metodológico do trabalho. Em seguida, apresentarmos a instalação com alguns dos seus componentes e configurações que evocam um percurso de transformações do aparato rumo a uma arqueologia da imagem técnica.

2 CONTEXTUALIZAÇÃO REFLEXIVA E METODOLOGIA

Projetado em meados dos anos 50 pela empresa italiana Durst Phototechnik, Durst Laborator 138 S foi concebido como um ampliador profissional de impressão e cópia fotográfica de grande, médio e pequeno formato [9]. Sua estrutura robusta, foco e lentes ajustáveis, fazem dele um artefacto paradigmático da imagem analógica no século XX de produção e reprodução matrizes fotográficas. Mesmo antes da instauração do regime digital nos anos 90, a descontinuidade do modelo se deu na concorrência com novos aparelhos mais compactos e portáteis, os quais pareciam atender a uma indústria da imagem cada vez mais voltada para eficiência dos processos e formatos médios e pequenos.

No contexto atual, marcado por plataformas digitais, circulação acelerada e interfaces computacionais, o ampliador fotográfico torna-se um objeto técnico pouco reconhecido pelo público em geral, frequentemente relegado a depósitos institucionais, oficinas de reparação especializadas ou coleções museológicas. Sua presença oscila entre o estatuto de resíduo tecnológico e o de testemunho histórico. Essa condição, entretanto, revela seu potencial como instrumento de reflexão crítica sobre a arqueologia técnica da imagem. Com base nisso, o trabalho concentrou-se na reativação de um ampliador Durst Laborator 138 S, possivelmente utilizado no ensino e na aprendizagem de design e arte na cidade do Porto, Portugal.

Um dispositivo que historicamente contribuiu para a "perda da aura" [1] na era da reprodução técnica da imagem, o ampliador retorna na instalação Aura-Fox Redux como um objeto estranho, mas com presença e performance no tempo e espaço. Essa reinserção opera como um gesto de subversão do seu papel histórico e da sua função original, deslocando o problema da reprodutibilidade e da própria lógica representacional. De acordo com Samuel Weber [6], "a aura, apesar de todo o seu definhamento, dilapidação e declínio, nunca desaparece completamente", o que exige atenção aos vestígios que persistem nos meios que, segundo o próprio Benjamin, lhe seriam mais hostis, como o cinema e, posteriormente, a televisão. Para Weber, "o que se condena na era da reprodutibilidade técnica não é a aura como tal, mas a aura da arte como obra de representação, uma obra que teria seu lugar fixo, que tomaria seu lugar em e como uma imagem do mundo". Em contextos como o da televisão, por exemplo, o que sobra é "a mediaura de um aparelho cujo olhar tudo capta e nada devolve, exceto talvez num piscar de olhos" [6]. Nesse sentido, Weber apresenta a aura como um conceito dinâmico [10] que permite levar em consideração a materialidade técnica e a performance dos dispositivos.

Alinhada com a perspetiva experimental da arqueologia dos media proposta por Andreas Fickers e Annie van den Oever [5], Aura-Fox Redux defende a necessidade das práticas de reativação crítica, nas quais os dispositivos não são alvo de uma reverência museológica, mas são manipulados, testados e compreendidos em sua operacionalidade concreta. Nesse sentido, "desauratizar" [5] surge não como uma forma de suprimir a aura, mas recusá-la como valor estático ou transcendental, mas a favor de reposicioná-la no âmbito da manipulação e do engajamento com a materialidade. Essa abordagem aproxima-se da noção flusseriana de jogo com o aparelho [11] e do entendimento da experimentação técnica discutido por Jeanne-Marie Gagnebin [7], para quem a experiência transforma o regime de sentido do dispositivo.

À luz dessas premissas, o trabalho adotou um percurso metodológico de investigação ancorada na prática, entendido como condição para a produção de conhecimento e para a consolidação da articulação teórica. Esse caminho possibilitou a elaboração e a interconexão de estratégias múltiplas, fundamentais para estabelecer mecânicas operacionais e relações conceituais que orientassem a ressignificação do ampliador como instalação. Entre essas ações, destaca-se o processo de conhecimento e análise do estado do aparelho por meio de sua manipulação e reparação, etapa que exigiu a pesquisa e a reconstrução de seus componentes, muitos deles dispersos, danificados ou perdidos.

A ausência de determinados elementos evidenciou valências implícitas na estrutura principal de funcionamento do equipamento. Por exemplo, a caixa principal de condução da luz remete a referências históricas de dispositivos de projeção de imagem, como a lanterna mágica.

Outra estratégia metodológica envolveu a contextualização histórica e técnica do aparato, realizada por meio do levantamento de manuais, catálogos industriais e literatura sobre processos fotográficos. Esse procedimento possibilitou a compreensão tanto do funcionamento operacional quanto do programa de uso subjacente ao dispositivo. Durante a manipulação contínua, emergiram "affordances" não previstas, interpretadas como oportunidades para exploração criativa. A reflexão sobre a condição contemporânea do ampliador e a necessidade de substituição de peças conduziu à expansão das "affordances" originais, concretizada por meio da prototipagem de novos componentes, sem comprometer a integridade estrutural do equipamento. Entre essas intervenções, destaca-se a capa negra adaptada ao painel de lentes, que permite a operação do ampliador mesmo em ambientes com incidência de luz.

Com base nas considerações teóricas e metodológicas, o título do trabalho tensiona conceitos como "Aura", como proposto por Walter Benjamin [1], ao referir-se à unicidade de um objeto em sua presença irrepetível no tempo e espaço. "Fox", por sua vez, faz alusão ao sentido de iluminação e astúcia, seja como referência à gíria portuguesa (particularmente usada no Minho) que indica inteligência sutil, onde "foxe" designa um instrumento de luz, seja



Figure 1: João Lima (Limamil) no processo de reparação do ampliador. Documentação feita por Camila Mangueira, Julho de 2025.



Figure 2: Detalhes de Aura-Fox Redux com uso de lanterna. Imagens extraídas do vídeo de documentação da instalação.

como metáfora do pensamento crítico implicado no design de mediações técnicas [2] [3]. E "Redux" (do latim reducere que alude a retorno, a restaurar) problematiza a reencenação performativa do objeto técnico [4] [5] e a ideia de aura nas mediações [6] e na experimentação contemporânea [7], enquanto resgata também a ideia do gesto implícito na gíria portuguesa "foxe" de "trazer o foco para ver melhor".

3 INSTALAÇÃO

Na instalação, um objeto técnico de grande porte habita um ambiente escurecido, com entrada controlada de luz natural ou artificial. Trata-se de uma máquina de grande porte, pesada e deslocada, cuja presença desperta a curiosidade e convida à exploração tátil e visual. Lanternas dispostas no local iniciam a sua revelação através da luz.

A[1] interface analógica do aparato inclui uma caixa superior (a "cabeça" do ampliador), um suporte pedestal e uma mesa de apoio. O corpo do equipamento é equipado com diversas alavancas e botões que permitem ajustes verticais e rotações, possibilitando diferentes posicionamentos do aparelho. Essas configurações geram jogos de reflexos, projeções de luz e imagens efêmeras, ora nítidas, ora distorcidas, que só adquirem sentido na interação. Dessa forma, as imagens tornam-se performáticas, vinculadas a gestos únicos de exploração e descoberta.

O aparato é inicialmente apresentado na exposição sem alguns de seus componentes originais, como condensadores e o espelho frontal, evidenciando seu estado de descoberta e inaugurando um processo de montagem customizada pelo público. Os componentes ausentes são disponibilizados sobre a mesa do ampliador, juntamente com materiais como películas, acetatos digitais e objetos vinculados a diferentes fontes de luz, incluindo candeeiros, lanternas e lâmpadas. Esses elementos participam ativamente da construção da imagem, evidenciando as múltiplas instâncias processuais da produção técnica e permitindo ao público engajar-se diretamente com a materialidade e a operação do aparato.

Entre os materiais disponibilizados para interação, destacam-se pequenos objetos tridimensionais produzidos em película fotográfica, que podem ser inseridos no interior do ampliador e manipulados por meio do espelho e da lanterna, transformando o aparato em uma espécie de caixa teatral. Nessa configuração, a codificação bidimensional da imagem não anula a presença volumétrica do objeto, evidenciando um jogo constante entre projeção, corpo e espaço, no qual a perceção e a performatividade do público se tornam parte integrante do processo de produção da imagem.

Outra possibilidade oferecida pela instalação consiste em acionar a lâmpada do aparelho e inserir os dois condensadores projetados

[1] https://vimeo.com/1130449345



Figure 3: Caixa teatral ou pré-ampliador. Mini-escultura de barco feita com película fotográfica é disposta na caixa principal da máquina e explorada visualmente com uso de lanterna e espelho. Imagens extraídas do vídeo de documentação da instalação.[1]



Figure 4: Pré-ampliador. Caixa central iluminada por lâmpada da máquina. Após a inserção do porta-negativo com matriz, o público pode apreciar uma imagem do primeiro instrumento de iluminação. Imagens extraídas do vídeo de documentação da instalação.[1]

industrialmente para transformá-lo em um ampliador. Nesse contexto, podem ser utilizados os filmes e acetatos disponibilizados sobre a mesa, incluindo o da lanterna, que inicialmente serviu como objeto de exploração e especulação do aparato. Agora, a lanterna passa a funcionar como matriz para a projeção da luz elétrica do ampliador, integrando-se à narrativa performativa da instalação. Esse procedimento enfatiza o jogo ambíguo entre referente e imagem.

Ao abrir espaço para a performance "dos fantasmas" e das promessas latentes da técnica no dispositivo, o trabalho estabelece uma crítica histórica ao tornar visível trajetórias esquecidas ou desviantes da tecnologia, desafiando narrativas lineares de progresso técnico [8]. Nesse sentido, a instalação possibilita ao público articular e confrontar os modelos óticos da câmara obscura e da lanterna mágica, ambos mediados pela própria luz como agente estrutural. Essas configurações, no entanto, podem ser tensionadas ou mesmo subvertidas pela proposição na instalação de experimentações que escapam à lógica projetiva ou impressão tradicional, como é o caso da "pinhole invertida"[2] ou do laboratório químico alternativo no próprio corpo do objeto.

As imagens produzidas pela instalação remetem à noção de espanto, conforme discutida por Pedro Miguel Frade [12], segundo a qual a fotografia, em seus primórdios, provocava uma experiência sensorial capaz de suspender os esquemas usuais de significação e inaugurar uma percepção original da imagem. Para Frade, essa experiência sensível foi progressivamente diluída pela repetição cultural e pela industrialização da fotografia. Ao articular o trânsito entre referente e imagem, entre o objeto real e sua dimensão performática, Aura-Fox Redux evidencia os limiares instáveis da visualidade, ressaltando a natureza processual e experimental da imagem técnica.

4 CONSIDERAÇÕES FINAIS

A partir da análise apresentada, Aura-Fox Redux se configura como uma proposta crítica para refletir sobre as descontinuidades e ambivalências entre objeto técnico, performance e público, oferecendo uma resposta situada e sensorial às demandas da tecnocultura contemporânea. O trabalho demonstra como a investigação baseada na prática artística possibilita tensionar relações habituais com a imagem técnica, deslocando o foco da representação para a performance e da autoridade técnica para a experiência sensível e situada.

[2]Trata-se de uma técnica explorada por João Lima (limamil) de inversão do feixe luminoso em máquinas de ampliação e com uso de matrizes digitais e analógicas. Algumas experimentações realizadas em parceria com Camila Mangueira foram expostasna 5ªMuestra Internacional de Fotografía Estenopeica (2023). https://www.fotomaiz.org/wp-content/uploads/2023/Muestra-Estenopeica-2023-Participantes.pdf



Figure 5: Detalhe do disparador da câmara e da lanterna mágica no interior do objeto. Imagens extraídas do vídeo de documentação da instalação.[1]

Distante de projetos de contemplação nostálgica, a instalação propõe caminhos para questionar a previsibilidade e os automatismos que frequentemente estruturam os regimes contemporâneos da imagem. Para tanto, utiliza o espanto e a experimentação como estratégias de interrupção percetiva, incentivando modos inéditos de interação com as mediações. O percurso metodológico envolveu a reparação, manipulação e expansão das "affordances" do dispositivo. Essas práticas fornecem abordagens aplicáveis a outros contextos de investigação com objetos técnicos obsoletos, históricos ou esquecidos. Nesse sentido, Aura-Fox Redux se consolida como contribuição significativa para a arqueologia dos media, para estudos de performatividade técnica e para práticas críticas de sensibilização e reativação de aparatos.

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Co-creation and personalisation of Immersive Web Environments: Initial Results from a Case Study

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Abstract

Este artigo apresenta os resultados de um estudo de caso realizado com alunos 7ºano de escolaridade, que idearam, personalizaram e utilizaram um Ambiente Web Imersivo (AWI) como sala de aula. O estudo pretendeu compreender o impacto que a participação ativa dos alunos nas diferentes fases teve sobre a motivação para a aprendizagem dos conteúdos curriculares e os da disciplina de inglês. Foram aplicados questionários aos alunos em três momentos distintos do processo, após a cocriação, após a personalização e após a utilização do AWI. Os resultados demonstram que a maioria dos alunos manifestou uma perceção positiva relativamente à sua participação, valorizando o trabalho em grupo e o processo de cocriação com os colegas. Revelaram ter gostado de ter aulas e de aprender no AWI, manifestando interesse em continuar a utilizá-lo, tanto de aulas de Inglês quer noutras disciplinas. A motivação para aprender inglês manteve-se estável ao longo das três fases, enquanto a motivação para construir e aprender em ambientes web imersos aumentou. Apesar de alguns constrangimentos técnicos mencionados pelos alunos, a perceção global sobre a utilidade do AWI como recurso pedagógico foi muito positiva. Entre os fatores mais indicados para o aumento da motivação destacam-se o trabalho colaborativo; a possibilidade de aprender com os colegas, num espaço tridimensional, onde podem usar óculos de realidade virtual; a possibilidade de personalizar facilmente o AWI; assim como a participação ativa no processo de cocriação do AWI, onde todos contribuíram para a sua criação. Os dados sugerem que a participação dos alunos no design e posterior utilização do seu AWI pode potenciar aprendizagens mais significativas, reforçando o papel do aluno agente ativo na construção do seu conhecimento.

Résumé

This article presents the results of a case study conducted with 7th grade students who designed, personalised and used an Immersive Web Environment (IWE) as a classroom. The study aimed to understand the impact that students' active participation in the different phases had on their motivation to learn the curriculum content and English content. Questionnaires were administered to students at three different stages of the process : after co-creation, after personalisation and after using IWE. The results show that most students had a positive perception of their participation, valuing group work and the process of co-creation with their peers. They said they enjoyed having classes and learning in the IWE, expressing interest in continuing to use it, both in English classes and in other subjects. Motivation to learn English remained stable throughout the three phases, while motivation to build and learn in immersive web environments increased. Despite some technical constraints mentioned by students, the overall perception of the usefulness of IWE as a teaching resource was very positive. Collaborative work ; the possibility of learning with colleagues in a three-dimensional space where they can use virtual reality glasses ; the possibility of easily customising the IWE ; as well as active participation in the IWE co-creation process, where everyone contributed to its creation, are among the factors most likely to increase motivation. The data suggests that the participation of students in the design and subsequent use of their IWE can promote more meaningful learning, reinforcing the role of the student as an active agent in the construction of their knowledge.

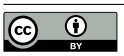
CCS Concepts

• **Human-centered computing** → Interaction design; Empirical studies in interaction design.

Keywords

Immersive Web Environments, motivation, co-creation, personalization

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1 Introdução

A realidade virtual (RV) e os ambientes digitais interativos, permitem uma exploração imersiva de mundos 3D [12], que possibilita envolver os alunos em cenários autênticos e ricos em significado, muitas vezes difíceis de reproduzir nas salas de aula tradicionais [9]. Contudo, a navegação em RV continua a representar desafios para muitos utilizadores ou por falta de familiaridade com os controlos ou pela ocorrência de efeitos adversos como o enjoo de movimento [12]. Com a adopção do padrão WebXR em browser, dispositivos móveis e óculos de realidade virtual, a criação e disseminação experiências de RV tornou-se mais acessível [12]. As experiências de RV baseadas na web não exigem instalação de software, o que facilita a distribuição de conteúdos [10, 12]. Neste contexto, ambientes web imersivos destacam-se pela facilidade de utilização, exigência de poucos recursos tecnológicos, funcionamento diretamente no

browser e por aliarem acessibilidade, interatividade e facilidade de personalização em experiências práticas e colaborativas [18].

Williams et al. (2021) demonstraram que a utilização do AWI promoveu níveis elevados de satisfação, envolvimento e interação. Apesar de alguns desafios técnicos iniciais, como o lag, os ajustes implementados, indicaram que pode ser um ambiente viável, acessível e eficaz para fomentar a participação, a colaboração e o sentimento de presença no processo educativo. A interação social, a perceção de "estar junto" com outros dentro do espaço virtual, podem contribuir para aumentar o grau de envolvimento, tal como a sensação de presença em ambiente partilhados, ou seja, a perceção de estar "dentro" do ambiente virtual, independentemente das limitações técnicas, influencia os comportamentos [17]. Estes ambientes possibilitam ainda experimentar e colocar a aprendizagem em contextos da vida real, ajudando a transferir conhecimentos para fora da sala de aula [9].

A criação de ambientes de aprendizagem digitais não se limita ao espaço tecnológico, segundo Morgado (2022), os ambientes imersivos são espaços onde simultaneamente acontecem dois fenómenos complexos: a imersão e a aprendizagem. Os ambientes de aprendizagem são todos os contextos onde fenómenos da aprendizagem se manifestam, podendo incluir espaços físicos tradicionais (uma sala de aula ou o laboratório), espaços online de comunicação e interação entre participantes; ou espaços isolados onde um indivíduo reflete e explora a sua cognição [14]. O conceito de imersão pode ser compreendida de forma tridimensional (Morgado, 2022): (1) sensação subjetiva de estar rodeado num espaço real ou virtual [16] ou percecionada [14, 19]; (2) envolvimento no significado do contexto, mediado por narrativas [14, 20]; e (3) como agência (envolvimento ativo do participante) num contexto, seja ela por iniciativa, seja por reação aos desafios que emergem do contexto [14, 21]. [11, 14, 21]

O presente estudo propõe-se analisar a perceção e a motivação dos alunos do 7.ºano de escolaridade ao serem envolvidos como cocriadores do seu próprio ambiente de aprendizagem. Esta abordagem alinha-se com os princípios do design thinking [1] e do design participativo [15], representando uma oportunidade para promover aprendizagens mais significativas, colaborativas e motivadoras, indo de encontro aos desafios pedagógicos do século XXI e do desenvolvimento das competências que os alunos necessitam para enfrentar contextos complexos em constante transformação [5]. Tendo em conta as recomendações de Williams et al. (2021), destaca-se ainda a importância de uma preparação prévia adequada, especialmente com os professores, e da otimização dos ambientes virtuais, nomeadamente através da utilização de objetos 3D low poly, assim como a adoção de interfaces simples e acessíveis. O design centrado no utilizador é um fator decisivo para a adoção destas tecnologias no contexto educativo.

2 Metodologia

2.1 Contexto e participantes

O estudo, realizado numa escola pública portuguesa, teve como principal objetivo compreender como a participação ativa dos alunos no desenho, personalização e utilização da sala de aula imersiva como sala de aula pode influenciar a motivação para aprender nesses ambientes. Participaram no estudo 37 alunos, de duas turmas, do 7.ºano de escolaridade, com idades compreendidas entre os 11 e os 16 anos [6, 7]. Direção, pais/encarregados de educação e alunos foram informados sobre projeto de investigação, que foi autorizado pela direção da escola, e os pais consentiram a participação dos seus educandos. Os alunos foram esclarecidos quanto à finalidade da utilização dos seus trabalhos, respostas dadas nos inquéritos e de que os seus dados seriam tratados de forma anónima e confidencial. Foram também informados de que podiam desistir a qualquer momento, uma vez que a sua participação era voluntária [4, 6, 8].

2.2 Procedimentos e duração

A intervenção decorreu durante 11 semanas, em aulas de 50 minutos [4, 6, 7]. Durante as sessões e sob a orientação da professora, os alunos trabalharam em pequenos grupos, tendo sido desafiados a idear, construir e, posteriormente, utilizar o AWI como sala de aula [4, 6, 7]. Durante a fase de ideação, os alunos, organizados em grupos de 3 a 4 elementos, desenharam em papel de cenário, com lápis a sala imersiva que imaginavam [4, 6, 7]. Os desenhos foram digitalizados e expostos num AWI, criado pelos investigadores e, visitado, usando óculos de realidade virtual, dispositivos móveis (tablet e telemóveis) e computadores, pelos alunos [4, 6, 7]. Após explorarem o AWI e conhecerem todas as propostas, os alunos votaram na sala que gostariam de construir [6, 7]. Concluída a votação, com apoio da professora, os alunos refletiram coletivamente sobre como integrar os contributos de todos os grupos na versão final da sala a construir [6, 7]. Em conjunto redesenharam a sala, recorrendo novamente a papel e lapis [6, 7]. Após a fase inicial, de ideação, pretendia-se que os alunos construíssem o AWI, modelando em 3D, usando a plataforma Spoke by Mozilla [22], que poderia ser diretamente acedido pela plataforma Mozilla Hubs [23], ou, em alternativa, exportassem o modelo para ser incluído em plataformas como Frame VR [24]ou Spatial [25]. Importa referir que as plataformas Mozilla Hubs e Spoke foram descontinuadas pela Mozilla a 31 de maio de 2024 [7], algum tempo após a realização da intervenção. Durante esta fase, construção, os alunos deparam-se com diversos desafios de ordem técnica, nomeadamente dificuldades de ligação à internet, frequentemente lenta ou indisponível, o que dificultou o acesso e trabalho na plataforma Spoke [6, 7]. Face a estas limitações e, de modo a garantir a continuidade da investigação, a modelação foi realizada por um elemento da equipa de investigação, com base nas ideias dos alunos [6, 7]. A professora acompanhou todo este processo, assegurando que tudo estava de acordo com o AWI cocriado pelos seus alunos.

Concluída a modelação do AWI, os alunos personalizaram-no, modelando alguns objetos 3D no Tinkercad [26], que foram integrados na sala imersiva construída na plataforma Spatial [6, 7]. Para além de usarem modelos por eles criados, os alunos incluíram também objetos disponíveis no Sketchfab, incorporado no Spatial, assim como imagens relacionadas com os conteúdos da disciplina [6, 7]. Na fase final da intervenção, o AWI foi utilizado como sala de aula. Durante essas sessões, os alunos realizaram atividades comunicativas e colaborativas em língua inglesa, centradas no vocabulário e no uso funcional da língua. As atividades decorreram inteiramente dentro do ambiente imersivo, recorrendo a diferentes dispositivos, tais como computadores, portáteis e smartphones [6, 7].

O AWI desenvolvido pelos alunos consistia numa casa com dois andares que incluia várias zonas de interação, totalmente personalizadas pelos alunos, como uma sala de cinema, de música, de sala de jantar, garagem entre outros espaços distintos [3]. No AWI os alunos exploraram o espaço, interagiram com os objetos 3D e discutiram, em inglês, os nomes apropriados das diferentes áreas e elementos criados e presentes no ambiente. Esta fase permitiu observar a aplicação prática da língua em contexto, reforçando o caráter colaborativo e situado da aprendizagem, bem como a consolidação de competências comunicativas. Estas tarefas foram integradas no plano curricular regular da disciplina.

As etapas de ideação e personalização do AWI decorreram em língua portuguesa, desta forma foi possível assegurar que todos os alunos compreendiam as tarefas propostas e expressar (reduzindo possíveis barreiras linguísticas) as suas ideias e decisões [6, 7]. Apenas na etapa de utilização da sala, os alunos comunicaram em língua inglesa, para promover a aprendizagem e a prática da língua, no contexto imersivo, por eles criado e personalizado [6, 7].

2.3 Recolha e análise de dados

A recolha de dados foi realizada através de inquéritos por questionário, aplicados em três momentos distintos: após cada uma das fases da intervenção (ideação, personalização e utilização do AWI). Os questionários incluíam: afirmações usando escala de Likert de 5 pontos: "Discordo totalmente" (1), "Discordo" (2), "Indeciso" (3), "Concordo" (4) e "Concordo totalmente" (5); questões de resposta fechada e resposta aberta. As afirmações, em que se usou a escala de Likert, foram organizadas em quatro dimensões e idênticas nos questionários, aplicados após a ideação e personalização, com algumas adaptações ao nível da linguagem para se adequarem ao momento da atividade. Por exemplo, "Senti dificuldades em pensar o AWI", após a ideação, foi reformulada para "Senti dificuldades em pensar nos objetos a colocar no AWI", após a personalização. Esta dimensões permitiram efetuar uma comparação entre as duas fases.

Envolvimento e Participação na Atividade

- Participei na elaboração do AWI/ Participei na personalização do AWI
- Gostei de fazer esta atividade
- Esforcei-me ao realizar a atividade
- Sempre que foi necessário tomar decisões, participei com a minha opinião

Desafios e Estratégias de Superação

- Senti dificuldades em pensar o AWI/Senti dificuldades em pensar nos objetos a colocar no AWI
- Quando senti dificuldades pedi ajuda a colegas
- Quando senti dificuldades pedi ajuda à professora
- Quando senti dificuldades pesquisei sobre o assunto

Articulação com a Aprendizagem e Reflexão

- Pesquisei sobre o assunto
- Relacionei a matéria que vou aprender na disciplina com o AWI
- Questionei-me sobre qual a melhor forma para atingir o objetivo
- Para construir o AWI vou, em casa, pesquisar e ver tutoriais sobre o assunto/ Para construir/personalizar o AWI, em casa, pesquisei e vi tutoriais sobre o assunto

Trabalho Colaborativo

- Gostei de trabalhar em grupo
- Gostei de trabalhar com os colegas do meu grupo

O terceiro questionário, aplicado após a utilização do AWI como sala de aula, também usou uma escala de Likert de 5 pontos: "Discordo totalmente" (1), "Discordo" (2), "Indeciso" (3), "Concordo" (4) e "Concordo totalmente" (5), e as afirmações foram agrupadas em três dimensões:

Perceção da Aprendizagem

- ter construído/personalizado a sala facilitou a aprendizagem dos conteúdos
- A utilização da sala facilitou a aprendizagem dos conteúdos
- Estes ambientes facilitam a aprendizagem de conteúdos

Motivação para Aprender

- Por ter construído/personalizado a sala, motivou-me a saber mais sobre a matéria que aprendo na disciplina
- A utilização da sala motivou-me a saber mais sobre a matéria que aprendo na disciplina

Atitude e Preferência pelo Ambiente Imersivo

- Gostei de ter aulas neste ambiente
- Gostei de aprender usando este ambiente
- Gostava de continuar a utilizar este ambiente nas aulas de Inglês
- Gostava de continuar a utilizar AWI noutras disciplinas

Os três questionários incluíram ainda duas questões de resposta fechada, com três opções: Aumentou/Diminuiu/Manteve-se Igual, relativas à perceção dos alunos, ao longo do processo. sobre a motivação para aprender inglês e a motivação para cocriar e/ou aprender (n)o ambiente imersivo. Mais uma vez, estas questões eram idênticas nos três questionários, tendo sido adaptadas consoante o momento da intervenção. Por exemplo:

- Após a ideação: "A tua motivação para aprender Inglês, por teres pensado e desenhado a sala imersiva…", "A tua motivação para construir a sala imersiva …"
- Após a personalização: "A tua motivação para aprender Inglês, depois de teres personalizado a sala imersiva…"; "A tua motivação para aprender na sala imersiva…"
- Após a utilização: "A tua motivação para aprender Inglês, por ter usado a sala …"; A tua motivação para aprender por teres pensado, personalizado e utilizado a sala…"

Os questionários incluíam três questões de resposta aberta e facultativas, onde os alunos deviam refletir sobre os fatores que consideravam contribuir para o aumento e/ou diminuição da sua motivação, assim como partilhar observações sobre a experiências. As restantes questões eram de carácter obrigatório. O questionário utilizado foi adaptado e ajustado ao contexto específico deste estudo de instrumentos usados em pesquisas na área de STEAM e IoT [2], [13].

Table 1: Perceção dos alunos após ideação do AWI

Afirmações (33 alunos)	Discordo totalmente (1)	Discordo (2)	Indeciso (3)	Concordo (4)	Concordo totalmente (5)
Participei na elaboração do AWI	1 (3%)	0 (0%)	1 (3%)	9 (27,3%)	22 (66,7%)
Gostei de fazer esta atividade	0 (0%)	0 (0%)	1 (3%)	8 (24,2%)	24 (72,7%)
Esforcei-me ao realizar a atividade	0 (0%)	0 (0%)	3 (9%)	15 (45,5%)	15(45,5%)
Senti dificuldades em pensar o AWI	7 (21,2%)	9 (27,3%)	9 (27,3%)	7 (21,2%)	1 (3%)
Pesquisei sobre ao assunto	2 (6,1%)	2 (6,1%)	8 (24,2%)	9 (27,3%)	12 (33,4%)
Relacionei a matéria que vou aprender na disciplina com o AWI	1 (3%)	1 (3%)	6 (18,2%)	16 (48,5%)	9 (27,3%)
Questionei-me sobre qual a melhor forma para atingir o objetivo	0 (0%)	2(6,1%)	7 (21,2%)	17 (51,5%)	7 (21,2%)
Quando senti dificuldades pedi ajuda colegas	2 (6,1%)	3 (9,1%)	7 (21,2%)	11 (33,3%)	10 (30,3%)
Quando senti dificuldades pedi ajuda à professora	1 (3%)	0 (0%)	2 (6,1%)	13 (39,4%)	17 (51,5%)
Quando senti dificuldades pesquisei sobre o assunto	3 (9,1%)	4 (12,1%)	6 (18,2%)	11 (33,3%)	9 (27,3%)
Gostei de trabalhar em grupo.	0 (0%)	0 (0%)	1 (3%)	5 (15,2%)	27 (81,8%)
Gostei de trabalhar com os colegas do meu grupo.	1 (3%)	0 (0%)	3 (9,1%)	1 (3%)	28 (84,8%)
Sempre foi necessário tomar decisões participei com a minha opinião	0 (0%)	1 (3%)	2 (6,1%)	18 (54,5%)	12 (33,4%)
Para construir o AWI vou, em casa, pesquisar e ver tutoriais sobre o assunto	8 (24,2%)	5 (15,2%)	9 (27,3%)	6 (18,2%)	5 (15,2%)

3 Apresentação dos resultados

Apresentam-se os resultados obtidos nos questionários, aplicados nos três momentos da intervenção. Ao questionário aplicado pós ideação (Tabela 1) responderam 33 alunos, enquanto os relativos à pós-personalização (Tabela 2) e pós-utilização (Tabela 3) foram respondidos por 34 alunos.

De forma geral, observa-se uma predominância de respostas nas categorias "Concordo" e "Concordo totalmente". A maioria dos alunos indica que gostou, participou e esforçou-se na realização da atividade, apesar alguns alunos referirem ter sentido dificuldades em pensar o AWI. Verifica-se também que os alunos pesquisaram sobre a temática e foram capazes de relacionar os conteúdos da disciplina com o AWI, assim como de se questionar sobre a melhor forma para atingir os objetivos. No entanto, nota-se, em algumas afirmações, como "Para construir o AWI vou, em casa, pesquisar e ver tutoriais sobre o assunto", uma maior dispersão nas respostas. No entanto, os alunos demostraram iniciativa para pesquisar sobre o assunto e sempre que sentiam dificuldades, a maioria pediu ajuda aos colegas e professora. Sempre que foi necessário tomar decisões, os alunos indicam que participaram com a sua opinião. Os alunos referiram que gostaram de trabalhar em grupo e com os colegas do seu grupo.

Em relação à motivação para aprender inglês, após terem pensado e desenhado a sala imersiva, 19 alunos (57,6%) indicaram que esta se manteve, enquanto 14 alunos (42,4%) assinalaram que a sua motivação aumentou. No que concerne à motivação para construir a sala imersiva, os resultados mostram que 22 alunos (66,7%) indicaram um aumento da motivação, enquanto 11 (33,3%) referiram que esta se manteve. Nenhum dos alunos referiu uma diminuição da motivação. Entre os fatores apontados pelos alunos para o aumento da motivação, destacam-se a possibilidade de testar os ambientes com óculos de realidade virtual, bem como o facto de aprenderem de forma diferente, experienciando estar num ambiente imersivo e interativo. Valorizam o facto de estar a aprender com os meus colegas num ambiente diferente. Nas observações referiram "gostei de desenhar com os meus colegas", "foi muito divertido desenhar a sala", "a proposta de trabalho (desenhar, construir e utilizar a sala) é muito interessante".

Os resultados continuam a mostrar uma tendência positiva nas respostas às afirmações, posicionando-se nas categorias "Concordo" e "Concordo totalmente". No entanto, comparando com os resultados apresentados na Tabela 1, observa-se um aumento do número de respostas na categoria "Indeciso". Continua a verificar-se que alunos participaram, esforçaram-se e gostaram da atividade de personalização e de trabalhar em grupo e com os colegas do seu grupo e que, sempre que foi necessário tomar decisões, participaram com a sua opinião. Apesar de sentirem dificuldades em pensar nos objetos a incluir no AWI, conseguiram relacionar os conteúdos da disciplina. Registou-se uma diminuição do número de alunos que se questionaram sobre a melhor forma de atingir os objetivos, bem como uma redução da iniciativa relativamente a pesquisar sobre o assunto, nomeadamente, em casa. Quando enfrentaram dificuldades, os alunos recorreram sobretudo à professora, apesar de terem procurado ajuda junto dos colegas.

Relativamente à motivação para aprender inglês, após a personalização do AWI, 19 alunos (55,9%) indicaram que esta se manteve,

Table 2: Perceção dos alunos após personalizarem o AWI

Afirmações (34 alunos)	Discordo totalmente (1)	Discordo (2)	Indeciso (3)	Concordo (4)	Concordo totalmente (5)
Participei na personalização do AWI	0 (0%)	0 (0%)	7 (20,6%)	9 (26,5%)	18 (52,9%)
Gostei de fazer esta atividade	0 (0%)	1 (2,9%)	4 (11,7%)	7 (20,6%)	22 (64,7%)
Esforcei-me ao realizar a atividade	0 (0%)	2 (5,9%)	4 (11,7%)	13 (38,2%)	15 (44,1%)
Senti dificuldades em pensar nos objetos a colocar no AWI	8 (23,5%)	4 (11,7%)	7 (20,6%)	11 (32,4%)	4 (11,7%)
Pesquisei sobre ao assunto	8 (23,5%)	5 (14,7%)	9 (26,5%)	7 (20,6%)	5 (14,7%)
Relacionei a matéria que vou aprender na disciplina com o AWI	0 (0%)	4 (11,7%)	10 (29,4%)	8 (23,5%)	12 (35,3%)
Questionei-me sobre qual a melhor forma para atingir o objetivo	2 (5,9%)	4 (11,7%)	11 (32,4%)	11 (32,4%)	6 (17,7%)
Quando senti dificuldades pedi ajuda colegas	4 (11,7%)	4 (11,7%)	10 (29,4%)	10 (29,4%)	6 (17,7%)
Quando senti dificuldades pedi ajuda à professora	2 (5,9%)	3 (8,8%)	2 (5,9%)	14 (41,2%)	13 (38,2%)
Quando senti dificuldades pesquisei sobre o assunto	7 (20,6%)	4 (11,7%)	10 (29,4%)	7 (20,6%)	6 (17,7%)
Gostei de trabalhar em grupo.	1 (2,9%)	2 (5,9%)	4 (11,7%)	4 (11,7%)	23 (67,6%)
Gostei de trabalhar com os colegas do meu grupo.	1 (2,9%)	1 (2,9%)	6 (17,7%)	5 (14,7%)	21 (61,8)
Sempre foi necessário tomar decisões participei com a minha opinião	0 (0%)	1 (2,9%)	5 (14,7%)	16 (47,1%)	12 (35,3%)
Para construir/personalizar o AWI, em casa, pesquisei e vi tutoriais sobre o assunto	4 (11,7%)	6 (17,7%)	11 (32,4%)	7 (20,6%)	6 (17,7%)

Table 3: Perceção dos alunos após a utilização do AWI como sala de aula

Afirmações (34 alunos)	Discordo totalmente (1)	Discordo (2)	Indeciso (3)	Concordo (4)	Concordo totalmente (5)
O ter construído/personalizado a sala facilitou a aprendizagem dos conteúdos	0 (0%)	1 (2,9%)	12 (35,3%)	17 (50%)	4 (11,7%)
A utilização da sala facilitou a aprendizagem dos conteúdos	0 (0%)	1 (2,9%)	11 (32,4%)	15 (44,1%)	7 (20,6%)
Por ter construído/personalizado a sala motivou-me a saber mais sobre a matéria que aprendo na disciplina	1 (2,9%)	1 (2,9%)	13 (38,2%)	11 (32,4%)	8 (23,5%)
A utilização da sala motivou-me a saber mais sobre a matéria que aprendo na disciplina	0 (0%)	2 (5,9%)	10 (29,4%)	15 (44,1%)	7 (20,6%)
Gostei de ter aulas neste ambiente	1 (2,9%)	2 (5,9%)	7 (20,6%)	13 (38,2%)	11 (32,4%)
Gostei de aprender usando este ambiente	0 (0%)	2 (5,9%)	6 (17,7%)	18 (52,9%)	8 (23,5%)
Gostava de continuar a utilizar este ambiente nas aulas de Inglês	1 (2,9%)	2 (5,9%)	7 (20,6%)	14 (41,2%)	10 (29,4%)
Gostava de continuar a utilizar AWI (noutras disciplinas)	0 (0%)	2 (5,9%)	6 (17,7%)	16 (47,1%)	10 (29,4%)
Estes ambientes facilitam a aprendizagem de conteúdos	0 (0%)	3 (8,8%)	8 (23,5%)	16 (47,1%)	7 (20,6%)

enquanto 15 alunos (44,1%) referiram que aumentou. Quanto à motivação para aprender no AWI, os resultados mostram que 24 alunos (70,6%) indicaram que a sua motivação aumentou, e os restantes 10 (29,4%) referiram que se manteve. Nenhum aluno afirmou que houve uma diminuição da motivação. Os fatores indicados pelos alunos como os que contribuíram para o aumento da motivação são curiosidade e interesse, associados ao carácter lúdico e inovador da experiência, por se tratar de "uma maneira diferente de aprender inglês", num ambiente diferente de aprendizagem onde podem navegar e que podem explorar e personalizar. Os alunos destacam a interação com os colegas, num espaço tridimensional, que todos contribuíram para a sua criação. Valorizam também interação com o próprio ambiente e com os objetos virtuais. Nenhum aluno indicou fatores que pudessem ter contribuído para a diminuição da motivação. Nas observações os comentários reforçam esta perceção positiva, os alunos indicam "gostei muito de trabalhar na sala imersiva", "gostei de trabalhar em grupo e de construir algo com os meus colegas". "é possível criar facilmente "adorei trabalhar nas salas imersivas", "esta aplicação é mega fixe", "a escola está muito fixe adorei".

Os resultados da tabela 3 continuam a revelar a maioria das respostas concentradas nas categorias ”Concordo” e ”Concordo totalmente”. No entanto, em algumas afirmações, observa-se uma percentagem bastante significativa de respostas na categoria ”Indeciso”, que por vezes representam de cerca de um terço das respostas dadas pelos alunos. Afirmações como: ”O ter construído/personalizado a sala facilitou a aprendizagem dos conteúdos”, apresenta 35,3% de indecisos; “A utilização da sala facilitou a aprendizagem dos conteúdos”, a percentagem de indecisos é de 32,4%; 38,2% de indecisos na afirmação “Por ter construído/personalizado a sala motivou-me a saber mais sobre a matéria que aprendo na disciplina” e “A utilização da sala motivou-me a saber mais sobre a matéria que aprendo na disciplina”, a percentagem é de 29,4% de indecisos, no entanto, e apesar destes valores, as categorias “Concordo” e “Concordo totalmente” somam valores superiores a 60% em todas essas afirmações. Importa ainda destacar que a maioria (67,7%) dos alunos concorda ou concorda totalmente com a afirmação “Estes ambientes facilitam a aprendizagem de conteúdos”. Os dados mostram que a maioria dos alunos gostaram de ter aulas e de aprender neste ambiente e revelam interesse em continuar a utilizá-los quer nas salas de aula de Inglês quer em outras disciplinas.

Relativamente à motivação para aprender inglês após a utilização da sala imersiva, 19 alunos (55,9%) indicaram que se manteve, enquanto 15 alunos (44,1%) referiram que aumentou. Sobre o impacto de terem sido eles próprios a planear, personalizar e utilizar o AWI, 16 alunos (47,1%) afirmaram que essa experiência contribuiu para um aumento da motivação, enquanto 18 alunos (52,9%) afirmaram que se manteve inalterada. Uma vez mais, nenhum aluno indicou diminuição da motivação. Entre os principais fatores mencionados para o aumento de motivação, destacam-se a possibilidade de trabalhar, interagir e aprender com os colegas num espaço imersivo e colaborativo, diferença em relação às aulas tradicionais e a possibilidade de personalização do ambiente. Nas observações referiram que a experiência foi interessante, diferente e divertida, destacando o facto de “ter aulas lá dentro”. Os alunos indicam ainda que “gostei muito”, “adorei” e “foi fixe”. Contudo, alguns alunos referiram dificuldades técnicas, nomeadamente erros da aplicação (“bugava muito”) e dificuldades de acesso ao espaço (“não conseguimos entrar lá dentro”), aspetos que podem ter condicionado parcialmente a experiência.

4 Análise e discussão dos resultados

4.1 Comparação entre a perceção dos alunos após ideação e personalização do AWI

As tabelas 1 e 2 apresentam afirmações idênticas, o que permite, apesar da ligeira diferença no número de participantes, uma análise comparativa das perceções dos alunos relativamente às fases de ideação (n=33) e de personalização (n=34) do AWI. Os dados das duas fases, de modo geral, revelam, por parte dos alunos, uma perceção globalmente positiva. Apesar de se verificar na fase de personalização, um aumento de respostas nas categorias “Indeciso” e “Discordo”. As respostas, nas duas fases situam-se maioritariamente nas categorias “Concordo” e “Concordo totalmente”, particularmente nas afirmações relativas à participação, esforço e gosto pela atividade, assim como às afirmações relacionadas com trabalho em grupo e com os colegas de grupo. Na fase de ideação, os dados são muito positivos, os alunos indicaram ter participado na elaboração do AWI (94%) e gostado de fazer a atividade (97%), enquanto 91%, indica ter-se esforçado na sua realização. Na fase de personalização, apesar dos valores se manterem elevados, observa-se que são inferiores, provavelmente devido à complexidade da tarefa. A participação na personalização do AWI é referida por 79,4%, enquanto 85,3% afirma que gostou da atividade e 82,3% indica que se esforçou para a realizar. Em relação ao trabalho colaborativo, trabalhar em grupo e com os colegas do grupo, o resultado mantém-se positivos nas fases, com uma ligeira diminuição na fase de personalização: o gosto por trabalhar em grupo passou de 97% para 79,3% e com os colegas do grupo, desceu de 88% para 76,5%. Também a perceção de participar nas tomadas de decisão apresenta uma ligeira descida de 87,9 para 82,4%. A percentagem de alunos que afirma que pesquisou sobre o assunto passou de 60,7% na ideação para 35,3% na personalização. De igual modo, a intenção de procurar tutoriais e pesquisar em casa passou de 33,4% na ideação para 38,3% na personalização. 24,2% dos alunos referiram dificuldades em “pensar o AWI” na fase de ideação, enquanto 44,1% indicou dificuldades em “pensar nos objetos a colocar no AWI” durante a fase de personalização. Estes resultados podem estar relacionados com maiores exigências cognitiva na fase de personalização, que, por envolver mais escolhas técnicas ou criativas, poderá ter gerado mais dúvidas ou insegurança nos alunos. Verificou-se, que em ambas as fases, os alunos, em momentos de dificuldade, procuraram mais apoio na professora, embora também aqui se observe uma ligeira diminuição, de 90,9% para 79,4%, tal como desce o apoio entre pares de 63,6% para 47,1%. Também se regista uma descida relativamente à pesquisa de 60,6% para 38,3%, à ligação entre o AWI e os conteúdos curriculares de 75,8% para 58,8% (valor acompanhado de um crescimento significativo na categoria “Indeciso”) e ao questionamento sobre a melhor forma para atingir o objetivo que baixa de 72,7% para 50,1%. Os resultados mostram que a fase inicial desperta momentos de maior entusiasmo, possivelmente motivado pela novidade, e que à medida que as tarefas são mais exigentes e complexas a perceção tende a diminuir, no entanto, pode-se indicar que a avaliação é globalmente positiva, confirmando o potencial pedagógico dos AWI, enquanto promotores do envolvimento ativo e do trabalho colaborativo.

4.2 Perceção após a utilização do AWI

Os resultados da tabela 3, mostram a perceção dos alunos após utilização efetiva do AWI como sala de aula. As afirmações são das fases anteriores (ideação e personalização), o que inviabiliza uma comparação direta entre os dados. Nas fases anteriores, pretendeu-se ter a perceção sobre o processo cocriação e personalização da sala, nesta fase a perceção sobre a experiência de frequentar aulas no ambiente imersivo. Os resultados continuam a evidenciar uma perceção globalmente positiva, com a maioria das respostas nas categorias “Concordo” e “Concordo totalmente”, apesar de se observar um número significativo de respostas na categoria “Indeciso”. A maioria dos alunos indicou ter gostado de ter aulas (70,6%) e de aprender (76,4%) no AWI, 70,6% dos alunos gostaria de continuar a utilizar AWI nas aulas de Inglês, e 76,5% manifesta interesse em utilizar noutras disciplinas. Estes resultados evidenciam, por parte dos alunos, um elevado nível de aceitação relativamente à utilização do AWI como ambiente de aprendizagem e uma predisposição para

Table 4: Perceção dos alunos ao longo das três fases da intervenção

Fase da Intervenção	Tipo de motivação avaliada	Aumentou (%)	Manteve-se (%)	Diminuiu (%)
Pós-ideação (1)	Para aprender inglês	42,4	57,6	0
	Para construir o AWI	66,7	33,3	0
Pós-personalização (2)	Para aprender inglês	44,1	55,9	0
	Para aprender no AWI	70,6	29,4	0
Pós-utilização (3)	Para aprender inglês	44,1	55,9	0
	Por ter planificado/personalizado/utilizado o AWI	47,1	52,9	0

integrar os AWI de forma regular em contexto educativo, como complemento ao ensino tradicional. Esta aceitação é acompanhada por uma perceção de eficácia pedagógica uma vez que 67,7% dos alunos considera que os AWI facilitam a aprendizagem, o que reforça o potencial pedagógico do AWI. Apesar dos dados demostrarem uma perceção muito positiva, é de destacar que cerca de de um terço dos alunos assinalou a categoria "Indeciso", principalmente nas afirmações relacionadas com o impacto da construção e personalização do AWI na aprendizagem e motivação. Por exemplo, 61,7% dos alunos afirmaram que participar na construção e personalização do AWI facilitou a sua aprendizagem, mas 35,3% permaneceram indecisos. De modo semelhante, 64,7% reconheceram que a utilização da sala, independentemente de terem construído ou personalizado facilitou a aprendizagem, enquanto 32,4% permaneceram indecisos. 55,9% dos alunos indicaram que por terem construído/personalizado a sala, aumentou a motivação para saber mais sobre os conteúdos da disciplina, enquanto 38,2% se mantêm indecisos e, 64,7% atribuíram esse aumento de motivação à utilização da sala, no entanto, 29,4% dos alunos referem que estão indecisos. Este número de alunos indecisos, apesar de não invalidar os resultados positivos obtidos, reforça a importância de em futuras intervenções, utilizar instrumentos de recolha de dados, que permitam compreender o porquê destas perceções. Fatores como a novidade da experiência, dificuldades técnicas enfrentadas durante a experiência e que foram repostadas pelos alunos, ou a complexidade em refletir sobre o processo de aprendizagem, podem justificar estes dados.

4.3 Impacto na motivação dos alunos

A análise comparativa dos dados recolhidos nas três fases da intervenção está sintetizada na Tabela 4.

Em geral, os dados mostram, ao longo das três fases, uma estabilidade nos níveis de aumento de motivação para aprender inglês com percentagens muito próximas. Em nenhuma das fases, foi registada uma diminuição da motivação, o que reforça o impacto positivo da intervenção. Contudo, observam-se variações distintas entre as fases consoante o tipo de motivação avaliado. Na fase pós-ideação, 66,7% dos alunos referiram um aumento da motivação para construir o AWI, valor o superior ao aumento da motivação para aprender inglês (42,4%). Este resultado pode estar relacionado com o carácter inovador, criativo e colaborativo da tarefa de desenhar a sala imersiva, bem como com o interesse suscitada pela possibilidade de utilização de óculos de realidade virtual. As observações dos alunos reforçam esta perceção da dimensão prática e visual do projeto "gostei de desenhar a sala com os colegas". Na fase pós personalização, observa-se um aumento da motivação para aprender no AWI (70,6%), enquanto o aumento da motivação para aprender inglês é de 44,1% Estes resultados sugerem que o envolvimento ativo dos alunos na personalização o espaço virtual é um fator potenciador da motivação para aprender, sobretudo por via da exploração de novas formas de interação com os conteúdos e com os colegas. Esta ideia é corroborada por comentários como "gostei de trabalhar em grupo e de construir algo com os meus colegas" ou "adorei trabalhar nas salas imersivas". Na fase pós-utilização do AWI como sala de aula, verifica-se que 44,1% dos alunos referem um aumento da motivação para aprender inglês (mantendo-se nos mesmos níveis registados na fase anterior). Quando se analisa a perceção sobre o impacto de terem sido os próprios alunos a planear, personalizar e utilizar o ambiente, 47,1% afirma que essa experiência contribuiu para um aumento a sua motivação. Embora o valor seja ligeiramente inferior aos valores observados anteriormente, estes resultados continuam a refletir perceções positivas. Os constrangimentos técnicos, como por exemplo dificuldades de utilização das plataformas, reportados por alguns alunos, podem ter condicionado parcialmente a experiência, justificando a descida nos níveis de motivação.

A análise comparativa permite concluir que envolver alunos nas diferentes fases (ideação, construção e/ou personalização e utilização do AWI) teve um impacto positivo na sua motivação para aprender. Apesar de alguns constrangimentos técnicos, que se verificaram durante a intervenção, a perceção dos alunos é de que os AWI possuem um elevado potencial na promoção da motivação para aprender neste tipo de ambientes, reforçando a pertinência da integração de AWI em contextos educativos.

5 Considerações finais

O presente estudo teve por objetivo compreender o impacto da participação ativa dos alunos na cocriação, personalização e utilização de um AWI na sua motivação e perceção da aprendizagem. Os dados recolhidos ao longo das três fases da intervenção, ideação, personalização e utilização do AWI, indicam que os alunos tiveram uma perceção positiva da experiência e revelam um aumento na motivação para aprender. Os dados das fases de ideação (desenho) e personalização da sala demonstraram que os alunos gostaram e se envolveram na atividade, participando colaborando com os colegas. Os resultados da fase de utilização do AWI como sala de aula, sugerem que esta contribuiu para consolidar a perceção quanto à de utilidade dos AWI na aprendizagem de conteúdos, apesar de algumas dificuldades técnicas referidas que podem ter condicionado a experiência. Entre esses fatores surgem questões como dificuldades de acesso à sala virtual, o que destaca a importância de garantir

condições técnicas adequadas à implementação deste tipo de iniciativas. A análise comparativa entre os três momentos revelou consistência na perceção positiva dos alunos, em particular no que diz respeito ao impacto do AWI na motivação para explorar novas formas de aprender. Não se registaram, em nenhuma das fases, respostas que indicassem diminuição da motivação, o que reforça o potencial educativo da combinação entre ambientes imersivos e metodologias ativas.

Embora esta fase inicial do estudo se tenha centrado numa análise quantitativa da motivação e perceção dos alunos, os resultados permitem identificar tendências positivas sobre a integração pedagógica de ambientes imersivos cocriados, bem como estabelecer relações diretas entre o processo de cocriação de AWI com os princípios do *design thinking* e de *design participativo*. O processo de cocriação do AWI seguiu as etapas de *design thinking* (empatia, ideação, prototipagem e teste) e evidenciou os princípios do design participativo, onde os alunos assumem o papel de cocriadores e e não apenas de utilizadores.

Apesar dos resultados encorajadores, este estudo apresenta algumas limitações. A amostra é limitada a um único contexto escolar e a um número reduzido de alunos, o que não permite a generalização. Além disso, a intervenção teve uma duração limitada. A análise dos impactos do AWI baseou-se na perceção dos alunos, não havendo dados que avaliem o impacto no desempenho académico. As dificuldades técnicas experienciadas podem também ter condicionado e influenciado algumas das respostas.

Em investigações futuras, é importante a realização períodos de intervenção mais prolongados, incluir amostras mais diversificadas e alargar a análise a outras disciplinas. Considera-se também relevante complementar os questionários com outros instrumentos como entrevistas e/ou observação direta, que permitam aprofundar a compreensão sobre os diferentes níveis de envolvimento dos alunos, em especial daqueles que manifestaram indecisão ou perceções menos positivas e compreender melhor impacto pedagógico destes ambientes, quer na aprendizagem de conteúdos, quer no desenvolvimento de outras competências como a colaboração, a criatividade e a autonomia, entre outras.

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Subjective Views: Video Art as a Mirror of Culture and Artistic Performance

Olhares Subjetivos: A Videoarte como Espelho da Cultura e da Performance Artística

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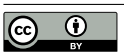
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Abstract

This article proposes the concept of documentary video art through the analysis of the role of subjectivity in videographic works of a documentary nature, as a record of artistic and cultural performances, demonstrating how the authorial perspective can enrich this type of record and broaden its interpretive horizons. Through a theoretical approach and the analysis of three case studies, *Moon Moth Bed* by Virginia L. Montgomery, A *Love Song for Latasha* by Sophia Nahli Allison, and *Consonant Camera* by E. V. Aleksandrov, the study explores how video art integrates documentary fidelity, poetic narrative, and aesthetic innovation. The concepts of the *Consonant Camera*, fragmented visual memories, and natural metaphors illustrate strategies that combine ethics, creativity, and cultural sensitivity. It is argued that video art, by transcending the boundaries between art and documentation, is an essential medium for preserving intangible cultural heritage and constructing narratives that blend critical reflection and aesthetic experience.

Resumo

Este artigo propõe o conceito de videoarte documental, através da análise do papel da subjetividade em obras videográficas de cariz documental, enquanto registo de performances artísticas e culturais, ao demonstrar como a perspetiva autoral pode valorizar este tipo de registo e ampliar os seus horizontes interpretativos. Através de uma abordagem teórica e da análise de três estudos de caso, *Moon Moth Bed* de Virginia L. Montgomery, *A Love Song for Latasha* de Sophia Nahli Allison, e *Consonant Camera* de E. V. Aleksandrov, explora-se como a videoarte articula fidelidade documental, narrativa poética e inovação estética. O conceito de *Consonant Camera*, a criação de memórias visuais fragmentadas e a utilização de metáforas naturais exemplificam estratégias que integram ética, criatividade e sensibilidade cultural. Argumenta-se que a videoarte, ao ultrapassar as fronteiras entre a arte e o documento, constitui um meio essencial para a preservação do património cultural imaterial e para a construção de narrativas que combinam reflexão crítica e experiência estética.



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CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Information systems** → Information systems applications; Multimedia information systems; • **Social and professional topics**;

Keywords

Video art, Subjectivity, Documentation, Artistic Performance, Intangible Cultural Heritage

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1 Introdução

A videoarte, enquanto linguagem interdisciplinar, tem-se afirmado como um meio relevante para o registo de práticas culturais e artísticas, ao desafiar as fronteiras entre arte e documento [1] [2]. A sua natureza experimental confere-lhe profundidade interpretativa, ao permitir que o realizador explore novas formas de expressão, questione convenções e amplie o alcance do significado cultural e artístico dos conteúdos documentados. Esta abordagem revela-se particularmente pertinente numa época em que a preservação do património cultural imaterial (PCI), exige propostas criativas e éticas [3].

Elementos subjetivos podem reforçar dimensões simbólicas e emocionais muitas vezes ausentes na documentação tradicional [4]. A linguagem versátil deste meio permite reorganizar o material registado e gerar novos sentidos, ao fixar acontecimentos efémeros e convertendo-os em objetos de reflexão crítica [5] [6].

Este artigo defende que, ao integrar ética, criatividade e sensibilidade autoral, a videoarte se pode afirmar como uma ferramenta valiosa para a preservação do PCI. Para isso, analisa três estudos de caso que ilustram estratégias distintas de articulação entre registo documental e subjetividade autoral.

2 Definição de conceitos no mundo audiovisual

2.1 O cinema, o vídeo e as suas vertentes documentais

A distinção entre cinema e vídeo, embora cada vez mais ténue na era digital, mantém a sua relevância nos estudos sobre a imagem em movimento [7] [8] [9]. Além das diferenças tecnológicas evidentes, a análise destas formas exige uma atenção particular aos seus contextos estéticos, históricos e culturais.

Desde o final do século XIX, o cinema consolidou-se como arte e indústria, com a película de 35mm a tornar-se o padrão devido à sua qualidade e controlo na captação e exibição. Este processo fotoquímico exigia um planeamento rigoroso e equipas especializadas, o que conferia um caráter artesanal à produção cinematográfica [10]. Por sua vez, o vídeo emergiu na segunda metade do século XX, inicialmente no formato analógico e posteriormente digital, e veio democratizar significativamente a produção audiovisual ao permitir gravações no imediato e uma edição simplificada. A portabilidade e acessibilidade das câmaras impulsionaram o surgimento de linguagens audiovisuais como o documentário e a videoarte [11].

No que respeita especificamente à documentação audiovisual, o cinema e o vídeo apresentam características e histórias distintas. O cinema documental, surgido no início do século XX, esteve sempre associado à utilização de película (16mm, 35mm) e a uma linguagem cinematográfica evolutiva. Devido aos elevados custos de produção e à sua complexidade técnica, exigia equipas mais robustas, o que condicionava a quantidade de filmagens, a sua distribuição predominante era destinada a salas de cinema e à televisão [12] [13]. Em contrapartida, o vídeo documental, popularizado a partir de meados do século XX, beneficiou do surgimento do vídeo analógico e da revolução digital subsequente. A utilização de câmaras portáteis permitiu democratizar o acesso à produção documental, e esse fator favoreceu linguagens mais ágeis, flexíveis e com maior incidência na captação direta [14] [15].

A nível estético e metodológico, o cinema documental associa-se tradicionalmente a um formalismo cuidado, que privilegia composições visuais mais complexas, uma iluminação controlada e uma edição rigorosa, características estas herdadas do cinema clássico, embora aceite também abordagens experimentais [16] [17] [18]. Num outro prisma, o vídeo documental adota frequentemente uma estética mais de encontro aos acontecimentos imediatos e explora a espontaneidade, com uma edição mais simples, que permite responder rapidamente aos acontecimentos registados [19] [20].

Em termos institucionais e sociais, o cinema documental continua ligado a circuitos prestigiados como festivais e salas especializadas, refletindo a sua densidade histórica e artística. O vídeo documental, por seu lado, encontrou espaço em plataformas digitais e meios televisivos, com uma maior rapidez e adaptabilidade à contemporaneidade. Esta divergência sublinha o contraste entre o prestígio histórico do cinema documental e a versatilidade e acessibilidade do vídeo documental [12] [21].

Apesar das suas diferenças, ambos coexistem no panorama audiovisual contemporâneo, enriquecendo as possibilidades de representação da realidade. A coexistência e interação contínua entre estes meios permite múltiplas abordagens, perspetivas e profundidades na representação documental, ao unir tradição e inovação tecnológica num mesmo campo visual [7] [8] [9] [13].

2.2 A videoarte e a sua capacidade documentativa

A videoarte surgiu na segunda metade do século XX, no meio de múltiplas transformações tecnológicas e culturais, caracterizada pelo seu espírito experimental e pela apropriação crítica do meio televisivo. Desde a sua génese, desafiou as convenções das artes tradicionais, com a proposição de novas formas expressivas que redefiniram os paradigmas estéticos [22]. O desenvolvimento da videoarte acompanhou os avanços nas tecnologias de captação e edição de imagem. A introdução da Sony Portapak nos anos 1960 conferiu aos artistas uma maior autonomia na produção visual e encontraram no vídeo um meio artístico prático e versátil. Este dispositivo permitiu o registo de performances e intervenções de um modo mais ágil, além de abrir espaço para a experimentação estética, com consolidação do vídeo como ferramenta de expressão criativa [23].

Com o seu surgimento num período de contestação social e cultural, a videoarte afirmou-se como um veículo de crítica à cultura de massas e à hegemonia mediática. Com promoção de discursos alternativos, desconstruiu narrativas televisivas e questionou os padrões da comunicação de massa. A relação com a televisão revelou-se ambígua, marcada por uma apropriação da sua estética, simultaneamente subvertida através de estratégias que desafiavam a sua lógica comercial e narrativa [24].

A versatilidade do vídeo possibilitou abordagens plurais, desde o registo de eventos efémeros até à criação de narrativas fragmentadas, com a exploração da interação entre imagem, som e espaço expositivo. A sua plasticidade favoreceu a conceção de instalações imersivas e obras interativas, com ampliação do diálogo com o espectador e redefinição da experiência artística [25] [26].

Com a revolução digital, a videoarte integrou novas possibilidades, como a manipulação computacional da imagem e a interatividade, com expansão das suas fronteiras expressivas [22]. Atualmente, este meio encontra-se presente em vários cenários distintos, desde o cinema experimental às instalações multimédia, com a manutenção do seu caráter dinâmico no âmbito das artes visuais [27] [28] [29].

Neste artigo propomos o conceito original de videoarte documental, entendido como uma vertente específica que combina o espírito experimental da videoarte com uma abordagem consciente e deliberada ao registo documental. Este formato híbrido explora a subjetividade autoral como um recurso de valor na construção de narrativas audiovisuais, ao permitir registar acontecimentos reais, mas também interpretá-los, ressignificá-los e ampliá-los através de estratégias estéticas inovadoras. Desta forma, a videoarte documental estabelece um paralelismo contínuo entre fidelidade documental e criatividade artística, ao tornar-se uma ferramenta eficaz para a reflexão crítica e a documentação de práticas culturais e performances artísticas.

O seu estatuto híbrido atravessa disciplinas e reflete as transformações tecnológicas e culturais do seu tempo. A sua capacidade de adaptação e experimentação desafia os limites da arte contemporânea, com a exploração de formas narrativas e imersivas que desafiam as convenções tradicionais. Ao longo das décadas, a videoarte acompanhou mudanças culturais, mas também as antecipou, com

afirmação como um espaço fértil para a inovação estética e a reflexão crítica.

3 O valor da subjetividade no contexto audiovisual

Existe na videoarte um potencial interpretativo com a capacidade de amplificar o olhar direto sobre os acontecimentos documentados, ao assumir um papel central na criação de novas narrativas e sentidos [6]. Esta capacidade é reforçada especialmente em contextos educacionais ou performativos, onde a subjetividade do realizador pode recair sobre detalhes simbólicos e emocionais muitas vezes ausentes ou secundarizados nos formatos tradicionais de documentação audiovisual [30] [31].

A dimensão colaborativa da videoarte neste contexto documental, surge como uma característica substancial, com a capacidade de criar envolvimento entre o realizador, outros artistas e sobretudo com o público, num processo ativo e interativo de criação e interpretação. Este caráter participativo contribui significativamente para uma ampliação sensorial, que converte a videoarte numa prática aberta e dinâmica, onde o acontecimento registado e o olhar subjetivo do realizador se encontram em constante comunicação [3].

Todavia, a subjetividade implica uma responsabilidade acrescida. Na documentação de práticas culturais, por exemplo, a interpretação subjetiva pode induzir a distorções, o que exige do realizador uma postura ética vigilante, mediadora e constantemente aberta ao diálogo com as comunidades ou indivíduos representados. Esta preocupação ética torna-se particularmente evidente em contextos museológicos, onde os registos são apresentados como obras autónomas, sujeitas a múltiplas reinterpretações pelo público [32] [3]. No momento da edição, o realizador deve organizar o material documentado de modo a atribuir-lhe novas camadas de significado através de decisões criativas que vão de encontro à narrativa final, mas que se mantenham fiéis aos conteúdos registados. Este processo torna a videoarte num veículo de preservação, mas também de ressignificação e criação artística, que perdura e evolui ao longo do tempo [33].

O desenvolvimento de novos conceitos e tecnologias como o Cinema Interativo e a Inteligência Artificial tem proporcionado novas janelas de oportunidades criativas, onde o valor subjetivo da videoarte permite estabelecer relações emocionais mais intimistas e interativas com o público [34].

Ao fundir memória, criatividade e interpretação crítica, a subjetividade na videoarte constitui-se como uma ferramenta interessante, na preservação de eventos culturais e performances, mas sobretudo na capacidade de proporcionar uma reflexão contínua sobre os mesmos. É através desta lente subjetiva que a videoarte se posiciona como mais uma alternativa no universo da documentação audiovisual, com a capacidade de ir ao encontro das novas gerações ao proporcionar experiências mais imersivas e multifacetadas, de modo a capturar a essência de uma realidade em constante mutação [35] [36].

4 A documentação na performance

A natureza efémera das performances, por vezes dependentes da presença física e da interação direta com o público, exige que a documentação audiovisual encontre meios eficazes para comunicar o acontecimento em si, mas também o ambiente emocional e a complexidade simbólica envolvida, de modo a criar valor estético acrescido e a ir ao encontro das novas gerações de público [2] [37]. Documentar performances artísticas através do valor estético da videoarte gera novas oportunidades de relacionamento com o público. Esta abordagem propõe uma ressignificação e expansão da experiência original, ao transforma-se numa obra autónoma, oferece ao espectador uma leitura renovada e sensível do acontecimento, e assim projeta o seu impacto emocional e intelectual [38] [3].

No processo de edição, como referido no ponto anterior, deve-se manipular cuidadosamente os conteúdos registados, de modo a garantir a intenção inicial da performance e promover uma experiência próxima da vivida pelo público presente no momento original [39] [40] [41]. Este formato de documentação audiovisual acentua-se em contextos museológicos, educativos e comunitários, onde o vídeo pode atuar como uma extensão das performances, conferindo-lhes um caráter duradouro e interativo. No espaço museológico, por exemplo, a videoarte pode transformar performances efémeras em exposições permanentes ou temporárias, proporcionando ao público múltiplas oportunidades para se envolver criticamente com a obra [37] [42].

A documentação performativa na videoarte possui o potencial de reforçar o envolvimento comunitário, através da promoção de práticas culturais de grupos negligenciados ou comunidades alienadas, com a criação de oportunidades para que os mesmos se revejam nas obras desenvolvidas [43]. O processo de reconhecimento e identificação apresenta a capacidade de desencadear uma experiência significativa e duradoura, detentora de um legado perdurável no tempo. Pode ainda consolidar os vínculos culturais e emocionais entre o público e as performances documentadas, através do estabelecimento de uma relação reflexiva, de modo a instaurar uma conexão permanente entre memória, presença e interpretação.

Podemos então pressupor que a videoarte, ao agir como agente de preservação, pode construir uma experiência integradora e participativa, onde o público desempenha um papel central na produção de significado. Esta interação permanente assegura que a performance documentada mantenha a sua vitalidade e relevância cultural [38] [37]. A preservação desta dinâmica garante a constante ressignificação do evento, através da criação de canais interpretativos abertos entre o momento original e o público no momento expositivo. O espaço museológico adquire assim uma função ativa na permanente reformulação artística e conceptual do registo [44] [45] [38].

Nesse espaço de tensão criativa, o valor documental do vídeo ganha nova dimensão, ao ultrapassar o simples testemunho para se consolidar como mediador cultural e amplificador de significados. É precisamente na oscilação entre arte e documento que o registo videográfico atinge o seu pleno potencial. O que se fixa na lente não só conserva, mas também acrescenta valor, ao convidar a reflexões e diálogos contínuos em torno das práticas culturais e performativas, provando assim que a harmonia entre subjetividade e rigor documental se torna, numa última instância, uma força criativa [41] [46].



Figure 1: Imagem de um plano da curta-metragem *Moon Moth Bed*, fonte: hellovlm.com

5 Estudos de caso

5.1 *Moon Moth Bed*, de Virginia L. Montgomery

A obra *Moon Moth Bed*, da artista norte-americana Virginia L. Montgomery [47], constitui um exemplo significativo da capacidade da videoarte para conjugar expressão subjetiva e função documental. Neste trabalho, a artista combina imagens de mariposas e elementos simbólicos do corpo humano para construir uma narrativa visual centrada na metamorfose, feminilidade e ciclos de transformação pessoal. O título remete à mariposa-lua (Actias luna), cuja metamorfose funciona como metáfora de vulnerabilidade e renovação. Através de uma abordagem poética e sensorial, Montgomery [47], relaciona o processo biológico das mariposas com experiências humanas de transição e resiliência, explorando as interseções entre o biológico, o simbólico e o cultural.

A cama surge como elemento simbólico central, representando um espaço de transformação, nascimento e repouso. Montgomery justapõe imagens de mariposas a emergir de casulos a fragmentos do corpo humano e objetos domésticos, criando um s entre o microcosmo natural e questões universais da existência. O motivo do casulo, associado à metamorfose, é trabalhado em paralelo com o corpo feminino, sugerindo um processo contínuo de regeneração que transcende o plano biológico. Esta articulação é acentuada pela montagem, que alterna momentos de contemplação com sequências em câmara lenta, reforçando o caráter introspectivo da obra.Embora *Moon Moth Bed* não seja uma performance ao vivo, incorpora elementos performativos, como gestos de mãos e interações da artista com elementos naturais, que reforçam a sua presença enquanto mediadora da experiência criativa. A câmara opera de forma próxima e subjetiva, permitindo observar texturas, movimentos e detalhes que intensificam a ligação entre natureza e simbolismo. Este enquadramento íntimo sublinha a abordagem autoral de Montgomery [47], que recorre à subjetividade como recurso criativo para evocar reflexões sobre identidade e mudança.

A montagem combina planos de mariposas e objetos humanos com sobreposições visuais e manipulações digitais que criam uma atmosfera etérea. O áudio, composto por sons de asas, água e paisagens sonoras, amplia a imersão sensorial. Esta fusão de elementos visuais e auditivos transforma a obra numa narrativa estética e simbólica, que transcende a documentação de um fenómeno natural.

O trabalho de Montgomery [47], evidencia o potencial da videoarte no registo documental e na criação artística. Ao captar o ciclo de vida das mariposas-lua, a artista interpreta esse processo de forma subjetiva, associando-o a temas como vulnerabilidade, transformação e resiliência. Tal abordagem demonstra que a videoarte, ao integrar subjetividade e simbolismo, pode converter o registo factual numa experiência estética que convoca a emoção e o pensamento crítico.

5.2 *A Love Song for Latasha*, de Sophia Nahli Allison

A curta-metragem *A Love Song for Latasha*, dirigida por Sophia Nahli Allison [48], constitui um exemplo notável da capacidade da subjetividade na prática documental audiovisual, na superação das convenções tradicionais do género e ao alinhar-se com as expressões estéticas da videoarte. A obra recapitula a trajetória de Latasha Harlins, uma jovem afro-americana cuja morte em 1991 intensificou tensões sociais que culminaram nos distúrbios de Los Angeles em 1992. Através de uma abordagem poética e não linear, Allison [48], reconfigura a memória de Latasha, posicionada como figura central



Figure 2: Imagem de um plano da curta-metragem *A Love Song for Latasha*, fonte: imdb.com.

da sua comunidade, com a exploração dos significados simbólicos das suas aspirações.

A narrativa organiza-se enquanto evocação lírica da vida de Latasha, com recurso a testemunhos de amigos e familiares, imagens recriadas, animações e sobreposições visuais. Em vez de reconstruir cronologicamente os eventos da sua morte, o filme celebra a sua existência, com destaque para o seu impacto pessoal e coletivo. A perspetiva subjetiva confere à obra uma profundidade íntima, com as vozes de quem conviveu com Latasha entrelaçadas à visão autoral da realizadora, em distinção das formas documentais ortodoxas.

Entre os recursos estilísticos, sobressaem as animações e as sobreposições visuais, que estabelecem uma ligação simbólica entre imagem e imaginário, com aproximação do filme à videoarte. Estes elementos configuram uma reflexão visual sobre identidade, memória e justiça social. O design sonoro, composto por depoimentos, paisagens sonoras elaboradas e silêncios estratégicos, intensifica a imersão emocional, com dispensa da narração convencional e promoção de uma abordagem sensorial.

A estrutura fragmentária, construída a partir de memórias e afetos, apresenta Latasha como uma figura complexa, em desafio ao reducionismo frequentemente associado à cobertura mediática de vítimas de violência. A obra adota uma hermenêutica interpretativa que privilegia a subjetividade, com subversão das convenções do documentário tradicional e prioridade a uma representação simbólica e afetiva.

A dimensão ética da obra manifesta-se na amplificação das vozes de pessoas próximas de Latasha, com preservação da sua memória em dignidade. Allison [48], consagra o meio audiovisual como um espaço de justiça simbólica, com reivindicação do lugar de Latasha no imaginário histórico e cultural, em contato com os princípios da videoarte, que mobiliza subjetividade e experimentação para reconfigurar narrativas sociais.

5.3 *Consonant Camera*, de E. V. Aleksandrov

O projeto *Consonant Camera*, delineado por Aleksandrov [49], apresenta uma abordagem inovadora à documentação de práticas culturais e religiosas, com ênfase na subjetividade e na relação de confiança entre o realizador e os sujeitos filmados. Desenvolvido no contexto das comunidades dos Velhos Crentes na Rússia, o projeto introduz o conceito de *Consonant Camera*, fundamentado num modelo de documentação colaborativo e empático, com integração do ritmo e dos valores das comunidades retratadas.

Os Velhos Crentes, grupo religioso que se separou da Igreja Ortodoxa Russa no século XVII, mantêm tradições culturais e litúrgicas que resistem às influências da modernidade. Aleksandrov [49], destaca a necessidade de uma abordagem documental que respeite os códigos culturais dessas comunidades, com promoção de uma comunicação constante. A *Consonant Camera* incorpora tal sensibilidade, com rejeição de uma postura distanciada e adoção de um registo audiovisual que privilegia a autenticidade cultural e os seus referentes simbólicos. A metodologia assenta em três princípios fundamentais:

- Empatia, que permite ao realizador uma integração respeitosa no ambiente cultural, com captação de momentos significativos da vida comunitária;
- Colaboração, na qual os membros da comunidade participam ativamente, com seleção de momentos e perspetivas representativas;
- Respeito pelos códigos culturais, com garantia de que as escolhas narrativas e estéticas evitam a descontextualização ou a banalização dos elementos registados.

Aleksandrov sintetiza, nestes princípios, a integração ética da subjetividade no processo documental. O projeto abrange o registo de rituais religiosos, cânticos litúrgicos e cenas do quotidiano, com recurso a uma estética contemplativa. A câmara capta gestos e expressões, com transmissão da intensidade simbólica das práticas. Tal abordagem alinha-se com a videoarte, ao construir uma narrativa visual que transcende o registo factual e incorpora elementos interpretativos. A montagem organiza o material de modo a refletir o ritmo dos rituais e o ambiente emocional, com criação de uma experiência imersiva para o espetador.

A subjetividade do realizador, em vez de comprometer a fidelidade do registo, enriquece a representação cultural, com adição de camadas de significado emocional e simbólico que uma abordagem estritamente objetiva não alcançaria. Aleksandrov [49], materializa esta dimensão através de planos detalhados de objetos rituais, manipulações subtis de luz e uma seleção meticulosa de momentos que revelam a conexão entre os participantes e as suas práticas. Esta articulação entre fidelidade cultural e expressão autoral reforça a pertinência da metodologia para a documentação do PCI.

Além do seu valor documental, o projeto contribui para a revitalização da memória cultural. Aleksandrov [49], sublinha que o vídeo não se limita à preservação, mas constitui um meio de reaproximação entre as comunidades e as suas tradições, especialmente entre as gerações mais jovens, que redescobrem o seu património por via da mediação audiovisual. O conceito de Aleksandrov [49], propõe uma metodologia que concilia autenticidade cultural e sensibilidade autoral, com aproximação à videoarte pela integração de estética e emoção no processo documental.

6 Conclusão

A análise realizada ao longo deste artigo demonstra como a videoarte, ao integrar subjetividade, ética e inovação estética, pode funcionar como um meio valioso para a documentação de performances artísticas e práticas culturais. Os estudos de caso abordados, Moon Moth Bed, de Virginia L. Montgomery [47], A Love Song for Latasha, de Sophia Nahli Allison [48], e Consonant Camera, de E. V. Aleksandrov [49], oferecem exemplos concretos de abordagens que transcendem os limites da documentação convencional, ao proporem formas de registo que valorizam a interpretação autoral e o envolvimento sensorial. Estes exemplos revelam que a subjetividade, contribui para uma representação apelativa e abrangente dos fenómenos culturais e artísticos.

O conceito de Consonant Camera proposto por Aleksandrov [49], exemplifica uma abordagem de colaboração e respeito mútuo que reforça a legitimidade do registo videográfico como documento cultural. A sua metodologia mostra que a confiança entre o realizador e a comunidade documentada garante uma maior autenticidade e permite que a documentação ultrapasse a simples observação para se transformar numa experiência imersiva e significativa. De forma semelhante, A Love Song for Latasha explora a memória e a justiça simbólica através de uma narrativa visual e sonora que recria o legado de Latasha Harlins, ao evidenciar como o registo videográfico pode simultaneamente preservar e reinterpretar a história. Por sua vez, Moon Moth Bed reflete sobre os ciclos naturais e a condição humana, com recurso à metamorfose enquanto metáfora para processos de transformação e resiliência.

A reflexão sobre estes estudos de caso valida a documentação através da subjetividade da videoarte, ao demonstrar que o registo videográfico não se limita à reprodução factual, mas amplia o seu potencial ao dialogar com os elementos simbólicos, emocionais e éticos das práticas culturais e artísticas. Esta abordagem preserva os eventos documentados e contribui para a construção de narrativas que promovem uma compreensão mais abrangente do PCI, ao envolver o espetador numa reflexão crítica e estética. A videoarte, assim, posiciona-se como um meio que conecta o passado ao presente, permitindo a coexistência de memória, interpretação e expressão artística.

Podemos concluir que a documentação através da videoarte pode perpetuar o PCI, e paralelamente transformá-lo em objeto de reflexão contemporânea. Com a integração de subjetividade no processo de registo, a videoarte beneficia a experiência do observador e amplia o impacto das obras enquanto ferramentas de preservação e projeção cultural. Os estudos de caso analisados comprovam que este meio se torna uma ferramenta de valor ao abordar a complexidade das práticas culturais, ao conjugar rigor documental com liberdade interpretativa, e reafirma assim a sua relevância no campo da documentação e das artes visuais. Este equilíbrio entre subjetividade e documentação posiciona a videoarte como uma linguagem a ter em conta na preservação e na reinterpretação do PCI no século XXI.

Reconhecimentos

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Videogame as Emotional Mediation: an Interactive Installation in Media Arts

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Abstract

Videogame as Emotional Mediation: an Interactive Installation in Media Arts is configured as a theoretical-practical investigation within the field of media arts, focused on exploring processes of sensory and affective mediation through the articulation of videogame, light, and sound. It starts from the hypothesis that these elements, when integrated into the exhibition space, are capable of creating immersive atmospheres that catalyze emotional states and expand the viewer's perceptual agency. The conceived installation proposes a multidimensional sensory environment, in which visual and sound elements operate as aesthetic components and performative instances that guide the participant's experience. The videogame, as a narrative and interactive device, is conceived as a mediator of experience, promoting a symbolic relationship between body, space, and action. The methodology assumes an empirical and interactive nature, articulating three main dimensions: theoretical review, technical experimentation, and documentation of the creative process. The bibliographic research focuses on contributions from the phenomenology of perception, emotional design, sensitive interaction, and game feel. The prototyping process will be carried out using digital and electronic tools, with emphasis on the expressive possibilities of chromatic combinations, sound variations, and interaction modes.

Résumé

Videojogo como mediação emocional : uma Instalação Interativa em Media Arts configura-se como uma investigação teórico prática no âmbito das Media Arts, focalizada na exploração dos processos de mediação sensorial e afetiva, por meio da articulação entre videojogo, luz e som. Parte-se da hipótese de que tais elementos, mobilizados de forma integrada no espaço expositivo, são capazes de instaurar atmosferas imersivas que catalisam estados emocionais e ampliam a agência percetiva do espectador. A instalação concebida propõe um ambiente sensorial multidimensional, no qual os elementos visuais e sonoros operam como componentes estéticos e instâncias performativas que orientam a experiência do participante. O videojogo, enquanto dispositivo narrativo e interativo, é pensado como mediador da experiência, promovendo uma relação simbólica entre corpo, espaço e ação. A metodologia assume natureza empírica e interativa, articulando três dimensões principais : revisão teórica, experimentação técnica e documentação do processo criativo. A investigação bibliográfica incide sobre contributos da fenomenologia da perceção, do design emocional, da interação sensível e do game feel. O processo de prototipagem será conduzido com ferramentas digitais e eletrónicas, com ênfase nas possibilidades expressivas das combinações cromáticas, variações sonoras e modos de interação.

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CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Media Arts, Interactive Installation, Emotional Mediation, Game Feel

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1 INTRODUÇÃO

"A experiência artística interativa redefine a fronteira entre observador e obra, transformando cada gesto num elemento co-criativo" [1]. Desde as primeiras experiências cinéticas e cibernéticas da arte do século XX, a luz deixou de ser mero instrumento de visibilidade para se tornar matéria expressiva e mediadora. Cruz-Diez, em *Chromosaturation* [2], mergulha o espectador em câmaras monocromáticas, explorando sensações de dissolução do contorno e transcendência sensorial. Turrell, em *Skyspace I* (1975), converte os espaços arquitetónicos em vastos planos de cor que evocam nostalgia, contemplação coletiva e consciência do corpo no mundo [3]. Mais recentemente, Eliasson, em *Your Rainbow Panorama* [4], e Munro, em *Field of Light* [5], demonstraram como padrões circulares e pulsantes podem gerar estados de encantamento e pertencimento. No entanto, tais obras concentram-se sobretudo na reação afetiva e poucas aprofundam o papel da luz como instrutor de ações, em diálogo com ambientes digitais interativos.

No campo das *Media Arts*, Tribe e Jana [6] destacam que a interatividade redefine o estatuto da obra: ela só se completa na presença do espectador, cujo corpo e gesto modulam sistemas em tempo real. A fenomenologia da perceção reforça esse ponto: "é pelo corpo que habitamos o espaço" [7], implicando que qualquer interface que envolva luz, cor ou som atua diretamente no campo vivido do

participante. Por outro lado, a literatura de HCI Norman [8] e Hassenzahl [9] enfatiza que componentes visuais e hedónicos são tão determinantes quanto a usabilidade, mas ainda privilegia elementos gráficos em ecrã ou resposta háptica via controlos físicos. Pouco se investiga, entretanto, o potencial da luz programável como canal instrucional, capaz de orientar o gesto do utilizador num ambiente lúdico complementar.

No domínio dos videojogos, Swink [10] introduziu o conceito de *game feel*, sublinhando que a latência mínima entre ação e *feedback* é crucial para a continuidade motora e o envolvimento emocional. Bogost [11] e Sicart [12] ampliaram a discussão ao mostrar que as regras e a poética do ato de brincar produzem significado e retórica procedimental. No entanto, tais estudos concentram-se na experiência confinada ao ecrã ou ao controlador, raramente considerando a luz externa como parte integrante da interface lúdica. O vácuo teórico criado por essa lacuna convida a explorar, de modo sistemático, de que forma um anel de luz com sua forma circular carregada de arquétipos de totalidade e passagem [13 - 16] pode assumir simultaneamente funções de mediação emocional e de guia instrucional em sincronia com um videojogo digital.

Essa lacuna teórica e prática, situada entre as instalações sensoriais e os sistemas lúdicos interativos, sustenta o problema central desta investigação: como a luz, enquanto linguagem programável e sensível, pode assumir simultaneamente um papel estético e instrucional numa experiência mediada pelo corpo? A relevância do estudo reside na proposta de deslocar o foco das interfaces gráficas tradicionais para uma abordagem imersiva e sinestésica, onde o anel de luz se torna ponte entre o gesto e a emoção, entre o jogo e o espaço expositivo.

O objetivo geral da investigação é compreender como o videojogo, inserido numa instalação interativa em *Media Arts*, pode funcionar como agente de mediação emocional, articulando o espaço físico para orientar a ação do participante e enriquecer a sua experiência sensorial. Os objetivos específicos incluem: (1) desenvolver uma instalação imersiva que articule luz, som e videojogo como instrumentos expressivos e instrutivos; (2) explorar padrões cromáticos e sonoros capazes de evocar estados afetivos distintos; (3) investigar como a experiência física pode ser refletida poeticamente no videojogo; e (4) recolher e analisar as perceções do público por meio de observação direta e futura avaliação qualitativa.

Assim sendo, a questão que se procura explorar é: de que forma a manipulação de luz e do som, em uma instalação artística interativa, pode atuar como mediadora de experiências sensoriais e emocionais, e como essa experiência pode ser refletida e complementada em um videojogo?

2 TRABALHOS RELACIONADOS

2.1 Arte da Luz em Instalações

Desde as primeiras experiências cinéticas e cibernéticas da arte do século XX, a luz deixou de ser mero instrumento de visibilidade para se tornar matéria expressiva e mediadora. Schöffer [17], em *Cybernetic Tower* (1961), explorava a retroalimentação entre público, som e movimento, antecipando o diálogo entre corpo e sistema que caracteriza as instalações interativas contemporâneas.

Nos anos 1960, Carlos Cruz-Diez aprofunda essa dimensão perceptiva com *Chromosaturation* [2], transformando a cor-luz em experiência pura. Ao imergir o espectador em câmaras monocromáticas, o artista rompe com a luz como mero meio e a propõe como ambiente fenomenológico, onde o corpo é o filtro e o sensor da própria obra.

Já James Turrell, em projetos como *Skyspace I* (1975) [3], expande essa noção ao incorporar a luz como presença física e espiritual, provocando um estado de consciência espacial e emocional.

Nas últimas décadas, obras como *Your Rainbow Panorama* [4] de Olafur Eliasson e *Field of Light* [5] de Bruce Munro demonstram que a luz pode ser simultaneamente estrutura e emoção. Eliasson concebe espaços onde a cor envolve e desorienta, forçando uma escuta do corpo; Munro cria campos de LEDs pulsantes que evocam organicidade, memória e transcendência.

Ambos deslocam a luz do domínio da técnica para o da empatia sensorial, em que o público não observa, mas sente um princípio que ecoa diretamente na instalação na instalação denominada Imerge, nome atribuído à estrutura imersiva concebida para esta investigação. Tal como essas obras, *Imerge* entende a luz não apenas como elemento estético, mas como agente relacional. A circularidade do anel de LEDs remete simbolicamente à totalidade e à passagem [13–16], ao mesmo tempo em que atua como mediador entre o gesto e o espaço. A luz instrui, emociona e responde, convertendo-se num vocabulário vivo entre artista, máquina e participante. Assim, o projeto situa-se na linhagem da arte luminosa contemporânea, mas introduz um novo eixo: a fusão entre luz e lógica interativa, onde cada cor e cada ritmo têm função afetiva e cognitiva.

2.2 Interatividade e Mediação Sensorial

No campo das *Media Arts*, Mark Tribe e Reena Jana [6] sublinham que a interatividade redefine o estatuto da obra: ela só se completa na presença do espectador, cuja ação se torna parte da composição. Esse princípio desloca o público da posição de observador para a de coprodutor da experiência, transformando a interação em linguagem. Essa visão encontra ressonância na *Imerge*, onde o visitante não apenas contempla a obra, mas participa de um sistema que reage sensorialmente à sua presença.

A fenomenologia da perceção, formulada por Maurice Merleau-Ponty [7], reforça essa relação entre corpo e espaço: é através do corpo que habitamos o mundo e lhe atribuímos sentido. Na instalação interativa, essa ideia manifesta-se na forma como o corpo se torna interface, um mediador vivo entre estímulo e resposta. Em *Imerge*, a luz e o som operam exatamente nesse campo vivido, atuando como extensões sensíveis do gesto e como mediadores de estados afetivos.

Autores como Donald Norman [8] e Marc Hassenzahl [9] acrescentam que o valor emocional de uma experiência tecnológica depende tanto do prazer estético quanto da usabilidade. No entanto, as abordagens tradicionais do design emocional tendem a privilegiar interfaces gráficas e hápticas, relegando a luz e o som a papéis secundários. O projeto *Imerge* contrapõe-se a essa limitação ao propor uma interface sinestésica e não-verbal, em que o *feedback* não ocorre por botões ou menus, mas por gradientes cromáticos e variações sonoras.

Essa conceção aproxima-se da noção de "interação sensível", onde o comportamento do sistema é percebido como uma forma de escuta recíproca. A luz não apenas informa; ela sente e comunica. A interatividade torna-se, assim, uma mediação afetiva, onde cada oscilação luminosa traduz a presença e a emoção do corpo no espaço. Nessa perspetiva, *Imerge* amplia a ideia de imersão: não se trata de "entrar" num videojogo, mas de habitar um espaço que responde poeticamente à nossa existência física.

2.3 *Game Feel* e Experiência Lúdica

No domínio dos videojogos, Steve Swink [10] introduz o conceito de *game feel*, que descreve a sensação tátil-visual gerada pela resposta imediata entre ação e *feedback*. Essa relação de continuidade motora e emocional é essencial para a imersão, o corpo precisa sentir que o sistema o escuta. Outros autores, como Ian Bogost [11] e Miguel Sicart [12], ampliam esse entendimento ao considerar o jogo como ato simbólico e expressivo, onde a interação cria significado.

No entanto, essas discussões permanecem, em grande parte, confinadas à experiência dentro do ecrã. *Imerge* propõe uma expansão desse paradigma ao transportar a lógica do *game feel* para o espaço físico. Aqui, o *feedback* não é apenas visual ou háptico, mas luminoso e atmosférico. A luz pulsa, respira e reage como se fosse o próprio corpo do jogo, criando uma continuidade entre ação e emoção que transcende o controlo manual. O jogador não manipula a experiência: ele é imerso nela, guiado por um sistema que o conduz pela perceção sensorial.

Essa relação híbrida entre o lúdico e o sensorial faz emergir uma nova forma de jogo, um jogo de presença. A *Imerge* não depende de objetivos tradicionais ou pontuação; a sua ludicidade reside na descoberta fenomenológica, na escuta do próprio sentir. Ao integrar luz, som e gesto, o projeto desloca o foco da jogabilidade para a vivência estética, onde o prazer vem da sintonia entre corpo e ambiente.

Dessa forma, o conceito de *game feel* é ressignificado: não mais como sensação de controlo, mas como experiência de reciprocidade. O sistema responde, mas também provoca; orienta, mas também acolhe. Essa ambiguidade, entre guiar e ser guiado, traduz-se numa retórica poética que aproxima o jogo da instalação artística e reafirma o papel da luz como mediadora emocional e cognitiva.

3 CONCEÇÃO E DESENVOLVIMENTO DA OBRA

A instalação desenvolvida assume a forma de uma estrutura circular suspensa, composta por um anel de LEDs endereçáveis que envolve uma estrutura metálica a uma altura média do chão[1]. Esta estrutura funciona simultaneamente como limite visual, foco de atenção e dispositivo expressivo. No centro da instalação, o visitante interage com o sistema através de um plinto, onde se encontram os auscultadores, um controlador físico e, no interior do círculo, um tecido branco que serve como superfície de projeção para a componente visual do jogo. A escolha da forma circular não é apenas estética: ela carrega significados simbólicos associados à totalidade, ao ciclo e à passagem, funcionando como um portal sensorial que marca a entrada numa experiência distinta do quotidiano.

[1]Vídeo ilustrativo da obra: https://youtu.be/b8InqPGwovo

A luz, neste contexto, não é usada como mero elemento decorativo, mas sim como o principal canal de comunicação da instalação. Cada sequência cromática foi cuidadosamente pensada para evocar estados emocionais específicos: tons frios remetem à introspeção e à tristeza; tons quentes sugerem urgência ou ação; os padrões de ritmo e intensidade funcionam também como instruções para o visitante. O videojogo não ocupa o centro da experiência, mas atua como componente complementar, traduzindo digitalmente as transformações geradas pela interação com o espaço físico. Assim, luz, som e videojogo formam uma tríade sinérgica que medeia a relação entre o corpo do participante e o ambiente envolvente.

Esta abordagem foi concebida para favorecer a criação de um campo afetivo, onde a imersão resulta da confluência entre estética, narrativa simbólica e resposta sensorial. A obra, portanto, foi desenvolvida para transformar a instalação num organismo vivo, no qual o visitante participa numa coreografia de luz, ativando uma experiência emocional única.

3.1 Etapas Técnicas: Conexões Eletrónicas

Durante a fase de desenvolvimento físico da instalação, foram realizados testes manuais de conexão entre o Arduino e os componentes do anel de LEDs. Esta etapa foi fundamental para validar a resposta da estrutura às instruções seriais enviadas pela aplicação desenvolvida em Unity (Figura 1).

3.2 Esboço Conceitual da Instalação

Para guiar a montagem da estrutura, foi desenvolvido um esboço conceitual que indica a posição dos principais elementos da instalação: o anel de LEDs, o tecido branco para projeção e os comandos de interação. Este desenho serviu como base para refletir a lógica espacial e a disposição dos componentes (2).

4 METODOLOGIA

A metodologia adotada neste projeto assume um carácter exploratório e empírico, combinando práticas de prototipagem técnica, investigação sensorial e documentação reflexiva. Trata-se de um processo híbrido, típico das *Media Arts*, que articula o desenvolvimento de interfaces interativas com experimentações poéticas em tempo real. A proposta distingue-se por integrar um anel físico de luz como elemento instrucional, não apenas decorativo ou imersivo, atuando como ponte entre corpo, jogo e espaço expositivo. Essa abordagem busca expandir a noção tradicional de interface, deslocando-a do ecrã para o ambiente físico, e propondo uma experiência estética sinestésica. O projeto organiza-se em quatro fases metodológicas complementares, descritas a seguir:

4.1 Fase 1: Prototipagem

A instalação *Imerge* foi concebida como um sistema híbrido entre espaço físico e videojogo, explorando a comunicação entre uma estrutura luminosa circular e um videojogo desenvolvido em *Unity*. A forma circular da obra simboliza passagem, continuidade e totalidade, uma metáfora visual e sensorial que orientou todas as decisões conceptuais e técnicas.

O processo criativo teve início com explorações gráficas e conceptuais que definiram a atmosfera emocional da instalação, seguidas pela construção de um protótipo físico de anel luminoso composto

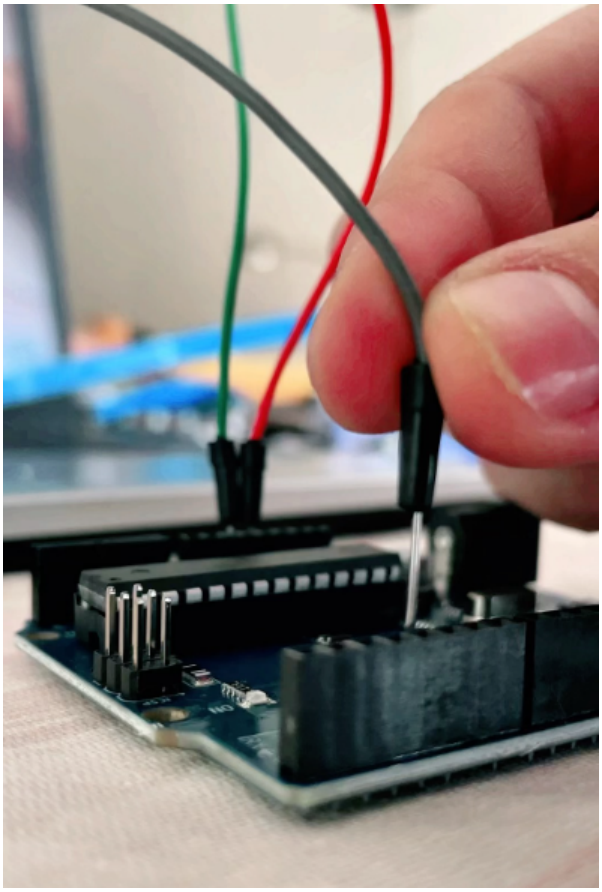


Figure 1: Testes manuais de conexão dos fios ao Arduinos, etapa essencial para o controlo dos LEDs na instalação. Esboço Conceitual da Instalação

por 240 LEDs endereçáveis. Essa estrutura foi conectada a um microcontrolador Arduino, responsável por interpretar e executar padrões de luz enviados pela aplicação em *Unity*.

A comunicação entre os dois sistemas foi realizada por porta serial, permitindo sincronização em tempo real entre estímulos digitais e respostas luminosas. Esse canal tornou-se o núcleo da obra, garantindo que a luz deixasse de ser um elemento decorativo para se tornar um agente comunicativo ativo, capaz de responder a eventos do jogo e provocar perceções emocionais distintas.

Paralelamente, a componente digital foi concebida em *Unity* como uma extensão da instalação física, reforçando a continuidade sensorial entre o espaço físico e o videojogo. Cada teste de integração constituiu uma oportunidade de afinar a relação entre estímulo e resposta, configurando um processo contínuo de experimentação e escuta, tanto tecnológica quanto poética.

A Figura 3 apresenta um excerto do script em Unity responsável por enviar os parâmetros de luz e posição ao Arduino, demonstrando a lógica de controlo do anel de LEDs baseada na posição do jogador e no modo de interação.

4.2 Fase 2: Prototipagem e Desenvolvimento Técnico

A fase de prototipagem seguiu uma lógica iterativa de testar, observar e reformular, característica dos processos de investigação artística em meios tecnológicos. Cada iteração envolveu não apenas ajustes técnicos, mas também decisões estéticas, pois as alterações na cor, intensidade ou ritmo de luz produziam variações no campo emocional da experiência.

O sistema de LEDs foi programado para executar padrões cromáticos específicos que correspondiam a estados emocionais, traduzindo sensações em códigos de cor e movimento. Essa codificação cromática não pretendia estabelecer um sistema fixo, mas sim um vocabulário aberto, capaz de ser interpretado intuitivamente pelo público.

Durante os testes, observou-se que a variação do brilho e do tempo de transição influenciava diretamente a perceção de conforto, presença e atenção do visitante. Assim, a afinação da luz passou a ser entendida como ato performativo e interpretativo, em que cada modulação de luz correspondia a um gesto expressivo. Essa relação entre programação e emoção tornou-se o eixo central do método: compreender o código não como mera instrução, mas como linguagem viva. A prototipagem também incluiu a implementação de efeitos sonoros, que, em conjunto com a luz, criaram um campo atmosférico coeso.

O método, portanto, não se limitou à experimentação de interfaces digitais, mas à criação de um ecossistema sensível entre máquina, espaço e corpo. A tecnologia foi tratada como matéria expressiva e relacional, e não como ferramenta neutra, o que exige do artista um processo constante de observação, escuta e adaptação.

A Figura 4 apresenta um excerto do código desenvolvido em Arduino, responsável por interpretar os comandos recebidos via serial e ativar os padrões de luz no anel de LED. Essa lógica garante que a experiência luminosa seja desencadeada em sincronia com os eventos do videojogo.

4.3 Fase 3: Mediação e Documentação

A etapa de mediação constituiu o momento em que a obra passou a interagir efetivamente com o público. Durante a exposição EMMA – Exposição do Mestrado em *Media Arts* (gnration, 18-26 julho 2025), foram recolhidas observações diretas e, posteriormente, aplicados inquéritos anónimos para avaliar a clareza instrucional da luz e a qualidade emocional da experiência.

A presença do público no espaço expositivo revelou-se parte essencial do método: o comportamento dos visitantes, as hesitações iniciais, os gestos e reações corporais tornaram-se dados de investigação. O olhar etnográfico e fenomenológico foi, assim, incorporado à metodologia, permitindo compreender a instalação não apenas como objeto, mas como acontecimento relacional.

O processo de documentação incluiu registos audiovisuais, anotações de campo e captura de dados qualitativos das respostas do público. Esses materiais foram posteriormente analisados por leitura descritiva e categorização temática, identificando padrões de comportamento e perceções recorrentes.

A avaliação da experiência pública foi realizada através de um inquérito anónimo e voluntário aplicado após a interação com a instalação. Participaram 13 visitantes, todos maiores de 18 anos, que

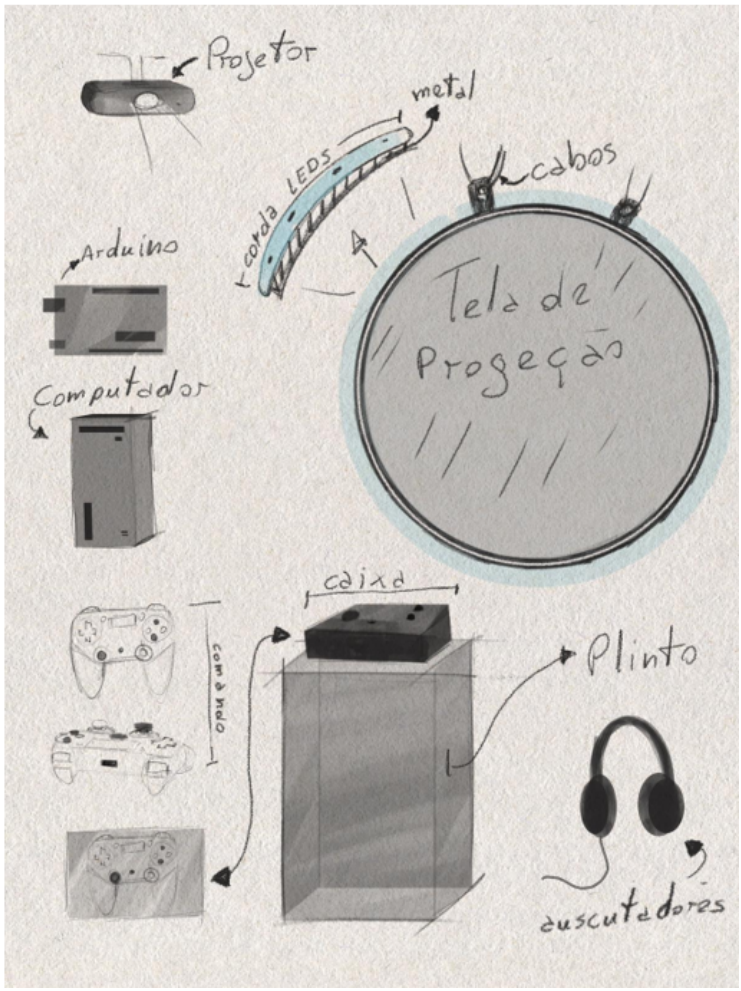


Figure 2: Esboço técnico da estrutura circular com LEDs e tecido para projeção, acompanhado das ideias iniciais para os comandos de interação.

consentiram colaborar de forma confidencial e em conformidade com os princípios éticos aprovados pela Universidade do Minho. O inquérito, desenvolvido em Google Forms, tinha duração média de dois a três minutos e combinava perguntas fechadas e abertas. As questões fechadas recorriam a escalas maioritariamente de 1 a 7, e numa questão de 0 a 10 para avaliar dimensões como familiaridade com instalações interativas, clareza das instruções transmitidas por luz e som, compreensão do que fazer no espaço, sensação de imersão, integração entre luz, som e videojogo, conforto físico, luminosidade e áudio, envolvimento emocional, duração percebida e probabilidade de recomendação da experiência a outra pessoa. As perguntas abertas recolheram descrições livres sobre o que funcionou melhor, o que gerou dúvida ou desconforto, e o que deveria ser ajustado. As respostas foram analisadas através de um procedimento misto: (i) leitura descritiva das distribuições numéricas para identificar tendências recorrentes de perceção e envolvimento; e (ii) categorização temática das respostas abertas, agrupando os comentários em eixos como orientação no espaço, clareza instrucional, integração sensorial entre luz, som e videojogo, conforto físico e impacto emocional. Essa articulação entre dados quantitativos e qualitativos permitiu mapear não apenas o grau de imersão declarado pelos participantes, mas também as fragilidades comunicacionais da instalação e as oportunidades de melhoria ergonómica e instrucional percebidas pelo público.

4.4 Fase 4: Experimentação

A fase de experimentação correspondeu ao momento em que a instalação foi apresentada publicamente com a sua estrutura física completa e operacional. A obra foi montada num espaço expositivo escuro, onde um anel de LEDs endereçáveis, suspenso numa estrutura circular metálica, funcionava simultaneamente como elemento visual central e como instrumento de orientação sensorial. No interior desse anel, um tecido branco servia de superfície de projeção para a componente visual do videojogo, estabelecendo uma ponte explícita entre corpo físico e videojogo.

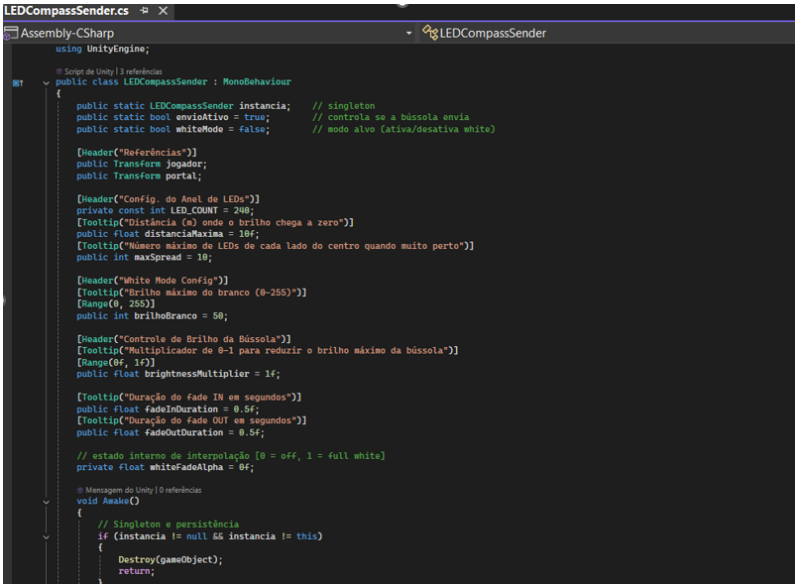


Figure 3: Trecho do script LEDCompassSender.cs em Unity, utilizado para calcular e enviar, via porta serial, os comandos que controlam o comportamento do anel de LEDs físicos durante a instalação

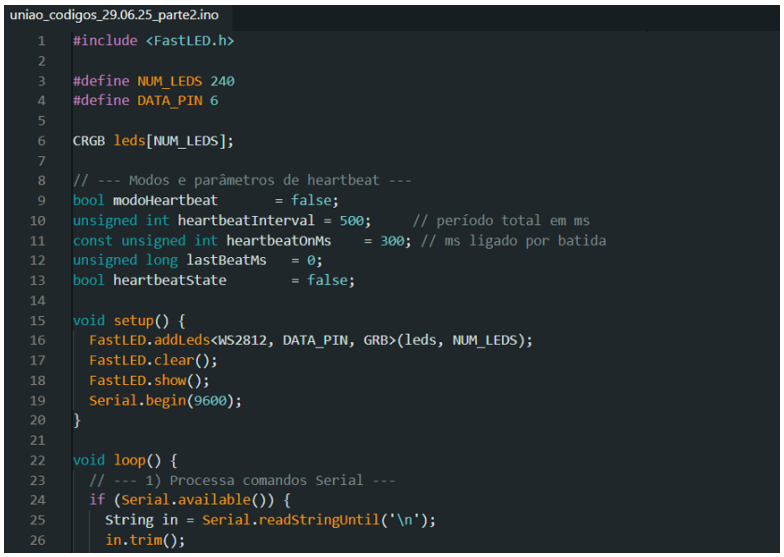


Figure 4: Trecho do código em Arduino (utilizando a biblioteca FastLED) responsável pela leitura dos comandos do Unity e pela ativação dos efeitos luminosos no anel de LED, em sincronia com os eventos da instalação.

À frente da estrutura circular foi posicionado um plinto de interação, que continha os auscultadores e um controlador físico. Esse controlador foi parcialmente abrigado dentro de uma caixa perfurada, expondo apenas os botões necessários à interação. Esta decisão espacial teve duas intenções: por um lado, reduzir a distração visual e preservar o carácter imersivo da experiência; por outro, sugerir ao participante que existe um ponto de contacto possível e permitido, diminuindo o receio inicial de "tocar no que não deve", típico do comportamento em contexto de galeria.

Durante essa fase, a instalação funcionou como um sistema sensorial unificado: eventos internos do videojogo desencadeavam padrões cromáticos, variações de intensidade luminosa e alterações sonoras percetíveis no videojogo. A luz deixava de ser cenário para tornar-se um mediador ativo, assumindo o papel de "guia silencioso" que chamava, sugeria aproximação, marcava momentos de tensão ou convidava à permanência. Esse encadeamento luminoso e sonoro permitiu testar, em ambiente real, se a obra conseguiria comunicar sem recorrer a instruções verbais explícitas.

Foi também nesta fase que se observaram comportamentos-chave do público. Muitos visitantes entraram inicialmente com cautela, percorrendo o perímetro da sala em silêncio, como se tentassem compreender "as regras" antes de agir. Alguns demonstraram hesitação em aproximar-se do controlador devido à baixa iluminação dirigida ao plinto, o que evidenciou a importância de garantir legibilidade mínima do dispositivo de interação mesmo em ambientes de baixa luz. Outros visitantes, após essa primeira hesitação, envolveram-se plenamente na proposta, descrevendo a experiência como "diferente", "mágica" ou "calma", e exprimindo vontade de permanecer mais tempo dentro do espaço.

Situações específicas observadas durante a experimentação reforçaram o potencial afetivo da instalação. Um episódio relatado foi o de uma criança que, após percorrer todas as obras da exposição, pediu para regressar à *Imerge* e interagir novamente. Esse retorno voluntário e insistente sugere a existência de um vínculo emocional direto com a instalação, não mediado pela necessidade de compreender regras explícitas, mas sustentado pela sedução sensorial da luz e do som. Esse tipo de resposta reforça uma leitura da obra como espaço de escuta e de presença, mais do que como um sistema orientado a objetivos.

A fase de experimentação também tornou visível a dimensão logística e física do trabalho. A ausência de uma luz suspensa sobre o plinto originalmente prevista no projeto como luz funcional para orientar o utilizador no primeiro contacto, revelou-se uma limitação prática, apontada por alguns participantes como fonte de desconforto inicial. Esse detalhe confirmou que pequenas decisões de iluminação de apoio podem influenciar significativamente a confiança do visitante ao entrar na instalação e, portanto, a qualidade da experiência desde os primeiros segundos.

Do ponto de vista metodológico, esta etapa final funcionou como um ensaio controlado em contexto real. A instalação deixou de ser apenas um protótipo técnico ou um exercício conceptual e passou a operar como experiência pública, permitindo recolher dados diretos sobre legibilidade instrucional, integração sensorial e envolvimento emocional.

O espaço expositivo foi estruturado de modo a valorizar a dimensão imersiva e sensorial da experiência, com destaque para a centralidade do anel de luz como mediador estético e instrucional (Figura 5).



Figure 5: Visão geral da montagem: anel de LEDs e tela de projeção integrados à estrutura circular, com plinto de interação contendo auscultadores e controlador.

5 RESULTADOS PRELIMINARES – ANÁLISE E DISCUSSÃO

5.1 Clareza Das Instruções

A avaliação revelou que a luz foi amplamente reconhecida como elemento comunicativo e instrutivo, confirmando a hipótese inicial de que a cor e o ritmo podem funcionar como linguagem de mediação sensorial.

Grande parte dos participantes afirmou compreender as intenções luminosas e perceber correspondência entre as variações de luz e as ações esperadas no espaço. Contudo, as respostas também evidenciaram heterogeneidade interpretativa: alguns visitantes descreveram a luz como "bela, mas ambígua", indicando a necessidade de uma codificação mais clara para os diferentes tipos de sinal.

A componente sonora, embora percebida como integrada e coerente com a atmosfera da instalação, foi associada sobretudo a uma função emocional e ambiental, mais do que instrutiva. Essa tendência reforça a natureza poética da obra, que privilegia o sentir em detrimento da instrução explícita, mas também aponta oportunidades de melhoria no equilíbrio entre emoção e legibilidade sensorial.

Essas perceções sustentam a importância de refinar o código de controlo dos LEDs e a espacialização sonora, buscando maior distinção entre estímulos informativos e afetivos. Assim, a clareza instrucional é confirmada em termos de potencial expressivo, mas ainda passível de aprimoramento técnico e semântico.

5.2 Integração Sensorial

Os resultados evidenciaram que os visitantes experienciaram a *Imerge* como um sistema sensorial unificado, onde luz, som e videojogo funcionam de forma interdependente. A maioria das respostas situou-se nos níveis mais altos da escala de satisfação, demonstrando perceção de continuidade entre o espaço físico e o videojogo.

Termos como *"imersão"*, *"ambiente"* e *"integração"* surgiram repetidamente nas respostas abertas, confirmando que o público reconheceu coerência entre os estímulos visuais e sonoros e a narrativa simbólica proposta.

Alguns participantes, contudo, relataram dificuldade inicial em compreender o que fazer, o que sugere que a ambiguidade sensorial,

embora poética, pode gerar hesitação nas primeiras interações. Essa oscilação indica que a obra equilibra dois estados, exploração intuitiva e orientação simbólica, que devem ser calibrados nas próximas versões.

De modo geral, a integração entre os elementos da instalação foi validada tanto estética quanto funcionalmente, consolidando a proposta de uma experiência híbrida onde os feedbacks físicos e digitais se fundem num mesmo gesto perceptivo.

5.3 Validação Metodológica

O inquérito demonstrou um elevado grau de imersão emocional e conforto sensorial entre os participantes. A maioria atribuiu pontuações máximas aos parâmetros de imersão, agradabilidade e desejo de recomendação da experiência, destacando a originalidade e a atmosfera contemplativa da obra.

Nas respostas abertas, surgiram termos como *"mágica"*, *"inovadora"*, *"curiosa"*, *"emocional"* e *"diferente"*, confirmando o impacto estético da instalação. Os participantes descreveram a *Imerge* como uma experiência que "transcende o jogo", aproximando-se de uma forma de escuta sensível e poética da tecnologia.

A totalidade dos participantes aceitou colaborar de forma anónima, o que evidencia predisposição positiva e envolvimento afetivo com a obra. Essa adesão reforça que a metodologia adotada, combinando experiência expositiva e inquérito qualitativo, favoreceu uma relação empática entre público e sistema interativo.

Ainda assim, as observações diretas e os comentários espontâneos revelaram nuances relevantes: alguns visitantes expressaram receio inicial de tocar nos comandos devido à baixa iluminação do plinto, enquanto outros relataram prazer na exploração livre do espaço. Esse contraste reflete a dualidade essencial da instalação entre contemplação e ação e sugere que ajustes na acessibilidade luminosa e no posicionamento físico poderão tornar a interação mais intuitiva sem comprometer o carácter imersivo e introspetivos da proposta.

A observação direta do público durante a exposição confirmou que a ergonomia luminosa do espaço influenciou de forma decisiva a clareza da interação. A luz de apoio inicialmente prevista para o plinto, destinada a iluminar discretamente o comando e marcar o ponto de ação, não foi instalada a tempo, o que resultou em zonas de baixa visibilidade e gerou hesitação inicial em vários participantes. Essa hesitação não foi apenas técnica, mas também corporal: alguns visitantes mostraram receio de tocar no dispositivo ou de se deslocar no escuro, sobretudo quem revelou maior sensibilidade visual ou menor familiaridade com ambientes imersivos. Esse cenário expôs um problema clássico de design instrucional em contextos artísticos imersivos: o equilíbrio entre atmosfera e legibilidade funcional. A experiência sugere que uma iluminação mínima e localizada, por exemplo: um foco suspenso de baixa intensidade sobre o plinto) não é apenas um recurso técnico, mas uma condição de acessibilidade e confiança, sobretudo nas fases iniciais da interação, quando o visitante ainda decide se "pode mexer" ou não. Este ponto foi igualmente reforçado nas respostas do inquérito, onde surgiram pedidos de maior clareza inicial sobre "o que fazer" e comentários sobre a estabilidade e leitura do comando. Assim, a questão ergonómica ultrapassa a mera iluminação e aproxima-se de um problema de orientação: tornar a entrada na experiência mais intuitiva e segura, sem diluir a qualidade sensorial da escuridão e da cor que definem a instalação.

No conjunto, os resultados confirmam que a *Imerge* cumpre a sua função como mediadora emocional, estabelecendo uma ponte entre corpo, espaço e som. A obra demonstra que a tecnologia pode ser experienciada como uma extensão sensível do sentir humano, traduzindo estados afetivos em presença luminosa e sonora.

5.4 Discussão Inicial Dos Resultados

A etapa de avaliação da instalação *Imerge* foi realizada após a exposição EMMA – Exposição do Mestrado em *Media Arts* (Gnration, Braga, 16 - 28 julho 2025), integrando pela primeira vez um inquérito pós-evento estruturado. Participaram 13 visitantes, todos maiores de 18 anos, em regime anónimo e voluntário, com consentimento prévio em conformidade com os princípios éticos aprovados pela Universidade do Minho – mais do que obter evidências estatisticamente generalizáveis, procurou-se, antes, gerar compreensão fenomenológica e pistas evolutivas sobre a experiência estética e interativa, à luz da natureza exploratória e qualitativa da investigação-criação em *Media Arts*.

O questionário foi aplicado através do Google Forms, com duração média de dois a três minutos, e recolheu perceções sobre clareza instrucional, imersão, integração sensorial, conforto físico e envolvimento emocional.

Os resultados demonstram que a experiência foi predominantemente positiva: a maioria dos participantes relatou elevado grau de imersão e envolvimento emocional, confirmando a eficácia da articulação entre luz, som e espaço. Termos recorrentes nas respostas abertas, como *"diferente"*, *"inovador"* e *"mágico"*, evidenciam o impacto estético e sensorial da proposta.

A integração entre luz, som e jogo foi amplamente reconhecida como o ponto forte da obra, validando a coerência entre as componentes física e digital. Os resultados referentes ao conforto físico da luminosidade e do áudio também foram altamente positivos, o que confirma a adequação técnica da calibração dos LEDs e da paisagem sonora.

Por outro lado, a avaliação revelou aspetos passíveis de melhoria, sobretudo na clareza das instruções luminosas e na interpretação da relação entre luz e ação. Embora os padrões de cor e ritmo tenham sido percebidos como intuitivos por grande parte do público, alguns participantes indicaram necessidade de maior distinção entre estados instrutivos e poéticos da luz. Esse ponto reforça a pertinência de refinar o código de controlo e a lógica cromática, de modo a equilibrar a subtileza estética e a legibilidade interativa.

As respostas abertas também evidenciaram o impacto emocional e contemplativo da instalação, mencionando sentimentos de calma, curiosidade e introspeção. Esse tipo de envolvimento confirma a premissa fenomenológica da obra, a tecnologia como extensão sensível do corpo, e não como mediação distante.

Além disso, o inquérito indicou uma alta probabilidade de recomendação da experiência entre os visitantes, o que atesta o êxito da mediação afetiva e a relevância estética do projeto no contexto das *Media Arts*.

De forma geral, a análise qualitativa dos dados reforça que a *Imerge* atingiu o seu propósito principal: instaurar um ambiente imersivo e emocionalmente responsivo. A metodologia de avaliação

aplicada, combinando observação direta e inquérito estruturado, permite agora uma leitura mais robusta da eficácia sensorial e comunicacional da obra, consolidando a proposta como uma investigação artística sustentada por evidências empíricas.

6 CONCLUSÃO E TRABALHOS FUTUROS

Este artigo apresentou uma instalação interativa desenvolvida no âmbito das *Media Arts*, que articula videojogo, luz e som como mediadores sensoriais e emocionais. A obra foi concebida, construída e exibida publicamente, permitindo observar reações espontâneas de imersão, curiosidade e envolvimento afetivo por parte dos participantes. O conjunto dessas observações confirma o potencial da instalação como um espaço de diálogo entre corpo e tecnologia, em que a mediação sensorial emerge como forma de comunicação não verbal e de empatia estética.

A investigação desenvolvida com a instalação *Imerge* permitiu compreender de forma aprofundada como a manipulação da luz, do som e do videojogo pode atuar como mediadora de experiências sensoriais e emocionais em contextos de arte interativa. Ao integrar videojogo, luz e som num mesmo sistema, o projeto demonstrou que é possível articular dimensões técnicas e poéticas de modo a produzir uma comunicação não verbal entre corpo e ambiente. A experiência do público confirmou que, quando tratada como linguagem viva, a luz é capaz de orientar, emocionar e instruir simultaneamente, tornando-se o principal elo entre o gesto e o espaço.

A metodologia de investigação-criação adotada assente em prototipagem iterativa, experimentação técnica e observação fenomenológica, revelou-se fundamental para a evolução da obra. Cada iteração trouxe novos níveis de precisão técnica e de compreensão estética, mostrando que a interação entre corpo e tecnologia não pode ser planeada apenas de forma abstrata, mas deve ser vivida, testada e escutada. O processo confirmou que a prática artística em meios tecnológicos é, antes de tudo, um exercício de escuta e adaptação: um diálogo contínuo entre intuição, erro e descoberta.

Do ponto de vista técnico, a instalação evidenciou os desafios inerentes à criação de sistemas de luz, em que pequenas variações de código ou de calibração alteram profundamente a perceção emocional. O desgaste físico dos componentes e a necessidade de manutenção contínua revelaram dimensões materiais e logísticas frequentemente invisíveis nas obras de arte tecnológica.

No plano expressivo, *Imerge* confirmou o potencial da luz como linguagem afetiva e cognitiva, mas também revelou os seus limites enquanto canal instrucional. A variação de interpretações observada entre os visitantes mostrou que a clareza comunicacional da luz depende não apenas de parâmetros técnicos, cor, ritmo, intensidade, mas também de fatores situacionais, como tempo de exposição, familiaridade com instalações interativas e disposição emocional do participante. Essa constatação abre caminho para futuras investigações sobre a legibilidade emocional da luz, explorando relações entre perceção cromática, resposta fisiológica e empatia sensorial.

A correspondência entre o videojogo e a instalação física surge como outra área de expansão. Investigações futuras poderão explorar modos mais orgânicos de transposição entre ambos os sistemas, tanto no nível visual e narrativo quanto na resposta comportamental. Pretende-se desenvolver novas camadas de feedback entre videojogo e instalação, em que a ação digital retroalimente o espaço físico e vice-versa, reforçando a continuidade emocional entre o real e o virtual.

Finalmente, esta investigação marcou um ponto de inflexão na prática artística da autora, introduzindo-a em territórios de programação, eletrónica e mediação sensorial. Essa imersão em novas linguagens revelou que o domínio técnico, quando orientado pela escuta poética, se transforma em meio de autoconhecimento e em ferramenta de empatia. *Imerge* reafirma, assim, que a arte interativa é um campo onde a tecnologia se converte em gesto poético e o código em matéria sensível, instaurando novas formas de presença e de encontro.

Em síntese, a obra propõe uma compreensão expandida da mediação emocional: mais do que criar ambientes imersivos, trata-se de conceber ecossistemas sensoriais que convidam à introspeção, à contemplação e à escuta. Os trabalhos futuros não se limitam à melhoria técnica da instalação, mas à continuação dessa busca por equilíbrio entre precisão e sensibilidade, entre controlo e entrega. A *Imerge*, portanto, não se encerra, permanece como processo em aberto, uma investigação viva sobre o modo como luz, som e corpo podem, juntos, traduzir o sentir em presença e o invisível em forma.

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Memórias do Futuro - Um Diálogo com o Passado Sustentável

Memories of the Future - A Dialogue with the Sustainable Past

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Abstract

O projeto "Memórias do Futuro" propõe uma intervenção artística no Sanatório de Mont'alto (Valongo, Portugal), um espaço de ruína arquitetónica e memória cultural. Utilizando fotografias digitais do local, processadas através de inteligência artificial (IA) generativa, foram criados catorze vídeos curtos que reimaginam o edifício abandonado como um cenário revitalizado por princípios de sustentabilidade ecológica. A figura de um boneco Panda, integrada nas imagens, funciona como um agente narrativo que simboliza o cuidado ambiental. A obra manifesta-se num artefacto interativo para *tablet* e num filme não interativo. Este artigo detalha o enquadramento histórico do sanatório e a metodologia de curadoria humano-máquina do projeto, analisando a obra no quadro teórico da pós-fotografia e do património digital. A experiência da sua exposição *in situ* é discutida à luz da teoria da Interação Humano-Computador (HCI) e da crise da narração de Walter Benjamin. Adicionalmente, desenvolve uma discussão crítica sobre as implicações desta *práxis* artística, analisando o deslocamento do conceito de "aura" para o *prompt* na era da reprodução por IA e confrontando a temática ecológica do projeto com a pegada ambiental da própria tecnologia utilizada (o paradoxo da "Red AI" vs. "Green AI"), estabelecendo um diálogo entre a criação artística e os paradoxos da sustentabilidade digital.

Résumé

The "Memories of the Future" project proposes an artistic intervention at the Sanatório de Mont'alto (Valongo, Portugal), a site of architectural ruin and cultural memory. Using digital photographs of the location, processed through generative artificial intelligence (AI), fourteen short videos were created that reimagine the abandoned building as a scenario revitalized by principles of ecological sustainability. The figure of a Panda toy, integrated into the images, acts as a narrative agent symbolizing environmental care. The work manifests as an interactive tablet-based artifact and a non-interactive film. This paper details the sanatorium's historical context and the project's human-machine curation methodology, analyzing the work within the theoretical framework of post-photography and digital heritage. The experience of its *in situ* exhibition is discussed in light of Human-Computer Interaction (HCI) theory and Walter Benjamin's crisis of narration. Furthermore, it develops a critical discussion on the implications of this artistic *praxis*, analyzing the displacement of the concept of "aura" to the prompt in the age of AI reproduction and confronting the project's ecological theme with the environmental footprint of the technology itself (the "Red AI" vs. "Green AI" paradox), establishing a dialogue between artistic creation and the paradoxes of digital sustainability.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Generative Photography, Digital Art, Urban Sustainability, Space Reuse, Interactivity, Green AI, Red AI, Walter Benjamin, HCI, Post-Photography, Digital Heritage

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1 INTRODUÇÃO: MEMÓRIA, RUÍNA E O IMPERATIVO DA REIMAGINAÇÃO

O projeto "Memórias do Futuro" emerge da intersecção entre a prática artística, a investigação tecnológica e a reflexão sobre o património abandonado, tomando como objeto de estudo o Sanatório de Mont'alto, em Valongo, Portugal. Mais do que uma mera estrutura em decadência, este local representa um palimpsesto de memórias culturais, arquitetónicas e sociais, cuja história encapsula uma narrativa de esperança, obsolescência e, finalmente, esquecimento [1] [2].

Para fundamentar a intervenção artística, é imperativo compreender o percurso histórico do edifício. Projetado pelo arquiteto Júlio José de Brito, o sanatório começou a ser construído em 1932 e foi inaugurado em 1958 para o tratamento de pacientes com tuberculose [2] [3]. A sua arquitetura refletia os princípios modernistas de saúde, com estruturas autossuficientes como uma capela, uma escola e uma lavandaria [2] [3]. Contudo, o rápido avanço da medicina tornou o modelo sanatorial obsoleto, e em 1975, apenas 17 anos após a sua abertura, o complexo encerrou as suas portas [2] [4] [5]. Este ciclo de vida – da sua construção como símbolo de progresso à sua rápida desativação – transforma o sanatório num poderoso cronotopo de uma modernidade falhada. A ruína torna-se, assim, um testemunho físico de uma trajetória interrompida, um futuro projetado e subsequentemente abandonado [6].

É neste contexto que o projeto se inscreve, não como uma proposta de restauro físico, mas como um exercício de "arqueologia

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especulativa". Este termo descreve o uso da inteligência artificial (IA) generativa não apenas para documentar ou restaurar digitalmente o património, mas para projetar futuros possíveis sobre ele, sem a necessidade de intervenção física e consumo de recursos materiais [6]. O projeto propõe um diálogo especulativo com o fantasma deste passado, questionando: que futuros alternativos poderiam emergir das cinzas desta promessa modernista? Ao invés de aceitar a ruína como um ponto final, a intervenção utiliza-a como um ponto de partida para reimaginar o potencial do espaço, propondo uma transição de um local de cura do corpo para um local de reflexão sobre a saúde do planeta.

Esta abordagem, contudo, revela imediatamente o paradoxo central do projeto: a utilização de uma tecnologia com uma pegada ambiental significativa e muitas vezes invisível para advogar pela sustentabilidade ecológica. Este artigo confronta diretamente esta tensão, posicionando a obra como uma *práxis* artística que explora as contradições inerentes à arte digital com preocupações ecológicas. Para tal, este artigo estabelece os seguintes objetivos: (1) detalhar a metodologia de curadoria humano-máquina que guiou a produção; (2) construir um enquadramento conceptual que articula a obra com as teorias da pós-fotografia, do património digital e da crise da narração; (3) analisar o artefacto interativo e a sua receção *in situ* à luz da teoria da Interação Humano-Computador (HCI); e (4) desenvolver uma discussão crítica sobre os paradoxos da sustentabilidade digital e a reconfiguração da "aura" artística na era da IA.

2 Enquadramento Conceptual: Pós-Fotografia, Património Digital e a Crise da Narração

O projeto "Memórias do Futuro" articula-se conceptualmente na confluência de três eixos teóricos que contextualizam a sua prática e as suas implicações: a natureza das imagens geradas por IA como pós-fotografia, a sua função no âmbito do património digital e a dificuldade de envolvimento do público como um sintoma da crise da narração.

2.1 A Geração de Imagens por IA como Pós-Fotografia

As imagens criadas para este projeto não são fotografias no sentido tradicional do termo – "escritas com luz" [7]. Elas representam uma nova categoria de imagem que a teoria contemporânea designa como "pós-fotografia" [8] [9]. Este conceito descreve imagens que, embora mantenham uma aparência fotográfica, não possuem uma relação indexical direta com a realidade; ou seja, não são o resultado de fotões de luz a impressionar um sensor ou película [10]. Em vez disso, são artefactos meta-fotográficos, gerados por algoritmos que processam os padrões estatísticos de milhões de fotografias existentes para criar uma nova imagem sintética [10].

A IA generativa funciona como um sistema voraz que "devora" o nosso vasto arquivo cultural de imagens e as devolve como híbridos, misturas que ecoam e distorcem o mundo familiar [10] [11]. Este processo desafia noções fundamentais de autoria, originalidade e a própria verdade da imagem, alinhando-se com as teorias de Baudrillard sobre o simulacro e a hiper-realidade, onde a cópia precede e gera o real [12]. As imagens do sanatório revitalizado não documentam uma realidade, mas sim um futuro possível, uma simulação que se torna mais real do que a própria ruína. O projeto, portanto, utiliza a pós-fotografia como uma ferramenta para criar não uma representação do que foi, mas uma visualização especulativa do que poderia ser.

2.2 O Património na Era da Reprodutibilidade Digital

A intervenção insere-se no campo emergente do Património Digital, que explora como as tecnologias digitais podem ser usadas para preservar, interpretar e disseminar a herança cultural [11]. A investigação nesta área demonstra o potencial transformador da IA generativa para a recriação, restauro e melhoria de artefactos culturais, textos e ambientes históricos [3]. Ao sintetizar dados de diversas fontes – como fotografias, manuscritos ou scans 3D – a IA pode restaurar digitalmente artefactos danificados e permitir experiências imersivas [7].

"Memórias do Futuro" expande esta prática da preservação para a reimaginação especulativa. O projeto não se limita a recriar o sanatório no seu estado original; em vez disso, utiliza a sua forma em ruínas como um "*dataset* do passado" para gerar um "*dataset* do futuro". O ato inicial de fotografar o local não é apenas documentação, mas uma forma de recolha de dados, curando um conjunto de imagens que serve de base para o processo generativo. Esta abordagem transforma o local físico num *input* computacional, estabelecendo uma ponte conceptual direta entre a história material do edifício e a abstração do processo algorítmico. A obra funciona, assim, como um catalisador para o diálogo sobre a reutilização de espaços abandonados, demonstrando como a IA pode ser uma ferramenta para a formulação de novas narrativas para o nosso património.

2.3 A Crise da Narração e a Dificuldade do Envolvimento

Para compreender a receção limitada do artefacto interativo durante a sua exposição *in situ*, é útil recorrer ao ensaio de Walter Benjamin, "O Narrador" [13]. Neste texto, Benjamin argumenta que a arte de narrar está em vias de extinção na modernidade. A narrativa tradicional, oral e baseada na partilha de experiências comunicáveis (a *Erfahrung*), foi substituída por duas novas formas de comunicação: o romance, consumido na solidão do indivíduo isolado, e a "informação" jornalística, que exige verificação imediata e tem um valor efémero [14]. Para Benjamin, a narrativa autêntica oferece conselho e sabedoria, tecida na substância da vida, e requer um ouvinte num "estado de relaxamento" e tédio, condições cada vez mais raras numa sociedade acelerada [15] [16].

A aparente falha de interação do público com o artefacto no Sanatório de Mont'alto pode ser interpretada não apenas como um desafio de Human-Computer Interaction (HCI), mas como um sintoma desta "crise da narração". Os visitantes de um local de exploração urbana não se encontram no estado de espírito recetivo que a narrativa benjaminiana exige [17]. Eles procuram a emoção da descoberta, a captura de imagens ou a atmosfera histórica – experiências individuais e, muitas vezes, mediadas pelos seus próprios dispositivos. O artefacto interativo, ao propor uma nova forma de narrativa num contexto "selvagem" e não-galerístico, confrontou um público que, em grande medida, perdeu a capacidade ou a predisposição para se envolver com uma história fora dos formatos

Table 1: Especificações Técnicas da Captura Fotográfica e Pós-Produção

Fase	Equipamento / *Software*	Especificações Técnicas
Captura Fotográfica	Câmara digital profissional	Lente 17-35mm; Abertura *f/4* a *f/22*; ISO baixo, ajustado à luminosidade
Pós-Produção	Adobe Photoshop; Adobe Lightroom	Otimização de contraste, luminosidade e detalhe



Figure 1: Fotografia original de uma das salas do Sanatório de Mont'alto, servindo como imagem-fonte para o processo generativo. Fonte: Autores.

de entretenimento pré-estabelecidos [18]. A hesitação em tocar no *tablet* reflete a perplexidade do indivíduo moderno perante uma proposta de experiência partilhada que não se enquadra na lógica da informação ou do consumo solitário. A experiência *in situ* torna-se, assim, uma confirmação empírica da tese de Benjamin sobre a crescente dificuldade de comunicar a experiência num mundo saturado de informação [13] [19].

3 Metodologia: A *Práxis* da Curadoria Humano-Máquina

A concretização do projeto "Memórias do Futuro" assentou num fluxo de trabalho metodológico rigoroso que combinou técnicas fotográficas, processos computacionais avançados e uma curadoria humana iterativa. Em resposta à necessidade de transparência académica e às sugestões dos revisores, esta secção detalha as fases do processo criativo-técnico, desde a captura de imagens no terreno até à composição final dos artefactos, aprofundando os critérios de seleção e as limitações encontradas.

3.1 Captura e Pós-Produção Fotográfica

A fase inicial consistiu numa sessão fotográfica no Sanatório de Mont'alto. O objetivo era duplo: documentar o estado de abandono do edifício e enquadrar o elemento figurativo do boneco Panda nas ruínas. A escolha do equipamento foi deliberada para garantir a máxima qualidade e detalhe, essenciais para o subsequente processamento por IA. As imagens foram capturadas com uma câmara digital e otimizadas em pós-produção para servirem de base ao trabalho generativo. Os detalhes técnicos estão sintetizados na Tabela 1. As Figuras 1 e 2 ilustram o ponto de partida e o resultado do processo de reimaginação digital, demonstrando a transformação de um espaço de abandono num futuro especulativo e sustentável.

3.2 Geração de Conteúdo e o Ciclo de Curadoria Humano-Máquina

A partir de um conjunto inicial de fotografias, foram selecionadas 14 imagens-chave. A seleção não foi aleatória, mas sim guiada por critérios específicos que visavam maximizar o potencial narrativo e



Figure 2: Imagem final gerada por IA, correspondente à Figura 2, após o processo de curadoria humano-máquina, reimaginando o espaço com princípios de sustentabilidade. Fonte: Autores.

simbólico de cada cena: (a) significado arquitetónico, privilegiando vistas icónicas do edifício; (b) potencial narrativo, focando em espaços que sugeriam atividade humana passada (cozinha, capela); (c) estética da decadência, capturando texturas de ruína e a recuperação pela natureza; e (d) ressonância simbólica, escolhendo enquadramentos que evocassem temas como isolamento ou esperança.

O processo de geração de conteúdo foi um diálogo iterativo entre o artista e os modelos de IA, e não um ato singular e automatizado. Foram utilizadas as plataformas FLUX Playground para imagens estáticas e Google Veo 2 "Fast" para os vídeos de transição, alimentadas por *prompts* textuais detalhados. Este processo de curadoria humano-máquina envolveu um ciclo de refinamento:

1. Geração Inicial: Um *prompt* base (Tabela 2) era aplicado a uma imagem-fonte.
2. Análise Crítica: O resultado era avaliado com base na sua coerência com a visão artística. Frequentemente, a IA "alucinava" detalhes bizarros, distorcia a arquitetura de forma inconsistente ou falhava em preservar a integridade da personagem do Panda.
3. Refinamento do *Prompt*: Com base na análise, o *prompt* era modificado. Por exemplo, se a IA gerasse elementos anacrónicos, adicionavam-se instruções como "evitar mobiliário de estilo vitoriano". Se a personagem do Panda ficasse deformada, o *prompt* era reforçado com a instrução "preservar o boneco de peluche Panda na exata mesma localização e condição".
4. Repetição: Este ciclo era repetido até se alcançar um resultado que equilibrasse a visão do artista com as capacidades e idiossincrasias do modelo de IA.

As principais limitações encontradas neste processo incluíram a dificuldade da IA em interpretar a profundidade espacial e a lógica estrutural da ruína, uma tendência para gerar clichés visuais de "arquitetura sustentável" (como jardins verticais excessivos) e uma perda ocasional do detalhe textural da fotografia original. A Tabela 2 apresenta as ferramentas e um exemplo do *prompt* base, enquanto a Tabela 3 resume o processo de curadoria e as limitações observadas.

3.3 Pós-Produção e Composição Videográfica

A fase final do processo técnico envolveu a edição e montagem dos materiais gerados. Os vídeos, com uma duração original de 8 segundos imposta pela plataforma, foram editados com o *software* iMovie para atingir uma duração de aproximadamente 20 segundos por cena. Esta extensão foi conseguida através da agregação sequencial da imagem original, do vídeo de transição gerado por IA e da imagem final gerada por IA, criando uma narrativa visual completa para cada uma das 14 transformações. Estas cenas individuais foram concebidas para funcionar no artefacto interativo. Simultaneamente, foram compiladas num único filme contínuo, com cerca de 5 minutos de duração, destinado a uma apresentação não interativa e disponibilizado na plataforma YouTube [20] [21].

Table 2: Parâmetros e Exemplo de *Prompt* para Geração de Conteúdo por IA

Plataforma de IA	Tipo de Geração	Exemplo de Prompt (Original em Inglês)
FLUX Playground	Imagem Estática (Foto para Foto)	"Transform a black and white photograph of a ruined industrial kitchen in an abandoned sanatorium into a hyper-realistic, modern space with photographic quality, moderate contrast, and vibrant yet natural colors. The space must be a large, clean, fully renovated industrial kitchen with a contemporary architectural style and minimalist interior design. Key features to include: – Three large modern windows allowing natural light to enter and illuminate the sink area, – Multiple dishwashing sinks with dishwashers underneath, – Lots of clean dishes placed on the countertops, – Industrial-grade equipment, functional surfaces, and modern lighting, – New walls built in a contemporary style, replacing all signs of decay. Preserve a plush panda toy in the exact same location and condition as the original photograph — unchanged in form, texture, or lighting — acting as a symbolic element bridging past and future. Remove all signs of ruin, such as crumbling walls, exposed bricks, uncontrolled vegetation, graffiti, or debris. Do not place greenery or vegetation on the building façade. Surrounding areas visible in the image should be replaced with ordinary, intact urban elements — no construction zones or unfinished surroundings. Introduce subtle, integrated sustainability elements, such as: – Vertical gardens (only indoors or in surrounding zones, not on the façade), – Solar panels (if visible externally), – Reclaimed or recycled materials, – Water-saving fixtures, – Energy-efficient systems and natural ventilation. Avoid including any text, names, hospital symbols, or signage. The space is located in a repurposed sanatorium, but no references to its past institutional function should be visually present. The resulting image should convey a visionary reimagination of forgotten architectural spaces, now transformed into sustainable, livable futures — a critical and ecological proposal that combines technology, memory, and design innovation. The goal is to use AI-generated photography as a tool of critique and creative projection, imagining alternative futures without depleting physical resources. Keywords: photorealistic, modern industrial kitchen, large windows, minimalism, sustainability, dishwashing area, reclaimed materials, clean space, urban integration, panda plush toy, architectural transformation, AI-generated future, ecological design."
Google Veo 2 "Fast" (via Flow)	Vídeo (Imagem para Imagem)	"Generate a dynamic, hyper-realistic, photorealistic video that transitions between two images, showcasing a modern architectural style with minimalist contemporary decor. The first image is a black-and-white photograph of abandoned ruins, depicting a sanatorium-like structure (resembling a hospital, without specific names or symbols). The second image, in vibrant yet natural colors with moderate contrast, represents the transformed version of the same space, revitalized with sustainable design elements. The video should animate a smooth transition from the black-and-white ruins to the colorful, reimagined space, emphasizing a connection between a forgotten architectural past and an ecologically conscious future. Integrate sustainable features such as vertical gardens, solar panels, repurposed materials, and energy-efficient lighting, seamlessly blended into the modernized structure.

	Highlight the creative and responsible reuse of abandoned urban/rural spaces, challenging their neglect through sustainable design solutions. A plush panda toy remains in the same position across both images, with subtle movements (e.g., slight tilting or shifting) during the transition for continuity. Ensure the animation is fluid, maintaining photorealistic quality, vibrant yet natural colors, and a minimalist aesthetic. The video should reflect a thoughtful narrative, using generative photography as a tool for critique and projection of alternative realities without physical resource consumption, combining technology, art, and ecology to explore the memory of places and their sustainable future potential. the transition of the images must create the panda's movements between image 1 and the elements of image 2. the Panda redoes the space and sits watching television."

Table 3: Critérios de Curadoria e Limitações do Processo Generativo

Fase do Processo	Critério/Ação de Curadoria	Limitação Observada
Seleção de Imagens Fonte	Priorizar espaços com forte carga simbólica e potencial narrativo (e.g., capela, cozinha).	Algumas áreas da ruína, embora visualmente interessantes, eram demasiado caóticas para um processamento coerente pela IA.
Geração Inicial	Utilizar um *prompt* base detalhado para estabelecer a estética geral (hiper-realismo, sustentabilidade subtil).	Tendência da IA para gerar clichés de "arquitetura sustentável" (e.g., excesso de vegetação) e para "alucinar" detalhes incongruentes.
Refinamento e Curadoria	Refinar iterativamente o *prompt* para corrigir anomalias e preservar a personagem do Panda. Rejeitar *outputs* com distorções significativas.	Dificuldade da IA em manter a consistência arquitetónica e a integridade da personagem do Panda em todas as gerações. Perda de detalhe textural da fotografia original.

4 Análise do Artefacto e da Sua Exposição *In Situ*

O culminar do projeto materializou-se num artefacto interativo concebido para permitir ao público explorar as narrativas visuais de forma autónoma. Esta secção descreve a sua criação, a sua implementação num contexto de exposição não-tradicional e analisa a receção do público, enquadrando a experiência como um caso de estudo relevante para o campo da HCI em espaços públicos.

A interface do artefacto foi desenvolvida utilizando a plataforma Microsoft PowerPoint, uma escolha pragmática que permitiu a criação de uma experiência de navegação simples e funcional. A estrutura da interação partia de uma imagem geral do Sanatório, a partir da qual o utilizador podia selecionar diferentes pontos de interesse (correspondentes às 14 fotografias originais). A seleção de um ponto desencadeava a reprodução do vídeo de transformação correspondente. Um ícone do Panda funcionava como um botão de retorno ao menu principal, garantindo uma navegação intuitiva [20]. A Figura 3 ilustra o esquema de navegação do artefacto. À esquerda, as primeiras imagens geradas por IA da vista exterior do edifício. Ao centro o primeiro esboço, num local com lixo, junto às ruínas da capela do edifício principal, onde foi idealizada a interação. À direita, as fotografias e as imagens geradas por IA dos 14 pontos de interesse selecionáveis na interface, que deram origem aos vídeos curtos. Cada cena deu origem a um vídeo com retorno ao menu principal pelo ícone do Panda.

A implementação do artefacto ocorreu *in situ*, na capela do Sanatório de Mont'alto. A apresentação foi instalada num *tablet* e, para atrair a atenção, foi utilizada uma coluna portátil que emitia sons artificiais de pássaros, criando um ponto de interesse auditivo que contrastava com o silêncio da ruína. A exposição, com uma duração de três horas, foi monitorizada devido a preocupações com a segurança do equipamento.

A interação do público com o artefacto foi, no entanto, limitada. Durante o período de exposição, apenas um pequeno número de pessoas se aproximou da instalação, com hesitação e sem explorar o conteúdo de forma aprofundada. Os autores atribuem esta fraca adesão à baixa afluência de visitantes nesse dia e a uma aparente falta de predisposição do público para encontrar e interagir com arte digital num contexto de exploração urbana.

Esta aparente falha na interação, quando analisada à luz da literatura de HCI e arte interativa, revela-se um dado qualitativo valioso. A investigação sublinha os desafios de implementar obras interativas em ambientes "selvagens" (*in the wild*), onde não existem regras de envolvimento pré-estabelecidas como numa galeria [15] [22]. O público não espera encontrar tecnologia interativa e pode não a reconhecer como tal ou não se sentir convidado a participar [23] [24]. O Sanatório de Mont'alto é um exemplo extremo deste desafio.

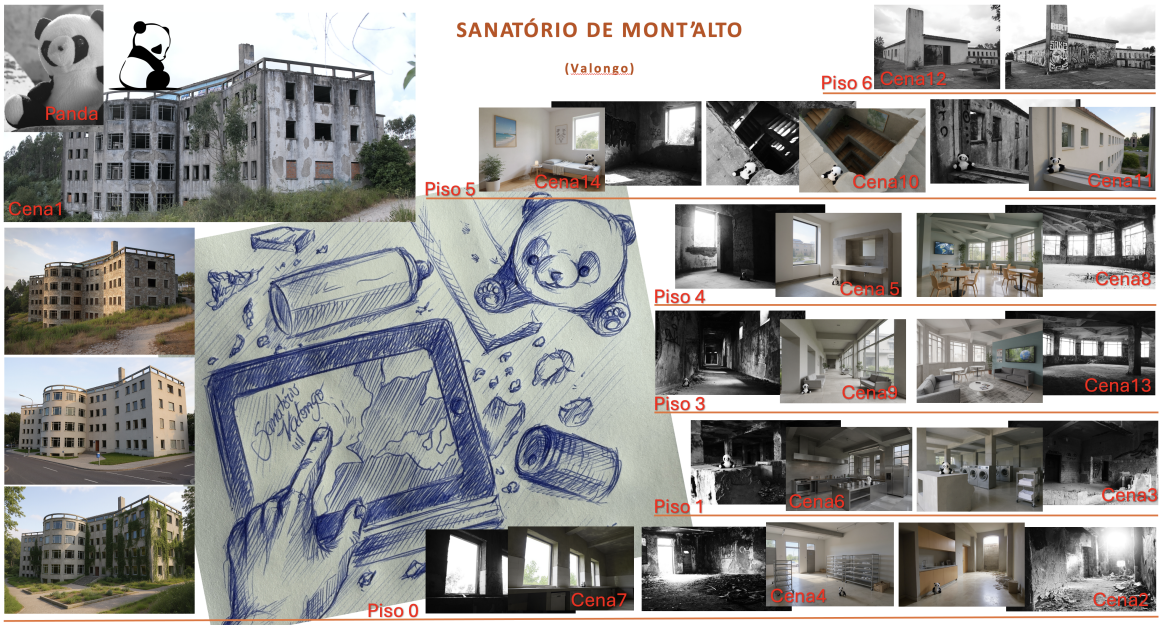


Figure 3: Esquema da Interface e Navegação do Artefacto Interativo. Fonte: Autores.

É um espaço onde os visitantes procuram a emoção da exploração, e não uma experiência mediada por um ecrã. Portanto, a hesitação do público confirma as barreiras contextuais e de expetativa que os *designers* de interação enfrentam. Como enquadrado anteriormente, esta reação pode ser vista como um sintoma da "crise da narração" de Benjamin, onde a capacidade de se entregar a uma experiência narrativa não solicitada diminuiu, favorecendo o consumo de informação ou o entretenimento em formatos familiares [13] [14].

5 Discussão Crítica: Os Paradoxos da Sustentabilidade na Arte Digital

A realização do projeto "Memórias do Futuro" não se esgota na sua produção técnica. A sua natureza, que entrelaça tecnologia avançada com temas de memória e ecologia, convida a uma reflexão crítica aprofundada sobre as suas próprias premissas. Esta secção aborda duas tensões centrais que emergem da *práxis* artística: a reconfiguração do conceito de "aura" na era da IA e o paradoxo de promover a sustentabilidade através de tecnologias com uma pegada ecológica significativa.

5.1 A Aura na Era da Pós-Fotografia: O Deslocamento para o *Prompt*

O uso de IA generativa coloca o projeto em diálogo direto com as teses de Walter Benjamin em "A Obra de Arte na Era da Sua Reprodutibilidade Técnica". Benjamin argumentava que a reprodução mecânica destrói a "aura" da obra de arte – a sua existência única no tempo e no espaço, a sua autoridade histórica [25]. À primeira vista, a arte gerada por IA, que cria ficheiros digitais infinitamente reprodutíveis e desprovidos de um original físico, parece ser a culminação deste processo.

No entanto, uma análise mais profunda do processo criativo deste projeto sugere que a aura não é eliminada, mas sim deslocada. Se a aura do objeto tradicional reside na sua materialidade única, a aura da obra de arte gerada por IA pode residir na intencionalidade e no processo da colaboração humano-máquina [26]. A transparência metodológica, nomeadamente a divulgação dos *prompts* detalhados (Tabela 2), revela que a criação não é um ato de pura automação. Pelo contrário, o *prompt* emerge como um artefacto textual dotado de densidade criativa. Nele estão codificadas as decisões estéticas, as instruções narrativas e a visão concetual do artista. A formulação de um *prompt* eficaz é um ato de ofício, uma arte em si mesma, que exige precisão linguística e sensibilidade artística.

Neste novo paradigma, o papel do artista evolui de criador de objetos para o de curador de dados e, crucialmente, de *prompt-smith* – um forjador de instruções. A autenticidade e a singularidade da obra já não se encontram exclusivamente na imagem final, mas no processo documentado que a gerou. A aura é transferida do produto para o diálogo intencional entre a mente humana e o modelo de IA. O que se valoriza é a originalidade do conceito e a mestria na condução do algoritmo. Assim, "Memórias do Futuro" demonstra que, mesmo na era da pós-fotografia, um novo tipo de aura pode emergir, ancorado na transparência do processo e na autoria partilhada entre o humano e a máquina [6].

5.2 A Pegada Ecológica da Memória Digital: Confrontando a "Red AI"

O projeto coloca a sustentabilidade no centro da sua proposta temática. Contudo, esta intenção colide com um paradoxo fundamental: a pegada ambiental da própria tecnologia utilizada. O discurso da "nuvem" etérea esconde uma infraestrutura física massiva com um consumo de recursos crescente. A IA generativa é

notoriamente exigente em termos energéticos. O treino e a inferência destes modelos requerem um poder computacional elevado, fornecido por *data centers* que consomem quantidades de eletricidade comparáveis a cidades e utilizam milhões de litros de água para arrefecimento [27]. Estima-se que o consumo energético global dos *data centers*, impulsionado pela IA, possa duplicar até 2030 [28] [29].

Este fenómeno levou a comunidade de investigação a distinguir entre "Red AI" – modelos que priorizam a precisão e o desempenho a qualquer custo computacional – e "Green AI", um campo emergente focado no desenvolvimento de IA mais eficiente e sustentável [30]. "Red AI" caracteriza-se por um aumento exponencial do custo computacional para ganhos de precisão logarítmicos, resultando em retornos decrescentes e um impacto ambiental desproporcional [30].

Neste contexto, o projeto "Memórias do Futuro", ao utilizar plataformas comerciais de IA generativa, participa, ainda que em pequena escala, no paradigma da "Red AI". Incorpora, assim, uma contradição central: utiliza um processo potencialmente insustentável para advogar pela sustentabilidade [31]. Esta tensão não deve ser vista como uma falha, mas como uma descoberta crítica resultante da própria *práxis* artística. Ela expõe a complexidade do conceito de sustentabilidade na era digital e força uma reflexão sobre os custos ocultos das nossas ferramentas criativas [32] [33]. A escala deste impacto não é trivial. O treino de um único modelo de grande escala como o GPT-3, por exemplo, pode emitir o equivalente a 552 toneladas de dióxido de carbono [34]. Além da energia, o consumo de água para o arrefecimento dos *data centers* é igualmente alarmante. Um centro de dados de hiperescala pode consumir mais de 2 milhões de litros de água por dia [29]. Embora a pegada específica deste projeto não tenha sido medida – uma limitação a ser abordada em trabalhos futuros –, é crucial reconhecer que cada *prompt* executado contribui para este sistema. A verdadeira sustentabilidade digital exige uma transparência radical sobre o seu custo ecológico. Futuras investigações e práticas artísticas nesta área devem procurar ativamente alinhar os seus meios com os seus fins, explorando modelos de "Green AI" [35] [36], utilizando ferramentas que reportam a pegada de carbono (como CodeCarbon ou Eco2AI), ou incorporando a própria pegada de carbono como um dado conceptual na obra de arte [35].

5.3 Posicionamento na Média-Arte Contemporânea

O projeto "Memórias do Futuro" insere-se num campo crescente de práticas artísticas que utilizam a IA como ferramenta criativa, mas distingue-se pela sua abordagem tripartida: patrimonial, especulativa e autocrítica. Enquanto artistas como Sougwen Chung exploram a colaboração física e gestual com braços robóticos, investigando a simbiose entre o corpo humano e a máquina [37], "Memórias do Futuro" foca-se na curadoria de *prompts* como o principal gesto artístico. Por outro lado, se comparado com o uso da IA no campo do património digital, que frequentemente se concentra no restauro fiel ou na reconstrução de locais perdidos [7], este projeto adota uma postura de "arqueologia especulativa". Não procura restaurar o passado, mas sim usar os seus vestígios como matéria-prima para imaginar futuros alternativos. A sua contribuição mais distintiva, contudo, reside na sua autoconsciência crítica, ao confrontar diretamente o paradoxo da "Red AI", um debate que, embora central na investigação tecnológica, é ainda incipiente na prática artística que aborda temas ecológicos [31].

6 CONCLUSÃO E VIAS FUTURAS

O projeto "Memórias do Futuro" constitui-se como uma investigação artística multifacetada que, partindo da ruína do Sanatório de Mont'alto, explora as interseções entre memória, tecnologia e ecologia. Ao empregar a IA generativa, a obra demonstrou o potencial desta tecnologia como ferramenta de especulação criativa, capaz de projetar futuros alternativos sobre locais de património abandonado.

A análise do processo criativo revelou que a autoria na era da IA se reconfigura, deslocando o conceito de "aura" do objeto final para a intencionalidade do processo colaborativo humano-máquina. A experiência de exposição *in situ* forneceu dados empíricos sobre os desafios da implementação de arte interativa em espaços não-controlados, cujas barreiras de envolvimento foram aqui interpretadas não apenas através da lente da HCI, mas também como um sintoma da "crise da narração" benjaminiana.

Mais significativamente, a reflexão crítica expôs um paradoxo central da arte digital contemporânea, explorando a tensão entre a promoção de uma mensagem de sustentabilidade e a utilização de tecnologias "Red AI" com uma considerável pegada ambiental. Este reconhecimento não invalida o projeto, antes o enriquece, posicionando-o como um caso de estudo sobre as contradições de se ser um artista ecológico na era digital.

As vias futuras para esta linha de investigação apontam para três direções principais:

- Exploração da "Green AI" na Prática Artística: Investigar e incorporar modelos de IA e plataformas computacionais que sejam energeticamente mais eficientes. Projetos futuros poderiam integrar ferramentas de medição da pegada de carbono, tornando o custo ambiental do processo uma componente transparente e conceptual da própria obra [36].
- Desenvolvimento de Estratégias de Interação Contextual: Aprofundar a investigação em HCI para superar as barreiras de interação observadas. Em vez de depender apenas da observação passiva, futuras exposições *in situ* poderiam empregar metodologias de investigação mais ativas, como a investigação contextual (observar e dialogar com os visitantes no seu percurso de exploração) ou a realização de protocolos *think-aloud*, convidando os utilizadores a verbalizar os seus pensamentos enquanto interagem (ou hesitam em interagir) com o artefacto. A implementação de interfaces mais resilientes e à prova de intempéries e a realização de testes A/B com diferentes pistas de interação (e.g., visuais, sonoras) poderiam fornecer dados quantitativos sobre as estratégias mais eficazes para convidar à participação em espaços públicos não convencionais [15].
- Aprofundamento da Crítica da Tecnologia na Arte: Continuar a explorar criticamente o papel do artista na colaboração com sistemas de IA, questionando não apenas as implicações estéticas, mas também as éticas, filosóficas e ambientais da sua utilização crescente na produção cultural [38].

Em síntese, "Memórias do Futuro" serve como um ponto de partida para um debate mais amplo sobre como a arte pode, de forma responsável e autocrítica, utilizar as ferramentas do presente para imaginar e contribuir para a construção de um futuro mais sustentável.

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Narrative Portals and Augmented Reality: Activating empathy in creative projects

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Abstract

In an era marked by the increasing fragmentation of human relationships – where mechanisms of social and emotional connection often struggle to adapt to the acceleration of communicational technologies and digital ecosystems – Digital Media Art assumes a role of critical and sensitive mediation. The experimental and research-driven exploration of ways to reconfigure modes of being-with-others through technology fosters intersections between creative practices and other means, such as digital narrative and augmented reality, particularly given their immersive and interactive potential oriented toward ethical, social, and cultural concerns. These practices propose frameworks for listening, sharing and symbolic co-presence, where empathy is not conceived as a passive emotion, but as a relational process. This article offers a theoretical reflection on such frameworks, focusing on narrative portals activated through augmented reality, and analyses four contemporary international art projects (2021-2025) - **Como Semillas en el Viento, Monumental Perspectives, Las Awichas** and **Augmented Landscapes of Empathy** – which integrate technology and storytelling to cultivate affective and community-based connections. Through comparative analysis, this article aims to understand how these creative projects are situated within the field of Digital Media Art and how they configure spaces of relation and collective memory.

Resumo

Numa época marcada pela crescente fragmentação das relações humanas, onde os mecanismos de conexão social e afetiva carecem de ajustes face à aceleração dos dispositivos comunicacionais e à aceleração dos ecossistemas digitais, a Média-arte Digital pode assumir um papel de mediação crítica e sensível. A proposta de experimentação e pesquisa de experiências que reconfigurem o(s) modo(s) de estar-com-o-outro através da tecnologia, potenciam o cruzamento de conjuntos de práticas artísticas, como a narrativa digital e a realidade aumentada, pelo potencial da imersão e da interatividade direcionados às preocupações éticas, sociais e culturais. Estas práticas propõem dispositivos de escuta, partilha e co-presença simbólica, nos quais a empatia pretende-se ativada não como emoção passiva, mas como um processo relacional. Este artigo pretende uma reflexão teórica em torno desses dispositivos, designadamente os portais narrativos ativados por realidade aumentada, analisando quatro casos de projetos artísticos internacionais contemporâneos (2021-2025) – **Como Semillas en el Viento**, **Monumental Perspectives**, **Las Awichas** e **Augmented Landscapes of Empathy** - que articulam tecnologia e narrativa com propósito de conceber dinâmicas de ligação comunitário-afetiva. Através da análise comparativa dos quatro casos de estudo, o artigo pretende compreender de que modo estes projetos artísticos inscrevem no campo da Média-arte Digital e configuram espaços de relação e memória coletiva.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**; • **Human-centered computing**; • **Human computer interaction (HCI)**; • **Interaction design**; • **Information systems**; • **Multimedia information systems**; • **Interactive multimedia**;

Keywords

Digital Media Arts, Augmented Reality, Digital Narrative, Empathy, Community Engagement

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1 THEORETICAL AND CONCEPTUAL FOUNDATION

In a society marked by a fragile network of support and a crisis of connection, the World Health Organization (WHO) recognizes the need to reduce social isolation and loneliness as key priorities in global public health - Social Connection Commission 2024-2026 [1]. In this context, empathy emerges as a fundamental human capacity, often eclipsed by feelings of apathy and isolation [2, 3]. Empathy, conceptualized as the ability to perceive, understand, and, to some extent, share the emotional states of another person, goes beyond mere recognition or sympathy. According to Cacioppo & Decety [4], empathy emerges from our evolution as a social species rooted in neurobiological mechanisms and cultural and social structures. It involves not only feeling with others but also an active disposition to

listen to, understand, and engage in reciprocal human relationships. Way et al. [3] reinforce this concept, emphasizing that empathy is an essential competence for social well-being and community cohesion, fostering networks of trust, solidarity, and mutual recognition. Recognizing its importance in relational and social processes, the current disparity is evident in the context of disconnection. The disconnection is exacerbated by the misuse of technology, reflected in declining levels of empathy and trust, contributing to social pathologies such as depression, anxiety, loneliness, and social isolation, and the loss of connection between individuals and their communities, stressed by growing social polarization and alienation [3, 5]. In this conjecture, the need to counteract this trend requires that efforts be focused on promoting human empathy and connection, recognizing the potential of the human species, and on a paradigm shift that integrates mind-body-thought-emotion-self relations. The adoption of obstinate disconnection processes alongside a sense of community, affective bonds, and curiosity about the 'other', arises with the potential aggregation of memory, to History and stories, allied to the feelings of missing someone and nostalgia that activates the pedagogical-ludic potential of the narrative [6] and of the incision in Culture, whose characteristics and capacities are simultaneously aggregating and sufficiently distinctive of society(ies). In this way, the dynamic field of Digital Media Art (DMA), characterized by its interdisciplinary and interactive nature, as well as its state of constant flow and transformation [7], proposes fostering cultural understanding and empathy through targeted technological applications. The reflection on how technology can foster the dynamics of empathy and interpersonal connection finds fertile ground at the intersection of art, digital media, and emerging narrative practices, with six theoretical-conceptual axes that support the analysis of the artistic projects to be addressed.

1.1 Digital Media Art as a hybrid and relational field

Digital Media Art functions as a hybrid and relational field, operating at the intersection of artistic practices, technological experimentation, and sensory engagement [7, 8]. It is not just a matter of incorporating digital media with artistic media, but also of establishing an aesthetic-technological regime that reconfigures the experience of fruition and participation. Thus, DMA is simultaneously an object and process, aesthetics and interaction, code and embodied experience, as discussed by Murray [9] in his integrated disciplinary perspective and Ronchi [10] in examples of interactive artworks that include motion or sound sensors to foster deep and personal connections with the viewer. Consequently, DMA has become fertile ground for proposals that seek to rethink the ways in which human relationships are mediated by technology. Its hybrid nature allows for the integration of various disciplines, fostering experiences that are visual, sensory, and emotional, in other words, potentially deeper in the connection between the audience and the artwork [11, 12]. This integration is key to designing interactive projects that respond to audience input, transforming passive consumption into active participation and co-creation.

1.2 Transmedia Narratives and Narrative Portals

The evolution of narrative languages in the digital context is marked by the multiplication of platforms and the fragmentation of discursive supports [13]. Transmedia Narratives (TN), as an expression of this evolution, distribute content across various media, inviting the audience to become co-authors of the narrative universe [13, 14]. In this process, mediation structures emerge that can be called Narrative Portals – sensitive entry points to fictional or documentary worlds that intersect the physical space with the digital and the tangible with the intangible [15]. These portals configure experiences of transition and crossing, where the narrative is updated through the activation of the body and presence, acting as digital entry points that overlay information and interactive content onto the physical environment by designing an interactive narrative experience [15]. This integration made possible by technology—particularly through the partnership between Augmented Reality (AR) and TN—enables the creation of narrative portals, transforming the way the connection between individual(s), stories, and emotional engagement takes place. Thus, portals are designed to help users navigate the environment and enhance the overall experience by combining deep immersion with locative spaces and memories, thereby preserving and exploring specific memories—the doorway effect [15:4]. This typology of portal is crucial for getting spaces that foster community connections and shared experiences, as the narrative unfolds through users' interactions with the environment(s).

1.3 Augmented Reality as an affective and participatory technology

Augmented Reality (AR) has increasingly been recognized not only for its ability to expand what is visible but also for its capacity to overlay the sensory upon the symbolic, creating a new ground for aesthetic and emotional engagement [13, 16]. By superimposing digital layers onto the physical world, AR becomes a privileged medium for building experiences that operate in the "intermediate" space—blurring the boundaries between the "here" and the virtual, connecting individual perception with collective experience, and memory with imagination. In artistic contexts, AR transcends its technical function to unfold as an affective technology: it allows the audience to inscribe themselves subjectively into the narrative space, fostering a sense of presence and deep involvement [16]. AR portals, for instance, enable stories to be experienced in an interactive and immersive way, with opportunities for emotional resonance, empathy, and individual identification through embodied interactions with both digital and physical elements. These experiences not only enhance sensory and emotional engagement but also promote community participation and the construction of shared meaning, as AR invites the audience to co-create, remember, and reflect in hybrid environments [15, 16]. Ultimately, the symbiosis between AR and the arts empowers the audience from passive observer to active and affective participant through connections that resonate both individually and collectively [16].

1.4 Digital empathy and community connection

Empathy, understood not only as the capacity to feel with others [4] but also as an openness to listening and reciprocity, finds a unique

experimental field in digital art [13]. Interactive and immersive narratives, especially those enabled by technologies such as AR and locative media, serve as devices for symbolic and emotional re-connection [13:2]. These environments promote new forms of community connection, allowing individuals to share and experience stories collectively—even while physically distant—activating and strengthening community bonds through the sharing of affective experiences [17, 18]. Through AR, users are invited into shared hybrid spaces, where presence, memory, and imagination are interwoven to foster a sense of belonging to something greater than the user per se [14, 19]. DMA turns the audience/spectators into co-creators of the narrative, catalysing a form of digital empathy rooted in participation, the construction of shared meanings, and mutual recognition. In this way, "digital empathy" transcends geographic boundaries, helping to rebuild networks of belonging and recognition within and beyond communities [20, 21]. Ultimately, digital art and immersive technologies aim to be a critical response to the contemporary crises of disconnection and social isolation, providing new rituals of collective engagement, fostering emotional resonance, and facilitating the reconstruction of empathetic and supportive communities in the digital age [17].

1.5 Culture of convergence and participation

In contemporary culture, characterized by the convergence of intense media and participatory production logics, the public increasingly plays an active role in creating and circulating narratives. As Henry Jenkins [14] considers, the concept of participation extends beyond technical or instrumental intervention to encompass emotional and political dimensions. In this context, DMA exemplifies convergence culture by bringing together technology, creativity, and interactivity to foster environments of collaboration, co-creation, and emotional investment [14, 22]. DMA projects encourage the public not only to consume but also to contribute and become co-authors, expanding user involvement into a process of collective meaning-making and shared authorship [20]. This participatory ethos challenges traditional passivity, often associated with media consumption, providing new spaces for listening, visibility, and recognition of diverse voices [20]. Furthermore, the collaborative and multidisciplinary nature of digital convergence fosters innovation, inclusion, and the democratization of cultural expression, positioning DMA as both a resistance to media passivity and a dynamic platform for affective, political, and creative participation in the digital public sphere [14, 20].

1.6 Preserving memories and heritage through digital storytelling

Allied to narrative, technology plays a fundamental role in preserving individual and collective memories. Projects that use AR and digital narratives to represent tangible and intangible heritage foster the creation of affective and living archives that transcend the limitations of static documentation, as highlighted by Nguyen [23] and Economou [17]. Digital narratives allow memory to function as a relational event—an event that is continuously revisited in the present through sensitive devices and experiences that activate and re-enact past stories, exemplified by the WNEIS – With New Eyes I See project - which Kidd [24] praises as an example of this ability. By overlaying historical and cultural layers onto contemporary spaces, AR enables the public to experience and participate in memory as an embodied presence. In Chapter 3 of Geroimenko [16], the authors, Klen Pucihar and Matjaž Kljun, propose a taxonomy of AR that categorizes it across art, education, entertainment, and cultural heritage. This proposal, which aims to expand the understanding of technology by adding layers of communication and personalization before, during, and after any user interaction with a work of art, heritage, and/or culture, justifies the use of AR for cultural applications with the specific purpose of preservation. By making stories, traditions, and local artefacts accessible in multisensory and interactive ways, these technologies ensure that cultural heritage is preserved, reinvented, and dynamically shared across generations [17]. This approach opens space for a multitude of voices, perspectives, and temporalities, metamorphosing cultural memory into a continuous, participatory process. Instead of treating memory as a closed archive, AR-based digital narratives invite communities to engage in processes of review, renewal, and co-authorship, enriching the cultural fabric by fostering a sense of shared identity and belonging.

2 METHODOLOGY

This article adopts a qualitative analytical approach, focusing on a comparative observation of four contemporary artistic projects that integrate augmented reality and narrative devices to foster community engagement and activate empathy. This is a non-empirical analysis guided by theoretical and conceptual criteria in line with the fields of Digital Media Art, interactive narratives, and participatory artistic practices. The projects were selected based on three main criterias:

1. Their inclusion within the recent time frame (2021-2025), in order to ensure the relevance of the practices analysed;
2. The conscious use of augmented reality as a central element of the artistic experience;
3. Explicit presence of objectives related to the promotion of empathy, active listening, or the visibility of community groups or stories.

The analysis was carried out through interpretation and examination based on five dimensions:

Artistic and/or conceptual intentionality. The way in which the project positions itself in relation to the audience and the aesthetic experience;

Technological devices and forms of mediation. Technical choices that support interaction with the public;

Narrative strategies. The structure of the narrative, its degree of linearity or fragmentation, and how it invites emotional involvement;

Participation and community engagement. The role attributed to participants or audiences in the creation, activation, or dissemination of the work;

Empathy activation potential. The project's capacity to foster identification, listening, and recognition among individuals or groups.

The purpose of the analysis is not to establish value judgments or aesthetic hierarchies, but rather to understand how each work articulates technological language with a relational proposal, thereby

contributing to the consideration of AR narrative portals as both conceptual and operational instruments in the field of contemporary digital art.

3 CRITICAL ANALYSIS OF SELECTED PROJECTS

This section presents an interpretative analysis of four international artistic projects selected for their relevance at the intersection of augmented reality, digital narrative, and community engagement. Although distinct in their contexts of creation, they all share the intention of using technology as a tool for listening, memory, and connection. The analysis explores artistic intent, narrative and technological strategies, the degree of participation proposed, and the empathetic potential of the experiences created in the process.

3.1 Augmented Landscapes of Empathy (2024)

The Augmented Landscapes of Empathy project (access link), developed by Katerina Girginova, Bill Gaver, and John Bowers, proposes a set of AR interventions via research through design [24] created in collaboration with caregiver communities, African-heritage mothers, and residents of socially marginalized neighbourhoods in the urban area of Philadelphia, United States. Comprising three AR-based awareness campaigns (Fig. 1), each intervention took the form of an "empathic landscape," made up of visual, textual, and audio elements that overlapped with urban space, challenging the neutrality of the landscape and making visible stories of struggle, care, and resistance from these communities within the traditional public space. Concrete actions included co-creating and disseminating, across different areas of East Philadelphia, posters and postcards with AR integration to test and compare responses from the target audience. Although their primary stated goal was to increase adherence to pediatric vaccination against Covid-19 and influenza, the process was grounded in participatory DMA and community co-creation strategies. From a narrative perspective, the project fragments and decentralizes the experience: there is no linear narrative, but rather multiple entry points, voices, and ways to engage with the content (the video accessed via AR through the QR code, the text included in the physical materials, among others).

Floating images, voice recordings, and short texts are distributed in space as fragments of testimonies and multiple iterations of the main message. In this case, the technology is not used to illustrate, but to reveal, to "augment" not the visible, but the absent. While there may be potential tension stemming from the instrumental application of empathy for persuasion, this is offset when the goal of behavioural change activates socially neglected voices and seeks to model emotional connection, inviting reflection at the intersection of digital art, activism, and social marketing. Thus, community participation is crucial: residents co-created the content of each AR installation, and members of the target community served as narrators. This co-authorship and embrace of local voices, experiences, and imagery reinforce the narratives' authenticity, fostering empathy that is not constructed through fiction but through a genuine perception of reality. The project culminated in the distribution of AR posters and postcards throughout the city, amplifying the campaign's resonance and perceived credibility. Another important aspect to highlight is the detail of hiring actors representative of



Figure 1: Postcard of the Second Influenza Campaign. Source: Girginova et al. (2024)

the target community for the videos and/or images. In this way, the project ensured that the content could be delivered in a relatable manner and was more easily accepted by the community. This article includes this project as a threshold case that expands definitions within the field, exemplifying both the potential of participatory technology to foster community connections and the ethical risks of empathy as a strategy for disseminating potentially persuasive messages. Although it originated in the context of promoting public health, it can be understood as a relational art project through its conscious adoption of co-creative practices, fragmented aesthetics and deep community participation. As endorsed by authors of socially engaged art, such as Nicolas Bourriaud in his work Relational Aesthetics [25] and Murray [9] in the context of interactive digital art, artistic work resides as much in the process and encounters as in the visible products. The use of AR to re-inscribe urban space, the use of multiple voices and sensory language, and openness to interpretation differentiate this project from traditional awareness campaigns. For this reason, its inclusion in the expanded field of contemporary art is well understood, serving as an example of the possible intersections between art, activism, and technology. Consequently, it is one of the four projects to be analysed.

3.2 Como Semillas en el Viento (2024)

Created by Alfredo Salazar-Caro (access link), Como Semillas en el Viento project [26] was commissioned by the Pérez Art Museum Miami (PAMM) and proposes an AR installation that intertwines 3D portraits of Latin American migrants with digitised Mesoamerican archaeological artefacts. These visual elements are complemented by a sound component featuring original poems inspired by the stories of those portrayed. This artwork constructs a poetic and political space in which AR serves as a symbolic gesture of reunion between the ancestral past and the migrant present (Fig. 2). The figures emerge on mobile devices as translucent, delicate, yet assertive presences, confronting visitors with faces and voices that often remain invisible in the public sphere. This juxtaposition of digital aesthetics and human testimony shapes the work's poetics, depicting subjects sharing their stories and identities in a living artistic



Figure 2: Imagem de acesso ao projeto Como Semillas en el Viento. Fonte: ar.pamm.org

composition. Participation is indirect, as the creative process does not take place in real time. Yet it is nonetheless structural: those portrayed contributed their stories and faces, becoming part of the artwork's fabric. The empathetic potential lies in the juxtaposition between aesthetics and testimony and between digital art and the dignification of individual memory. The shared narratives grant authenticity and uniqueness to the installations. The empathetic potential of the experience arises from the encounter between individual and collective memories, promoting the dignity of the migrant experience and highlighting the power of emerging technologies to reinvent memory, recognition, and cultural belonging. cultural.

3.3 Monumental Perspectives (2021-2024)

Resulting from a partnership between LACMA (Los Angeles County Museum of Art) and Snapchat, the artistic project Monumental Perspectives [27] (access link) combines art and technology, using AR to explore stories and perspectives from Los Angeles communities (Fig. 3). The project brought together local artists, communities, and AR developers—Snap Lens Creators—to design digital AR monuments that reflect and challenge the traditional paradigm of public commemoration and memory, cultural diversity, and the history of Los Angeles's local communities. Unlike traditional monuments, which are static, physical, and often exclusionary, these interventions are ephemeral, accessible through geolocation, and centred on stories absent from the official landscape, such as unrepresented moments and/or figures from the past. Each artist chose a concept, figure, or symbol they considered significant for recovering or reinventing the city's collective memory and then built interactive experiences that appeared in urban spaces via mobile devices. The narrative is symbolic and minimalist, based on objects, movements, and digital atmospheres that evoke memories without explicit discourse. Community participation manifested itself in two ways:

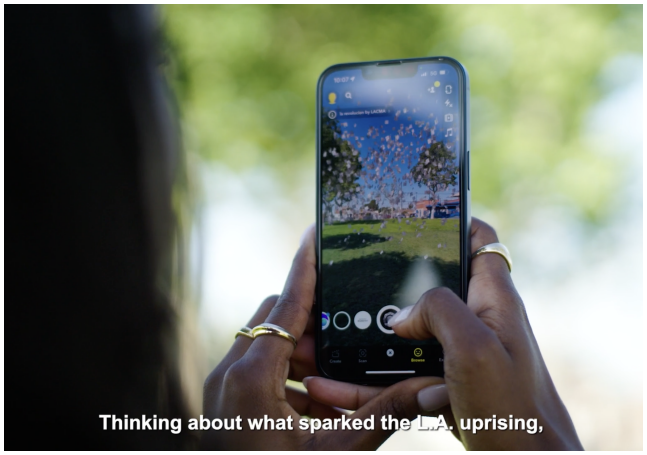


Figure 3: Video image LACMA x SNAPCHAT: Monumental Perspectives (Collection II). Source: lacma.org

first, in the theme of each work, that is, in the appreciation of narratives and presences usually absent from the official landscape; second, in the free and situational access to the works themselves, which appropriate urban space. In this sense, the project democratises the memorial experience. It promotes symbolic justice by giving voice to silenced groups, thereby acknowledging and celebrating their existence and contributions to the city's cultural fabric. Empathy is therefore invoked in this recognition: by seeing themselves represented in a digital monument, historically silenced groups experience visibility as a form of symbolic justice. On the ethical and artistic levels, Monumental Perspectives highlights the importance of empathy as collective recognition rather than mere emotional identification, positioning technology in the service of representation, plurality, and critical revision of urban memory.

3.4 Las Awichas (2024-2025)

Authored by Violeta Ayala, Las Awichas [28] (access link), this installation merges AR, artificial intelligence, and Andean Indigenous culture. Presented at King's College London in May 2024, the artwork features robotic figures and interactive textiles symbolizing ancestral grandmothers—the "awichas"—reimagined as animated digital sculptures and immersive sounds (Fig. 4). This fusion of oral tradition and advanced technology constructs a participatory experience in which the narrative is built from archetypes and collective memories, in a dialogue between oral tradition and technological reconfiguration. Visitors interact with the figures using mobile devices, activating gestures, sounds, and visual elements that invoke ancestral feminine knowledge, intergenerational strength, and resistance. The underlying narrative is collective and symbolic, interweaving archetypes, memories and female resistance. It is a distinctly sensory experience, where empathy is envisioned in the recognition of a shared affective lineage— even among different cultures and across geographical barriers. More than merely transmitting memory, technology assumes a ritual function: memory is transformed into a digital performance, summoning the community for a celebration that exalts the strength, transmission of oral knowledge, and resilience of the culture. Critically, this artwork



Figure 4: Image from the Las Awichas project. Source: kcl.ac.uk

exemplifies how AR and AI can be mobilized not only to preserve or document heritage but also to reinvent it through immersive collective experiences with emotional and cultural impact.

4 COMPARATIVE DISCUSSION

The analysis of the four projects highlights the emergence of an artistic and technological lexicon that, by integrating AR, narrative devices, and community concerns, reconfigures the possibilities of digital art as a medium for connection, listening, and public participation. In this context, DMA emerges as a critical and sensitive response to the growing fragmentation of human relationships, positioning itself as a privileged space for experimenting with new ways of being-with-the-other mediated by technology, as previously stated in this article. Although the projects present varied languages, contexts, and institutional frameworks, the observed cases reveal a convergence around three main axes: (1) the creation of symbolic presence, (2) the inscription of memory as a collective act, and (3) the activation—and ethical problematization—of empathy through sensitive and participatory interactions. Regarding **symbolic presence**, the projects share a concern for making visible voices, bodies, and stories that are usually absent from public spaces or the dominant collective imagination. Through the creation of digital monuments via collaborative processes (Monumental Perspectives), the evocation of ancestral female figures as intergenerational legacy (Las Awichas), the visual and poetic reconstruction of Latin American migrants' journeys (Como Semillas en el Viento), and the spatialization of invisible community testimonies (Augmented Landscapes of Empathy), AR is mobilized as a dual instrument of inscription: it symbolically marks the urban landscape. It activates collective memories, rewriting the fabric of coexistence and belonging. In this way, the four projects function as AR narrative portals, not merely as technological access points, but as zones of contact where technology serves listening, memory, and the cohabitation of difference.

Regarding **memory as a collective practice**, there is a transversal effort to convert individual testimonies into living archives that are shared, ritualized, and celebrated in public spaces. Projects such as Como Semillas en el Viento and Las Awichas demonstrate an intertwining of past and present, rooted in the reinvention and symbolic densification of cultural heritage. On the other hand, projects like Augmented Landscapes of Empathy reinforce the value of micro-narratives situated and the affective writing of territory, showing that collective memory is always a process of (re)construction, sparking new possibilities for community connection mediated by technology.

Empathy in these artworks is not limited to identification or passive feeling; it emerges as a true relational dynamic activated by immersive sensory interaction, participation, and dialogue. AR devices create liminal zones between the individual and the collective, the visible and the invisible, the private and the public, where users are invited to listen, share, and inhabit different narratives. However, it is important to highlight that in Augmented Landscapes of Empathy, empathy also takes on a strategic character—articulating ethics, activism, and persuasion—which introduces the challenge of the instrumentalization of emotions in technological mediation. In other projects, empathy is more explicitly directed towards the recognition of identity, dignification of silenced experiences, and restoration of symbolic justice.

Despite potential critical differences and emerging challenges, conceptual convergence does not overshadow fundamental differences in participation, action, and sustainability:

1. The **degree of community participation** varies: in Augmented Landscapes of Empathy, direct co-authorship and community listening are essential; in Como Semillas en el Viento, the focus is on representation and testimony (with less direct co-creation); in Monumental Perspectives, there is a hybrid model in which artists dialogue with communities, but appropriation is open; in Las Awichas, ancestral sharing is sensorially activated by the public, but with limited intervention at the conceptual stage;
2. **Technology function** reveals itself to be ambiguous: although it mediates access and experience, reliance on platforms (Snapchat, AR apps) and digital devices poses barriers of accessibility, literacy, and sustainability—the artworks may become ephemeral and their cultural legacy depends on volatile technological infrastructures;
3. Regarding the **frontier between art, artivism, and persuasion**, projects such as Como Semillas en el Viento and Las Awichas position themselves unequivocally as digital art and the reinvention of heritage; Monumental Perspectives navigates between symbolic activism and expanded museology; whereas Augmented Landscapes of Empathy challenges boundaries, blending relational art, social intervention, and public campaigning, inviting critical reflection on the legitimacy and intentionality of these practices.

Despite technical, formal, and ethical-institutional differences, these experiences constitute sensitive alternatives to alienation and the crisis of social connection that drives the beginning of this article. They converge in a desire to reconfigure the public experience of space, memory, and collective belonging, functioning as "living laboratories" of cultural citizenship, listening, and relational ethics in the digital age—even though the activated community is sometimes transient, dispersed, or virtual. They question who has a voice, who can (re)construct narratives in urban space, and

how technology can serve new modes of community and listening, that is, constructing narrative portals. However, they make it clear that such practices require ongoing critical attention, especially considering the risks of affective instrumentalization, access fragility, and impact continuity. The analysed projects demonstrate that AR narrative portals are more than technological interactions; they are structures of symbolic and relational passage. Each artwork activates, in its own way, a zone of crossing, where the public participates in situated, affective, and shared narratives. This configuration of narrative portals is the thread that unites these diverse experiences toward a common purpose: reactivating empathy, memory, and belonging through digital art. By articulating participatory technologies, narrative devices, and ethical-social concerns, these artworks not only renew the field of DMA but also demonstrate the potential of art as critical mediation, a space for collective healing, and a proposal for reconnection during times of fragmentation. Nonetheless, they leave room for further exploration, reflection, and future debate: How can we ensure that communities have a real voice and influence in these processes? How can the impact be evaluated beyond the experiential moment? Above all, how can DMA create ethical and sustainable models of affective engagement and shared memory in the era of immersive technologies?

5 FINAL CONSIDERATIONS

In a scenario characterized by the fragmentation of human relationships and a crisis of connection, this article sought to demonstrate how Digital Media Art, by articulating narrative portals activated by augmented reality, digital storytelling, and participation, can operate as a critical and sensitive mediator, fostering new ways of being with others in the digital age. The projects analysed demonstrate that AR, integration into narrative devices, and collaborative processes have the potential to create spaces for symbolic inscription, living archives, and the reconfiguration of a sense of belonging and collective memory. These projects serve as laboratory experiences in cultural citizenship, proposing alternatives to listening, recognition, and empathy, where the public is an active participant and a potential co-creator. However, the analysis also reveals risks and challenges: dependence on ephemeral technological platforms and infrastructures, the possibility of instrumentalising empathy for persuasion or mere superficial engagement, and the ongoing need to ensure accessibility, genuine community action, and the sustainability of practices in the field. Therefore, it is a priority to deepen critical and ethical assessment methodologies for these experiences, investing in metrics of engagement, community appropriation, and lasting impact. The field of Digital Media Art must continue to develop devices that are increasingly participatory, inclusive, and sensitive, and capable of balancing formal innovation, social commitment, and ethical responsibility. The future of these practices lies, above all, in their capacity to function as platforms for reconnection between memory and the future, the individual and the community, and the sensorial and the collective. By moving from mere technological innovation to the effective fostering of relationships, memory, and ethics, Digital Media Art can establish itself as a fundamental contributor to more empathetic, inclusive, and healthy digital societies. Within this dynamic, augmented reality (AR) is included as an aesthetic and relational technology in the construction of artistic experiences that aim for sensory immersion but, above all, the activation of affective and community bonds—a means of amplifying what often remains hidden in hegemonic narrative systems.

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Unblackboxing como prática artística
Unblackboxing as an Artistic Practice

Unblackboxing as an artistic practice

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Resumo

Este artigo reflete sobre práticas artísticas envolvendo tecnologias obsoletas a partir do conceito de "unblackboxing" proposto por Garnet Hertz [5]. Dialogando com contribuições teóricas de Vilém Flusser [4], Albert Borgmann [2] e Claude Lévi-Strauss [6], discute como desmontar, recombinar e reaproveitar dispositivos descartados torna-se gesto crítico e poético. Em vez de abordar a tecnologia como ferramenta opaca, tais práticas reintroduzem experimentação, incerteza e sensibilidade material, resistindo à obsolescência e recuperando agência sobre as máquinas.

Abstract

This article reflects on artistic practices involving obsolete technologies through the lens of the concept of "unblackboxing" proposed by Garnet Hertz [5]. Drawing from theoretical contributions by Vilém Flusser [4], Albert Borgmann [2] e Claude Lévi-Strauss [6], the text explores how dismantling, reassembling, and creatively reusing discarded devices becomes both a critical and poetic gesture. Rather than approaching technology as an opaque tool for image or sound production, these practices reintroduce experimentation, uncertainty, and material sensitivity into the process. By resisting the logic of technical obsolescence and reclaiming control over machines, artists transform so-called "waste" into fertile ground for imagination and reinvention.

CCS Concepts

• **Applied computing** → **Media arts**; *Fine arts.*

Palavras-chave

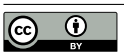
Unblackboxing, Media Art, Technological Obsolescence, DIY, Bricolage

Keywords

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1 Introdução

Neste texto pretendo apresentar o conceito de unblackboxing, tal como proposto por Garnet Hertz em 2023[5]. Trata-se da exploração de sistemas técnicos ocultos, as chamadas caixas-pretas, observada por esse autor nas práticas de hackers e bricoleurs. A caixa-preta é um símbolo clássico da abstração tecnológica e reflete o modo como interagimos com a maioria dos dispositivos: conhecemos apenas suas entradas e saídas, sem acesso ao que ocorre internamente. Num segundo momento, meu intuito será defender o unblackboxing como um verdadeiro modus operandi nas práticas artísticas que se valem de dispositivos tecnológicos.

2 Origens e exercícios pedagógicos

Antes de abordar o conceito de unblackboxing proposto por Garnet Hertz, é necessário examinar o percurso histórico da ideia de "caixa preta" no campo da tecnologia. Este termo, hoje amplamente utilizado para descrever sistemas cuja complexidade interna permanece oculta ao usuário, tem raízes tanto nas engenharias quanto na filosofia da tecnologia. Ao longo do século XX, o conceito se desenvolveu em diferentes contextos: da análise de redes elétricas e da cibernética às reflexões de pensadores como Flusser e Borgmann[2, 4]. Depois o conceito se tornou um emblema da opacidade tecnológica que permeia nosso cotidiano. Esta introdução busca traçar esse caminho conceitual, mostrando como Hertz retoma e resignifica essa herança em sua proposta de resistência técnica e estética. Embora o termo "caixa preta" não apareça explicitamente em seus escritos, Wilhelm Cauer, nos anos 1940, já trabalhava com um modelo analítico que antecipava o conceito: a análise de redes elétricas a partir das relações entre sinais de entrada e saída, sem acesso direto à estrutura interna dos circuitos ([3, 7]). Essa abordagem, consolidada mais tarde nas escolas de engenharia elétrica e eletrônica, deu origem a um tipo de exercício técnico em que estudantes analisavam caixas lacradas contendo circuitos ocultos. Com base nos sinais injetados e nos resultados observados, buscava-se inferir a composição interna da caixa (Ashby, 1956, p. 86[1, p. 86]). Durante os anos 1950, com o surgimento da cibernética, o conceito de "caixa preta" foi formalizado como uma metáfora para sistemas cujo funcionamento interno pode permanecer desconhecido, desde que suas entradas e saídas sejam compreendidas e manipuláveis. Essa ideia foi fundamental para pensar as máquinas e aparelhos e se tornou um ponto de referência importante na teoria dos sistemas. No livro "An introduction to cybernetics" de Ross Ashby, de 1956,

o sexto capítulo é dedicado às caixas pretas[1]. Esse véu que cobre a tecnologia ao nosso redor é central na nossa relação com ela, que se dá quase sempre apenas por meio das entradas e saídas.

3 Filosofia da tecnologia nos anos 1980

A partir dos anos 1980, pensadores como Vilém Flusser e Albert Borgmann aprofundaram a discussão sobre a mediação tecnológica e a crescente opacidade dos dispositivos. Borgmann não utiliza o termo no texto de 1984. Usa apenas o termo "dispositivos", mas fala de como são herméticos e opacos. Flusser adota o termo 'caixa preta' já no título de seu livro de 1985[4]. Ele usa o termo para descrever os dispositivos tecnológicos, que ele chama "aparelhos". Essa ontologia do aparelho é feita usando a câmara fotográfica analógica como exemplo, mas se aplica a todos os dispositivos tecnológicos que surgiram de lá para cá. Ele descreve como os aparelhos são programados e como tentam nos programar. O programa é a ligação de tudo e onde reside o pensamento teórico que deu origem ao aparelho. Em linhas gerais, os aparelhos estão prontos que funcionários explorem seus programas através de diveras entradas e se fartem de observar as diversas saídas. Funcionários são os humanos que usam apenas inputs e outputs de aparelhos que são previstos pelo programa. Ele discute extensamente os conceitos de entrada e saída (inputs e outputs) e o universo de possibilidades que eles abrem dentro dos aparelhos. Para Flusser só existe uma maneira de expandir o universo das imagens possíveis com um aparelho fotográfico: entrar na caixa preta, a entender e a modificar, ou até construir uma (Flusser, 1985[4]). No glossário há uma justaposição de duas palavras essenciais para esse conceito: "Fotógrafo: pessoa que procura inserir na imagem informações não previstas pelo aparelho fotográfico. Funcionário: pessoa que brinca com aparelho e age em função dele" (Flusser, 1985, p. 77[4, p. 77]). Já em "Holding On to Reality: The Nature of Information at the Turn of the Millennium" de 1999, Borgmann usa o termo "black box" algumas vezes. "Para dar sentido a um computador, é preciso reunir e ocultar os fluxos de elétrons de transistores e resistores nas diversas caixas de portas lógicas; agrupar as portas lógicas em somadores, os somadores e similares em uma unidade aritmética e lógica, caixas como essas na unidade central de processamento; e, por fim, colocar as placas, os periféricos e a fonte de alimentação na caixa preta mais externa — o computador" (Borgmann, 1999, p. 167[2, p. 167]). E ele ainda vai mais além e relaciona essa hierarquia de caixas pretas com um hierarquia similar de linguagens usadas para programar cada nível (ou caixa). Depois usa o termo "blackboxing" para falar do progresso: "A informação tecnológica [...] repousa sobre um substrato de máquinas que está se tornando oculto à compreensão daqueles que operam em sua superfície. A caixa-preta que resulta do progresso na tecnologia da informação encerra espaços cada vez maiores de hardware e software. É um desenvolvimento inevitável. As caixas-pretas maiores sustentam ferramentas mais poderosas."(Borgmann, 1999, p. 176[2, p. 176]).

4 Do "dispositivo" ao "unblackboxing"

O livro Art + DIY Electronics de Garnet Hertz traz uma discussão interessante sobre a mentalidade DIY e como ele acredita que ela está presente em diversos trabalhos da Electronic Art e das Media Arts[5]. Hertz analisa a expressão do-it-yourself para decifrar o significado mais profundo essa mentalidade. Do se refere à liderar a ação e não esperar por umas outra solução que poderá vir mais tarde. It é a construção ou o reparo. Yourself significa que é com o que a pessoa tiver à disposição, sejam materiais ou ferramentas, sem a pressão de fazer um serviço num padrão mais elevado do que o possível nessa situação. Além de citar Borgmann para explicar como as caixas pretas vivem dentro de outras caixas pretas ainda maiores[2], Hertz acaba por começar a usar o termo "unblackboxing" para se referir a essa necessidade ou curiosidade de entender melhor como algo funciona[5]. Hertz parte da postura DIY, dos hackers e bricoleurs, da maneira como eles investigam, modificam dispositivos e esbarra na obsolescência e no lixo eletrônico que formam o terreno fértil para essa exploração: "Quando o produto para de funcionar, o dispositivo geralmente se torna irreparável e inacessível para o consumidor comum. Diferente de uma lâmpada doméstica, que pode ter suas lâmpadas substituídas, muitos dispositivos eletrônicos de consumo não possuem partes que possam ser reparadas pelo usuário, e o objeto é descartado após quebrar. A despontualização, ou desmontagem do dispositivo em seus componentes, é dificultada pelos processos altamente especializados de engenharia e fabricação utilizados em seu design: as tecnologias eletrônicas são tipicamente projetadas para serem descartadas, e não reparadas. No entanto, artistas, músicos e outros praticantes do 'faça você mesmo' frequentemente tomam a obsolescência tecnológica como ponto de partida para seus trabalhos. Objetos obsoletos são regularmente desmontados, religados e reaproveitados para aplicações diferentes daquelas para as quais foram originalmente projetados e, nesse processo, as caixas pretas são 'dobradas' em novas formas" (Hertz, 2023, p. 120[5, p. 120]). Mais do que uma simples desmontagem ou um exercício de curiosidade técnica, Hertz descreve o unblackboxing como um processo inventivo e performático. O gesto de abrir e reconfigurar dispositivos é, para ele, uma forma de pensar com as mãos enquanto explora o aparelho. Esse ato de expor, modificar e reimaginar o interior dos aparelhos aproxima-se tanto de um fazer artístico quanto de um ato político: ao tornar visível o que estava oculto, o artista não apenas compreende o funcionamento do dispositivo, mas também muda seu sentido ou o sentido de sons e imagens produzidos com ele.

5 Unblackboxing como prática artística

A fim de abordar tanto o unblackboxing de maneira mais próxima, vou começar essa secção com um exemplo que me parece simples do que é uma caixa preta. Lidamos diariamente com um frigorífico em nossas casas e sabemos algumas regras básicas para seu uso cotidiano. O frigorífico precisa estar ligado à energia elétrica, permanecer fechado boa parte do tempo e só ser aberto brevemente e ser instalado ao abrigo do Sol. Sabemos que se essas condições estiverem cobertas, uma garrafa de água dentro do frigorífico, em um espaço de algumas horas, se transformará numa garrafa de água fresca. Muitas vezes, sequer sabemos o que faz o compressor, ou mesmo se o nosso modelo conta com um. Não sabemos como funciona o termostato, nem que tipo de gás corre pelas mangueiras do nosso frigorífico, mas isso não nos impede de ter gelado de menta para a sobremesa do jantar e comida que não estraga rapidamente em casa. Enquanto sabemos como o frigorífico deve ser usado, estamos a dominar suas entradas e saídas. Ao não sabermos como

ele de facto funciona, mas ainda assim somos capazes de usá-lo por completo, o frigorífico passa a ser essencialmente uma caixa preta. Ou seja, no processo de desenvolvimento tecnológico pelo qual o frigorífico passou, suas partes funcionais foram sendo sujeitas ao processo de blackboxing, seu funcionamento foi sendo escondido. Logo, o unblackboxing seria encontrar uma maneira de expor o funcionamento de um dispositivo, de revelar o que foi escondido pelo processo de blackboxing. Optar por um unblackboxing de um frigorífico que está a funcionar, pode nos deixar sem gelado e com comida estragada, mas no campo das artes, a abordagem do unblackboxing ganha uma dimensão prática, poética e política. Essa abordagem não é exclusivamente desmontar e abrir para observar, existem diversas outras maneiras de expor o pensamento que está guardado no interior dos dispositivos. Por exemplo, quando Nam June Paik encosta um imã num aparelho de TV, mesmo sem abrir o aparelho, ao distorcer a imagem por completo, ele consegue demonstrar a importância do magnetismo para controlar os raios catódicos e formar a imagem na tela. Nesse sentido, a prática de unblackboxing não é apenas sobre revelar o interior das máquinas, mas sobre transformar o próprio ato de manipular tecnologia em uma performance estética. Se, como vimos, artistas e hackers frequentemente operam desmontagens críticas da tecnologia, é preciso destacar que esse gesto não se limita à curiosidade técnica. Ele é, muitas vezes, um gesto de resistência frente à lógica industrial da obsolescência e da exclusão do saber técnico.

6 Risco, erro e reinvenção

No entanto, unblackboxing às vezes quer dizer mesmo desmontar, abrir, esmiuçar e explorar. E isso quer dizer que o dispositivo que será sujeito a esse processo estará em risco de não funcionar mais ou ser irremediavelmente modificado. Como podemos pensar em maneiras de aproveitar o risco e os possíveis erros durante esse processo a nosso favor? Podemos pensar no bricoleur de Claude Levi-Strauss, que também é citado por Hertz, e o comparar a um artista que se concentra em juntar dispositivos obsoletos e descartados (e/ou aqueles com os quais ele se permite arriscar) e que usa seu tempo e sua disposição para lidar com as limitações encontradas nesses itens (Levi-Strauss, 1976[6]). Esse artista faz um inventário do que ele tem, imagina as recombinações que são possíveis, escolhe um caminho e o executa. Nem sempre dá tudo certo, mas às vezes pode ser possível expandir o universo das possibilidades desses dispositivos. Se determinados dispositivos, suportes ou técnicas são considerados obsoletos, é porque o avanço insistente da tecnologia (muitas vezes em descompasso com a sustentabilidade do planeta) produziu novos aparelhos, acessórios e materiais que vieram substituí-los. Essa substituição constante de sistemas, sejam eles para gerar imagens, sons ou outras expressões artísticas, cria sucessivas camadas de processos descartados. E o que me incomoda é como isso atropela práticas individuais já consolidadas. Em algum ponto, artistas e criadores em geral são pressionados a abandonar processos que se tornaram parte de sua linguagem, de seu desejo de expressão. Essa pressão não vem apenas do "avanço tecnológico"em si, mas também dos investimentos e estratégias comerciais que o sustentam e que apresentam como ultrapassados certos modos de fazer. A própria linguagem da indústria contribui para esse apagamento. Um exemplo claro é a validade impressa em uma embalagem de filme fotográfico: ela pode induzir a ideia de que o material venceu no tempo e, portanto, perdeu sua função. Mas isso simplesmente não é verdade, a validade é uma data que se refere à garantia do produto dentro de uma relação comercial. Espero que produtores de imagens e sons percebam como a indústria tende a representar as ferramentas de modo binário: ou funcionam porque são novas, ou deixaram de funcionar por serem obsoletas. Na prática, há milhares de tonalidades entre esses extremos. Há papéis fotográficos mofados que ainda geram imagens incríveis, sintetizadores com botões defeituosos que produzem sons inesperados, câmeras quebradas que desenham o mundo de um modo insubstituível, scanners com lâmpadas queimadas que revelam texturas únicas. O fato de estarem fora do padrão vigente não os torna inúteis. Muito pelo contrário: são materiais que ainda respondem ao presente. E existem maneiras de driblar a pressão pelo novo: reinventando, adaptando, reconfigurando. Essas peças rejeitadas são, muitas vezes, instrumentos perfeitamente capazes de criar. Este texto propõe que essas sobras não sejam vistas como lixo, mas como componentes de um outro repertório técnico e expressivo. Podemos até chamá-las de uma espécie de hardware livre, disponível para unblackboxing, ou seja, para quem estiver disposto a imaginar novos usos para o que foi descartado. Outro ponto importante: esses materiais são, muitas vezes, mais acessíveis. Um filme vencido pode custar menos que um novo. Um scanner antigo pode ser doado. Um sintetizador parcialmente funcional pode ser encontrado no lixo eletrônico. E isso tem impacto direto na possibilidade de experimentar mais. Quando o custo é menor, o risco também é. E o risco, aqui, é valioso: ele permite errar, algo comum no processo de unblackboxing. Permite tentar algo mesmo sem a garantia do sucesso. Tira o peso da perfeição. E quase sempre, quando nos arriscamos, algo novo se revela. O risco, nesses contextos, é um catalisador de descobertas. É o que faz do processo um território fértil para inovações que ainda não conhecemos. Daí a maravilha de se jogar em um filme barato, em um circuito velho, em um driver incompatível, e descobrir maneiras inesperadas de ver, de escutar, de interagir com o mundo. Outro aspecto bonito desse reaproveitamento é que ele cria redes. Às vezes, alguém guarda um dispositivo para você. Às vezes, alguém lembra de você na hora de descartar algo. A prática de buscar materiais para criar passa a ser uma prática compartilhada, que envolve cuidado, escuta e colaboração. Penso nisso quando alguém se espanta ao me ver desmontar um scanner antigo e, depois, transformá-lo em parte de uma nova máquina. Há ainda um resultado indireto e importante: movimentos como esse, em diferentes partes do mundo, podem impactar a lógica de produção e consumo. Reduzem o desperdício, promovem sustentabilidade, democratizam o acesso à criação. Se é possível produzir imagens, sons ou experiências sensoriais com aquilo que foi descartado, é porque há um claro excedente de equipamentos e materiais circulando.

7 Limitações

É pertinente, a todo momento, perguntarmo-nos: que limitações nos serão impostas ao optar pelo reaproveitamento de um dispositivo descartado? Será que as imagens que produzirmos serão diferentes com uma câmara fotográfica velha? Serão, porventura, inferiores às que se fazem hoje com o que há de mais avançado? Quando um dispositivo se torna obsoleto, o conjunto de imagens ou de sons

possíveis com ele também muda. A precariedade e a improvisação podem estreitar possibilidades de um lado, mas expandi-las de outro. Às vezes, a diferença entre usar um processo antigo ou um moderno está apenas no tempo necessário para concluir uma captura. Pode acontecer de o resultado visual ou sonoro ser praticamente idêntico ou então de o processo mais demorado oferecer um tempo valioso para a reflexão sobre a peça em construção. Não há resposta definitiva para essas questões. Só a experimentação permitirá ao artista estabelecer expectativas e caminhos. Tento guardar aquilo que um dia foi perdido. Tento manter vivos os registros de como as coisas podiam ser feitas. Não repudio o digital e tudo o que ele representa, pelo contrário, lanço-me também nessa direção. Apaixono-me pela tecnologia digital e procuro entrelaçá-la em tudo que faço. Mas reconheço suas limitações, assim como reconheço as dos processos aos quais tento dar uma pequena sobrevida. Limitações existem em todas as direções. Vejo limites, vejo possibilidades, ouço imagens vejo sons, vejo processos, vejo soluções e ajustes a serem feitos e, sobretudo, vejo o espanto nos olhos dos que me observam trabalhando com as coisas decrépitas que carrego nas mãos. É preciso estar disposto a sentar e aprender a fazer. A olhar para essas coisas e imaginar o que elas ainda podem acrescentar a uma obra artística. A buscar soluções apoiadas em tecnologias em contínua obsolescência. É preciso estar disposto a ver o óbvio, a não criar expectativas, e a aprender com as imagens e com os sons.

8 Conclusão

Flusser fala da necessidade de entrar na caixa preta, de romper com o uso funcionalista dos aparelhos para produzir imagens imprevistas[4]. Levi-Strauss descreve o bricoleur como aquele que opera com os materiais que tem à mão, interpretando e recombinando usos de forma inventiva[6]. Hertz, por sua vez, observa como artistas e hackers contemporâneos dobram caixas pretas: desconstroem dispositivos, expõem seus mecanismos e os transformam em suportes para expressão e crítica[5]. Em comum, esses autores apontam para práticas que resistem ao apagamento técnico e ao distanciamento promovido pela lógica industrial. Nesse sentido, o gesto de desmontar, reaproveitar e reinventar tecnologias descartadas é mais do que uma curiosidade técnica ou uma resposta à escassez de recursos: é também um gesto profundamente político e poético. Ele desafia a obsolescência programada, questiona os monopólios do saber técnico e reabre possibilidades criativas que haviam sido encerradas. Artistas e criadores recuperam o risco, o erro e a descoberta como modos legítimos de relação com a tecnologia. Unblackboxing passa a ser um gesto de reencantamento. Ao abrir, modificar e imaginar novos usos para dispositivos condenados ao descarte ou pela obsolescência, artistas dão aos dispositivos tecnológicos suas possibilidades mais interessantes e significativas. O unblackboxing os transforma em um território fértil para o imprevisto e o sensível.

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A Media Art como meio de criação híbrida, colaborativa e participativa
Media Art as a means of hybrid, collaborative and participatory creation

Media Art as a means of hybrid collaborative and participatory creation

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Resumo

A proposta que aqui se apresenta tem como base a performance Esta Concha Soa a Vozes, uma criação coletiva desenvolvida pelo coletivo vocal comunitário Outra Voz, o performer Raúl Maia e um núcleo artístico multidisciplinar. Este projeto parte de uma proposta dramatúrgica sobre distopia evolutiva do Homo Digitalis para explorar criticamente os paradoxos do universo digital, instrumentalizando-o simultaneamente como objeto de reflexão e como pretexto de colaboração e criação coletiva. Através da interseção entre música eletrónica, prática vocal comunitária, legado oral e performance num resultado performático de som e movimento, propõe-se uma exploração sensorial e crítica das dinâmicas sociais contemporâneas mediadas pela tecnologia. O trabalho inscreve-se nos domínios da arte digital e instalações artísticas, arte interativa e media artworks e comunidades digitais e é caracterizado por um processo que espelha princípios associados à Teoria do Ator-Rede [6], no sentido colaborativo do processo e na integração de elementos humanos e não-humanos, corpo e técnica, som e escuta, indivíduo e comunidade, contemporaneidade e memória.

Abstract

The proposal presented here is based on the performance Esta Concha Soa a Vozes (This Shell Sounds Voices), a collective creation developed by the community vocal collective Outra Voz, performer Raúl Maia, and a multidisciplinary artistic group. This project stems from a dramaturgical proposal about the evolutionary dystopia of Homo Digitalis to critically explore the paradoxes of the digital universe, simultaneously instrumentalising it as an object of reflection and as a pretext for collaboration and collective creation. Through the intersection of electronic music, community vocal practice, oral legacy and performance in a performative result of sound and movement, a sensory and critical exploration of contemporary social dynamics mediated by technology is proposed. The work falls within the domains of digital art and artistic installations, interactive art and media artworks, and digital communities, and is characterised by a process that mirrors principles associated with Actor-Network Theory [6], in the collaborative sense of the process and the integration of human and non-human elements, body and technique, sound and listening, individual and community, contemporaneity and memory.

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CCS Concepts

• **Applied computing** → **Arts and humanities**.

Palabras-chave

Arte Participativa, Comunidades Digitais, Composição Coletiva, Híbrido, Performance

Keywords

Participatory Art, Digital Communities, Collective Composition, Hybrid, Performance

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1 Introdução

Esta Concha Soa a Vozes é uma performance colaborativa e participativa concebida com participantes da comunidade — na sua maioria não-profissionais — e um núcleo artístico profissional, que emerge da utilização da tecnologia como motor e condição da criação. A obra discorre de uma abordagem ao digital enquanto veículo estético, dramatúrgico e relacional. A tecnologia não é apenas uma ferramenta que media o esforço de criação coletivo, como também se torna no próprio terreno criativo sobre o qual a dramaturgia assenta como proposta de reflexão para o público. A proposta parte de uma dramaturgia distópica para passar a convocar a noção de coletivo por oposição ao *hiperindividualismo* [7] e ao isolamento social. Uma composição contemporânea criada com elementos de música eletrónica (contendo elementos vocais registados com o próprio coletivo, drones, soundscapes de ruídos industriais), articulada com saxofone e percussão de dois intérpretes do universo da música clássica contemporânea e o reportório da Outra Voz (que

inclui composições originais criadas por encomenda por compositores nacionais consagrados, por elementos do próprio grupo e recolhas do legado oral local, estéticamente recontextualizadas) organizada por uma lógica dramatúrgica de cinco atos, inspirada por um poema criado com o auxílio de um modelo de linguagem de grande escala (OpenAi (2025)[10]). Estes materiais sonoros foram então, progressivamente inspirando, uma partitura de movimento desenvolvida pelo performer e coreógrafo Raúl Maia, regido pela mesma estrutura dramatúrgica, no sentido de criar um ecossistema performativo híbrido onde corpo e som se interligam como agentes técnico-humanos numa rede sensível (Latour, 2005) [6]. O título da performance é inspirado na expressão pop *Ghost in the Shell*, cuja origem remonta ao conceito filosófico *Ghost in the Machine*, cunhado por Arthur Koestler (1967) [5], inspirado na crítica de Gilbert Ryle (1949) [11] ao dualismo cartesiano. Em A Concha Soa a Vozes, a metáfora traduz-se no confronto entre a "concha" — o corpo performativo de Raúl Maia — e o "fantasma" — a massa sonora produzida coletivamente por Outra Voz. A obra propõe-se assim como um experiência estético-filosófica sobre a condição do Homo Digitalis, um ser solitário, hipertecnológico e em metamorfose. Esta abordagem dialoga também com a afirmação de Maribel Alvarez (2012) [1]: "The most significant initiatives that can be undertaken to support the participatory arts without altering their fundamental informal character, may in fact have something to do with supporting those nodes of cultural production in the nonprofit infrastructure where professional and amateur arts overlap, and can fruitfully cross-pollinate to strengthen each other". A sobreposição entre práticas vocais (que se permitem à falibilidade tonal), a performance corporal contemporânea, o uso de instrumentos clássicos e a produção eletrónica, em contexto comunitário permite não só a hibridação estética, mas também a reconfiguração de espaços partilhados de escuta e criação. Neste sentido, é pertinente convocar a noção de desafinação como estratégia estética e política. Politicamente, a desafinação coral assumida, afirma-se como gesto que rompe com a normatividade harmónica de uma tradição coral institucionalizada, defendendo o direito à dissonância, à diferença - um lugar para uma voz "feia". Esteticamente, aproximando-se das propostas de base que sustentam a Sound Art, pela representação sonora de um espectro mais alargado de frequências microtonais que se avizinham da dominante pretendida, o que em certos espaços pode resultar no surgimento de batimentos acústicos, pela reverbreação natural dos mesmos e que adicionam à experiência do espetador proporcionando também uma leitura semiótica: a procura pela perfeição (neste caso, o tom perfeito) que inevitavelmente não se consegue alcançar.

2 O coletivo Outra Voz como rede

Desde 2010, o coletivo Outra Voz reúne semanalmente participantes oriundos de diferentes localidades do território de Guimarães, de diferentes faixas etárias e contextos socioculturais, sob o pretexto da elaboração de objetos artísticos que em parte, exploram práticas vocais e corporais experimentais. Com presença regular em seis freguesias do concelho, o projeto promove a descentralização da criação artística e o combate ao isolamento social, sendo que esta assume uma preponderância central de entre todos os seus objetivos. O seu repertório é constituído por temas compostos por encomenda a artistas de renome nacional, de entre eles, José Mário Branco, Amélia Muge, Fernando Lapa, a banda Mão Morta, Rui Souza, composições originais criadas através de processos participativos pelos criativos do grupo, e recolhas de legado oral, junto aos elementos do coletivo, e que posteriormente são revisitadas e recontextualizadas estéticamente. Para esta criação, apresentada ao público no dia 24 de Maio de 2025 nas salas de ensaio do Teatro Jordão em Guimarães, o coletivo apresentou-se com 63 participantes (18 deles do género masculino), com idades compreendidas entre os 44 e os 78 anos. Identificando que uma das questões de conflito interno ao grupo, decorrente das dezenas de processos de apresentação de objetos artísticos ao longos dos seus 15 anos de existência, está associado a uma reivindicação egocêntrica por parte dos participantes por visibilidade cénica, a proposta artística proposta aos participantes, e da qual resulta esta criação, teve como um dos objetivos proporcionar uma reflexão sobre a noção do "outro". Para tal idealizamos um dispositivo cénico que, à partida remetia o coletivo para um segundo plano, um lugar de menor destaque, "escondido", quando dramaturgicamente, na narrativa da apresentação, assumiria o papel de toda a humanidade tornada em som. Assim, planeamos um percurso de preparação pela prática da escuta de uma sonoridade vocal coletiva, como um contra-dispositivo ao narcisismo digital contemporâneo, apontado por Lipovetsky (1989) [7] e Han (2018) [3], ao propormos uma estética assente na alteridade. A tensão entre o desejo de visibilidade individual e a dissolução do ego é assumida como matéria dramatúrgica: na performance, o coletivo dissolve-se numa paisagem sonora, enquanto a corporalidade de um indivíduo, o performer Raúl Maia, encarna a subjetividade das múltiplas vozes. Neste contexto, o digital atua como meio relacional que favorece a dissolução do indivíduo. O espaço acústico amplificado permite multiplicar e redistribuir a presença vocal, desafiando hierarquias convencionais e reconfigurando os modos de escuta e de performatividade coletiva. O corpo coletivo está ao fundo, mas preenche todo o espaço disponível do local da apresentação vendo assim reforçado o seu papel, como interveniente principal. Deste modo, paradoxalmente, o digital aparece ressignificado como um risco para uma humanidade que se afasta da sua característica essencial, na medida em que o público revendo-se no coletivo vocal, se sente "tocado" pelas vozes enquanto tem como "fronteira" o corpo do performer, ser senciente que ocupa o centro de cena. Assim, pode dizer-se que, de alguma forma, este dispostivo cénico, propõe ao público, a separação de si próprio, enquanto humanidade.

3 Metodologia: escuta, tecnologia e articulação de corpos

O processo criativo iniciou-se com a introdução ao conceito de escuta ativa junto dos participantes. Propusemos realizar uma performance vocal em finais de Novembro de 2024, de uma paisagem sonora que iniciamos a ensaiar em Setembro, e a ter lugar num local, rodeado de paisagem natural, sem público nem registos audiovisuais. A intenção era convocar uma relação íntima e sensível com o meio envolvente — exemplificando este gesto como algo semelhante a uma conversa privada com uma planta ou um animal, ato este que, em algum momento, todos já ensaiámos na nossa privacidade. No caso em específico, a "conversa privada" seria a peça performativa do coletivo interpretada para a fauna e flora

circundantes nesse instante performativo. Calculamos que a inscrição deste momento, na memória afetiva dos participantes seria um primeiro momento no sentido de abordar linguagens mais abstratas que eventualmente iriam surgir ao longo do processo colaborativo. A ausência de testemunho externo em forma de público (real ou virtual) como forma de reforçar a dimensão subjetiva, relacional e efémera da proposta, resgatando o valor da experiência partilhada na sua forma mais essencial. Foi este o primeiro ponto a partir do qual se começou a desenrolar uma composição coletiva, fruto da colaboração dos diferentes participantes (profissionais e não profissionais) — alicerçada por um poema gerado por recurso a um modelo de linguagem (LLM) ([10]). Neste caso em específico, hoje em dia, considerarmos o que um ser senciente poderia "imaginar" no contexto proposto de uma existência solitária em cenário pós-apocalíptico, pode ser materializado de uma forma mais fidedigna se efetivamente, considerarmos questionar um modelo que simula uma inteligência artificial. Este foi então, simbolicamente, um passo seguinte na direção da criação de uma composição coletiva entre a direção artística, os diretores corais, dois músicos de formação musical clássica (percussionista e saxofonista), dos diretores corais (na seleção de repertório vocal para os cinco atos performativos). Também o compositor de música eletrónica e os participantes, o primeiro, que cria uma nova paisagem sonora, a partir dos registos feitos na referida performance inicial com os participantes. Esta foi posteriormente (Janeiro de 2025), registada num estúdio que improvisamos na Blackbox do Centro Internacional das Artes José de Guimarães. Existem ainda outros níveis do envolvimentos dos participantes no processo. Uma delas sendo a particação na partilha de legado oral que incluímos na criação. Uma outra, associada à criação de um "poema de bancada"em torno do universo do egocentrismo, uma espécie de "cadáver exquis", composto por diferentes partes das partilhas escritas, de cada um dos participantes. Poema este, que foi partilhado na folha de sala e que embora, se revestisse de uma importância performativa, que por fim, não conseguimos materializar, foi de vital importância, para o processo, que iterativamente foi tentado provocar a sensibilidade e despontar reflexão sobre a matéria em criação e o mundo pós-contemporâneo, junto dos participantes. Mas, de facto é preciso ter em conta que o factor tecnológico tem um papel determinante no suporte destas colaborações criativas. Estas são apenas possíveis pelos suportes que os meios digitais ubíquos da atualidade nos proporcionam: partilha remota de ficheiros, registos áudio digitais, plataformas de produção digital (DAWs), plataformas de videoconferência. Possibilitam um fluxo contínuo de troca criativa, que alicerçada por uma mesma âncora dramatúrgica, resulta em objetos finais de alguma complexidade, assemblados somente nos quatro dias anteriores à estreia. Esta metodologia, que de si, parte de uma vontade empírica de experimentação no "campo", quando analisada mais profundamente, pode ser carateriza a partir de da Teoria do Ator-Rede (Latour, 2005) [6], pela articulação de elementos humanos e não-humanos — vozes, corpos, gravações digitais, microfones, algoritmos de processamento sonoro, reverberação do espaço acústico performativo — numa ecologia de criação relacional. Duplos sentidos que se vão manifestando por diferentes redes e estrato sócio-económicos de um território. O som eletrónico digital, por exemplo, adquire aqui uma função dupla: evoca o legado industrial subjacente ao passado industrial do território da cidade de Guimarães e serve de superfície de inscrição coletiva, onde se grava a memória comum. A utilização da tecnologia torna-se, assim, parte integrante da identidade dramatúrgica e sensorial da obra — não apenas infraestrutura de suporte, mas linguagem de composição, perceção e receção. A mediação digital permite redimensionar a escuta comunitária, possibilitando novas formas de presença e de coautoria, em ambos públicos e participantes. E aí, o dispositivo performativo pode também assumir-se como elo agregador do familiar e do bizarro, do humano e da máquina, criando uma simbiose que se traduz em novas estéticas e que evoca o espírito de hibridação cultural (Canclini 1990) [2] que se acredita estar na base, por exemplo, de géneros musicais como o fado e o flamenco. Neste caso em concreto, com a particularidade de um hibridismo caracterizado pelo esbatimento das barreiras culturais que separam o homem da máquina, o digital do natural e que possibilita a normalização do ser humano tornado quimera ou ciborgue (Haraway 1985) [4].

4 Arte digital, media híbridos e comunidade: paradoxos e possibilidades

Esta Concha Soa a Vozes afirma-se como um media artwork híbrido que utiliza a tecnologia para desnovelar estéticamente e técnicamente os paradoxos do digital: entre solidão e conectividade, entre invisibilidade e centralidade expositiva. O universo do digital, ao invés de acentuar a fragmentação, é aqui reimaginado como uma forma significante da partilha do processo criativo. Resulta da continuidade de uma prática de envolvimento comunitário em objetos poético-participativos, com algumas décadas com o qual os agentes da rede cultural regional e nacional, se têm vindo a comprometer, no sentido da acessibilidade à cultura e da mediação de experiências de impacto sob o ponto de vista afetivo e emocional e que neste caso se centraliza na atenuação do distanciamento conceptual ubiquamente presente no nosso discurso quotidiano em torno do humano, da máquina e do biológico. Ou seja, o discurso sobre a alteridade que passa a integrar um "outro" que vai para além do nosso semelhante humano, na aurora de um Homo Digitalis, híbrido de próteses tecnológicas e biológicas. Surge de um diálogo com projetos como Scotoma Scintilante de Jonathan Uliel Saldanha ou Feral Choir de Phil Minton [8], pela metodologia empregue no cruzamento entre investigação vocal, experimentação performativa e participação comunitária. Tal como em Feral Choir, onde a voz é explorada nas suas dimensões mais cruas e não convencionais por um coletivo não profissional, também nesta performance a desafinação tornada em timbre de maior riqueza harmónica e a voz dissonante são assumidos como matérias expressivas e políticas. A voz é libertada da normatividade coral e devolvida à sua condição orgânica e plural, afirmando a multiplicidade como uma noção estética de reapropriação da comunidade. De realçar, que no âmbito de uma parceria entre a Outra Voz - Associação Cultural e a produtora "O belo e os monstros"foi promovida, a um público amplo da área geográfica de Guimarães e arredores, a participação numa performance com Phil Minton e Audrey Chen, e na qual participaram vários elementos da Outra Voz, a 7 de Maio de 2024. Esta visava já um longo percurso de envolvimento da comunidade no sentido destas perspetivas performativas de maior caráter experimental. No caso de Scotoma Scintilante, a criação de Saldanha parte de uma dramaturgia sonora expandida, sustentada por um complexo sistema de difusão multicanal, sensores e algoritmos, onde o som

atua como campo energético e sensorial que reorganiza o espaço performativo. A tecnologia é aqui mais do que um meio: é um operador dramatúrgico que transforma a percepção, ativa estados de presença e engendra uma escuta intensificada. Esta Concha Soa a Vozes aproxima-se desta abordagem, ao fazer do espaço natural e das tecnologias digitais, próteses e extensões do corpo coletivo, onde o som é construído como matéria viva, vibrante, multi direccional. Ambas as propostas evidenciam uma abordagem onde a escuta — e não o olhar — é o fundamento da arquitetura da experiência. Num quadro mais alargado, a comparação com estas obras de arte media participativas permite evidenciar o papel da escuta como política estética. A escuta, entendida como prática ativa e partilhada, constitui-se como eixo ético e estético destas propostas, assumindo o potencial de reconfigurar as formas de convivência e de criação coletiva.

5 Considerações finais: a concha, a voz e o corpo técnico

A humanidade assumiu um papel predominante no domínio dos recursos naturais. Culturalmente, afastou-se da noção de pertença e de fluxo da matéria que a ciência nos comprova. Poderá este sentimento de parte integrante da matéria, sob uma perspectiva horizontal de poder, vir a ser reocupado pela integração de próteses digitais e biológicas, como assistimos no advento da ciborguização e da nanotecnologia? Não estarão, o Homo Digitalis, a quimera, o ciborg, mais próximos de uma noção integrante de tudo o que nos rodeia pela prova viva que representam enquanto híbridos? Não poderá ser este o retorno ao equilíbrio da existência da humanidade no ecossistema global e eventualmente universal? Um retorno a uma forma outra de animismo? Esta Concha Soa a Vozes propõe-se a um passo nesse sentido de pensar novas formas de hibridismo sensível entre humanos e tecnologia. Num tempo em que o digital tende a ser associado à desumanização, esta obra propõe uma via alternativa, um "além-homem" como proposto por Nietzsche (1883) [9], produto da imensidão de vozes que ressoam de um coletivo. No universo performativo, a concha não resguarda apenas um eco, como multiplica as vozes de um coletivo. O corpo do performer Raúl Maia, torna-se representante do gesto humano a partir do coletivo sonoro, como se o corpo recuperasse dessa memória, dessa herança oral, a sensibilidade que o identifica enquanto ser. O "ghost"— que dá título à obra por referência a *Ghost in the Shell*[11] e ao conceito filosófico de Gilbert Ryle, que ironiza o dualismo mente-corpo — encontra-se aqui não como fantasma isolado, mas como voz coletiva que habita uma concha sonora comum. Este projeto levanta ainda questões relevantes para o campo da educação artística e da continuidade da prática de processos participativos. A possibilidade de construção de um arquivo digital vivo — onde os registos sonoros e visuais da criação possam continuar a circular, ser reutilizados ou transformados. Aponta para novas formas de sustentabilidade, memória e ativação do comum no contexto das artes digitais. Tal como propõe a Teoria do Ator-Rede (Latour, 2005) [6], esta criação emerge de uma rede de interações entre humanos e não-humanos, onde a agenciamento está distribuído por diferentes sensibilidades, vozes, tecnologia e espaço performativo. A exploração desse dispositivo híbrido permite que a performance se constitua como nodo gerador de transformação, com o potencial de "contagiar" redes sociais concorrentes e de maior escala.

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Artemídia e IA: Projetos colaborativos e imagens-movimento

Media Art and AI: Collaborative projects and moving images

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ABSTRACT

The article is the result of research that investigated collaborative artistic projects and video artworks, or strictly speaking, movement-images, which discuss issues of gender, race and ethnicity, ecology and the emergence of the environmental crisis associated with the impact of AI tools on ethics and aesthetics. The study arose motivated by the following questions: how can AI tools be applied to the debate on ethics in collaborative practices on racism and gender equity? Can the use of AI tools by artists provoke the emergence of audiovisualities that collaborate with the aesthetic and ethical debate proposed by such collaborative practices? To answer such problems, the study mapped and analyzed a set of collaborative artistic practices and moving images related to the use of AI. The results indicate that the artists create their works as aesthetic devices aiming to amplify the experience with art to shift it to the field of ethics and articulate technology to social issues, to the extent that they transform the works into spaces of collaborative, participatory and collective action, with emphasis on an ethical-aesthetic debate about image, art and AI.

RESUMO

O artigo é resultado de uma pesquisa que investigou projetos artísticos colaborativos e obras de videoarte, ou, mais precisamente, imagens-movimento, que discutem questões de gênero, raça e etnia, ecologia e o surgimento da crise ambiental associada ao impacto das ferramentas de IA na ética e na estética. O estudo surgiu motivado pelas seguintes questões: como as ferramentas de IA podem ser aplicadas ao debate sobre ética em práticas colaborativas sobre racismo e equidade de gênero? O uso de ferramentas de IA por artistas pode provocar o surgimento de audiovisualidades que colaboram com o debate estético e ético proposto por tais práticas colaborativas? Para responder a tais problemas, o estudo mapeou e analisou um conjunto de práticas artísticas colaborativas e imagens em movimento relacionadas ao uso da IA. Os resultados indicam que os artistas criam suas obras como dispositivos estéticos com o objetivo de ampliar a experiência com a arte para transferi-la para o campo da ética e articular a tecnologia com questões sociais, na medida em que transformam as obras em espaços de ação colaborativa, participativa e coletiva, com ênfase em um debate ético-estético sobre imagem, arte e IA.

Palavras-chave

Media art and AI, Collaborative artistic practices and AI, Image-movement and AI, Ethic, aesthetic and AI

1 Introdução

O vídeo como ferramenta de visibilidade e denúncia ou discussão sobre o social é uma vertente das imagens-movimento explorada desde as primeiras apropriações desta mídia pela arte, em associação com o campo da comunicação e interface com a tecnologia audiovisual. O estudo surgiu motivado pelas seguintes questões: como as ferramentas de IA podem ser aplicadas ao debate sobre ética em praticas colaborativas sobre racismo e equidade de gênero? Podem as ferramentas de inteligência artificial provocar emergência de outras audiovisualidades e outras expressões da videoarte que colaboram com o debate proposto por tais práticas colaborativas?

Para responder a essas inquietações motivadoras, mapeamos e analisamos um conjunto de práticas

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colaborativas e imagens-movimento relacionadas ao uso da IA na arte ou propostas de ações envolvendo o debate e a crítica sobre a IA, e buscou elucidar a hipótese de que os artistas articulam a tecnologia às questões sociais, concebendo suas obras como aparatos estéticos que ampliam a experiência com a arte para deslocá-la para o campo da ética e o fazem transformando as obras em espaços de ação colaborativa, participativa e coletiva.

Com o avanço das tecnologias de IA surgem diferentes iniciativas de artistas que têm feito uso da IA para discussão e crítica sobre as próprias ferramentas de automação e plataformização da vida, que se multiplicam em uma desenfreada massificação social.

Para atingir os objetivos tal conjunto expressivo de obras e projetos, foi ainda, observado, organizado e apresentado em dois recortes distintos, que podem também ser associados aos ODS – Objetivos de Desenvolvimento Social da Agenda 2030, da ONU, a saber o ODS 5 – Igualdade de Gênero, o ODS 10 – Redução das Desigualdades e o ODS 16 – Paz, justiça e instituições eficazes [1].

O primeiro recorte é representado neste trabalho, pela descrição da experiência de dois projetos idealizados por artistas mulheres que articulam arte, tecnologia e o debate contemporâneo sobre racismo e equidade de gênero. Trata-se dos projetos de Joy Buolamwini e Caroline Sinders. A primeira, cientista da computação, artista e ativista digital canadense, e a segunda, pesquisadora e artista estadunidense, especializada em design de aprendizado de máquina.

O segundo recorte, neste contexto, articula obras em vídeo de duas artistas gregas, Gioula Papadopoulou e Lida Zacharopoulou, cujos resultados estéticos são imagens-movimento exploradas para promover um diálogo entre as audiovisualidades decorrentes do uso das ferramentas de IA na atualidade e o debate sobre aspectos éticos das imagens produzidas com esta tecnologia.

Conforme o sociólogo sul-coreano Byung-Chul Han, a Infocracia é o regime de informação que exerce uma dominação social, política e econômica evidente sobre os seres humanos. A digitalização do mundo impõe uma mudança radical nas relações humanas, no cotidiano de produção e veiculação de informação, na nossa relação com o mundo e sobretudo na nossa percepção. Essa avalanche de informação, produzida sem o debate e veiculada sem o embate na esfera pública resulta em forças destrutivas que corroem o espaço democrático e o que se tem observado é o aumento descontrolado das fake news. Han ressalta que esse modelo de produção e circulação de informação "abrange também, nesse meio-tempo, âmbitos políticos e leva fraturas e disrupções massivas no processo democrático. A democracia degenera em infocracia" [2].

Para uma maior compreensão do conceito de Infocracia, descrito por Han como uma forma de poder onde o domínio reside na produção e na gestão da informação, observa-se o conceito de Tecnocapitalismo que, embora distinto, se caracteriza por um estágio avançado do capitalismo centrado na tecnologia digital como o principal meio de produção, acumulação de valor e extração de lucro. Se na Infocracia, o poder se manifesta pela capacidade de gerar, filtrar e direcionar à atenção do sujeito e o debate público é transformado em um espetáculo de dados, onde a verdade é ofuscada pela performance da transparência e pela velocidade da propagação de bits, no Tecnocapitalismo a lógica é econômica e subjacente à paisagem que se desenha na Infocracia, pois impulsiona plataformas, softwares e patentes tornando os dados os ativos mais valiosos do sistema. O sujeito na Infocracia, cujo comportamento é previsível e manipulável para fins políticos e sociais, é reduzido a usuário ou ponto de dados, ao passo que no Tecnocapitalismo sua força de trabalho é precarizada, inclusive por sua ação gratuita que gera dados, treina algoritmos e consome sua atenção. A liberdade individual é sutilmente corroída pela vigilância algorítmica e pela psicopolítica na Infocracia, onde a exploração dos dados psíquicos e comportamentais se torna o novo campo de batalha. Já no Tecnocapitalismo, as Big Techs não apenas vendem produtos ou serviços, mas capturam e privatizam infraestruturas sociais essenciais (comunicação, transporte, entretenimento, trabalho), usando a tecnologia para otimizar a extração de mais-valia digital.

Em suma, embora distintos, tanto a Infocracia quanto o Tecnocapitalismo se alimentam da inovação tecnológica e da produção de dados e informação, dentre os quais as imagens e o audiovisual, como o vídeo, tem grande contribuição. Ambos convergem em um sistema onde a crítica e a resistência são constantemente dificultadas pelo excesso de transparência, pela velocidade da informação e pela colonização algorítmica da experiência humana. Por isso, a crítica se torna um elemento chave para artistas que subvertem esses meios e fazem da inovação tecnológica um campo de tensão e disputa em diálogo com o artivismo.

Para Pablo Sanguinetti, o ser humano tem atribuído um valor alto para o poder das máquinas, o que tem gerado a massificação da ideia de domínio e endeusamento da IA e isso afasta o homem do conhecimento real sobre elas. É preciso um diálogo imprescindível entre o humano e o tecnológico para uma reflexão no campo da filosofia estética. O autor defende que o modo como tratamos a inteligência artificial e a narrativa em torno da mesma influenciam na sua percepção, regulação e ainda propõe a ideia de um desenho narrativo pautado na estética como aporte para refletir aspectos éticos da inteligência artificial [3].

A pesquisadora Mariah Brochado investiga o impacto do modelo neural na inteligência artificial e aprendizagem profunda e define, a partir de um debate na filosofia da tecnologia, a relação entre os dados, as amostras de dados e as redes neuronais. Brochado trata de pontos relevantes, como a discussão sobre o GPT3, GPT – Genrative Pre-Training Transformer, criado pela OpenAI apontado pela autora como um sistema que resulta em "quantidade de produção e não qualidade no desempenho da máquina", que continua a depender de uma base de dados gigantesca e de fórmulas que permitam o cruzamento eficiente desses dados [4].

Antes dos resultados estéticos, cabe uma reflexão sobre os aspectos éticos envolvidos no uso das ferramentas de inteligência artificial para criação de imagens-movimento na atualidade. Esse estudo partiu de uma busca por aspectos estéticos para traçar um paralelo entre arte, tecnologias de IA e práticas sociais e artísticas colaborativas, mas antes deparou-se com questões éticas que definem a experiência com imagens-movimento produzidas com inteligência artificial, que de igual forma se associam ao debate sobre o comum, temas que impactam a comunidade, o coletivo e, em ultima instância, o social, para além do cultural.

Como sabemos, o termo inteligência artificial foi usado pela primeira vez em 1956 por John McCarthy, mas a origem da inteligência artificial data de 1943, quando foi criado o primeiro modelo computacional para redes neurais, por Warren McCulloch e Walter Pitts. Quando se trata de IA generativa, o ano de 2006 foi importante, pois foi quando se publicou o primeiro estudo sobre deep learning [5], embora a popularização dos algoritmos de deep learning aconteceu depois, em 2012. Mas desde 2022 e 2023 nota-se uma massificação do uso de ferramentas que objetivam a plataformização da vida e da cultura e o acesso aos dados, moeda da sociedade da informação, ou sociedade dos dados. Essa massificação passa pela automação de inúmeros processos, incluindo a produção de imagens.

Entretanto, nestes 68 anos de história da inteligência artificial foram projetadas diferentes aplicações, muitos modelos foram testados e nos últimos anos houve um aumento exponencial de ferramentas de IA generativa que pode ser definido, simplificadamente, pela geração de conteúdo – texto, imagem, som, vídeo, que são gerados pela máquina que aprende com dados já existentes, por meio de aprendizado de máquina e deep learning que consiste em um aprendizado profundo que envolve complexas redes neurais que buscam emular as redes neurais humanas.

Diariamente ouvimos inúmeros relatos de situações envolvendo ética e inteligência artificial, que nos fazem perguntar: Quais são os impactos da IA para a sociedade? É possível garantir sistemas que sejam éticos, justos e transparentes? Qual a relação entre Algoritmos de Inteligência Artificial e vieses?

Com o uso cada vez mais frequente dos sistemas de Inteligência Artificial para a resolução de problemas e na tomada de decisões, a discussão sobre algoritmos que não repliquem processos discriminatórios e preconceituosos é cada vez mais necessária. A tecnologia não é imparcial, os algoritmos são processos matemáticos criados por pessoas. Não é raro vermos soluções que usam tecnologias de inteligência artificial apresentando vieses racistas, sexistas e de classes sociais, como aplicativos que ao prometerem embelezar o rosto das pessoas, as embranquecem, diminuem seus narizes e aumentam seus olhos.

A pesquisadora Dora Kaufman afirma que o problema está no viés ético presente em diferentes etapas da IA, e exemplifica dois pontos: primeiro, no viés ético na geração de dados, quando um conjunto de dados imagéticos é gerado por países desenvolvidos que tem acesso a tecnologia de ponta e essas imagens tem um padrão heteronormativo, colonialista, e segundo, quando se observa os modelos desenvolvidos pelos hiper parâmetros gerados por seleção de variáveis. As pessoas contratadas pelas big techs para desenvolver os modelos, aqueles que tem a decisão de criar o modelo, profissionais de engenharia de machine learning, engenharia de prompt, cientista de dados, se baseiam sempre na funcionalidade da tecnologia e não se preocupa com o impacto social. Por isso, para Kaufman é bastante preocupante e arriscado falar sobre a autonomia da IA sem preocupar-se com as questões éticas e com o impacto

social, e claro cultural, das imagens ou vídeos gerados por essa tecnologia [6].

Mapeando projetos artísticos que envolvem o debate sobre imagem, inteligência artificial e comunidades, encontramos o projeto da artista, cientista da computação e ativista digital canadense, Joy Buolamwini, criadora da Liga da Justiça Algorítmica e protagonista do Documentário Netflix – Coded Bias (2020). Joy Buolamwini, que também é conhecida como a poetisa do código, trabalhou e estudou ciência da computação no MIT Media Lab, no Instituto de Tecnologia de Massachusetts (EUA), e lá desenvolveu um estudo de pós-graduação que questionou o viés racista e de gênero de ferramentas de reconhecimento facial que não liam o seu rosto negro, mas quando ela colocava uma máscara branca, era reconhecida.

O projeto começou em 2016, quando Buolamwini fez a pesquisa baseada nos embates que estava vivendo com sistemas de detecção facial que não reconheciam seu rosto negro, em sites de compras ou outros, que usam reconhecimento facial. Na pesquisa desenvolvida no MIT em sua tese de mestrado, Buolamwini relata várias experiências negativas nas quais ela não conseguia acesso a um sistema ou plataforma, pois o seu tom de pele não era reconhecido. Dois anos depois, em parceria com Timnit Gebru, Buolamwini publicou o artigo intitulado Gender Shades [7], que foi amplamente discutido, com grande repercussão. Neste estudo, um dos pioneiros no campo das ações práticas que indicam vieses éticos sobre gênero e raça, as pesquisadoras desenvolveram uma metodologia para avaliar a precisão de ferramentas de classificação de gênero que são alimentados por IA.

> "This evaluation focuses on gender classification as a motivating example to show the need for increased transparency in the performance of any AI products and services that focused on human subjects. Bias in this context is defined as having practical differences in gender classification error rates between groups" [7].

Explorando a área da inteligência artificial que desenvolve algoritmos e técnicas que permitem que os computadores ganhem competências para "ver" e interpretar imagem e vídeos, a pesquisa Gender Shades aplicou a visão computacional para classificação de gênero a partir de imagens de rostos e analisou as classificações das ferramentas de visão computacional, com esse mesmo fim, da IBM, Microsoft e Face++.

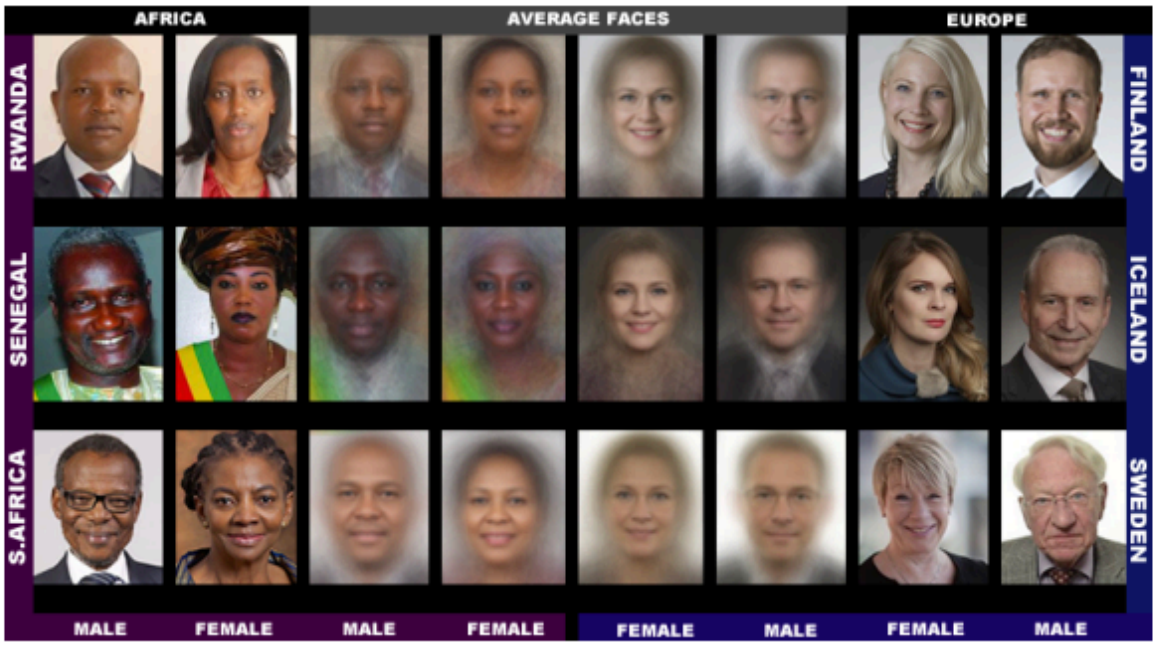


Figura 1: Gender Shades. Joy Buolamwini, Timnit Gebru. 2018. Fonte: http://gendershades.org/overview.html

Os resultados impressionam e desde 2018, a repercussão do estudo tem moldado a prática de vários setores sociais, de agendas e políticas públicas a indústrias e pesquisas acadêmicas. Conforme a agência Nature, a auditoria Genders Shades, mostrou, entre outros pontos significativos, que:

> "that individuals with light-coloured skin were the subject of 79.6% of the images in IJB-A and of 86.2% of those in Adience. This prompted Buolamwini and Gebru to compile their own set of images — one that offered a broader range of skin tones than did either of the existing options, as well as including similar numbers of men and women (commercial algorithms are typically not capable of dealing with non-binary classifications). To do so, they turned to photographs of politicians from countries with gender parity in their national parliaments. The resulting data set, known as the Pilot Parliaments Benchmark, contains images of 1,270 individuals from Rwanda, Senegal, South Africa, Iceland, Finland and Sweden" [8].

Entre as repercussões com maior impacto social e na comunidade, inclusive internacional, estão as diversas campanhas e litígios advocatícios que surgiram contra o uso indiscriminado e massificado de tecnologias de reconhecimento facial pelo mundo, até a produção do documentário Coded Bias [9]. Com diferentes graus de repercussão e mudança nos sistemas de reconhecimento facial, várias empresas de tecnologias, incluindo aquelas avaliadas pelo estudo, assumiram compromissos quanto à venda e uso de tecnologias de reconhecimento facial. O assassinato de George Floyd em maio de 2020, em Minneápolis nos EUA e o aumento da vigilância biométrica em espaços públicos ou privados com inúmeras prisões de pessoas de forma equivocada, fez crescer a opinião pública contra estas tecnologias, levando a IBM a aposentar sua produção de softwares de classificação de gênero baseada em rostos no ano de 2023.

> "We collaborated with internal and external researchers to understand the limitations and potential benefits of this technology and navigate the tradeoffs. In the case of emotion classification specifically, these efforts raised important questions about privacy, the lack of consensus on a definition of "emotions," and the inability to generalize the linkage between facial expression and emotional state across use cases, regions, and demographics. API access to capabilities that predict sensitive attributes also opens up a wide range of ways they can be misused—including subjecting people to stereotyping, discrimination, or unfair denial of services. To mitigate these risks, we have opted to not support a general-purpose system in the Face API that purports to infer emotional states, gender, age, smile, facial hair, hair, and makeup. Detection of these attributes will no longer be available to new customers beginning June 21, 2022, and existing customers have until June 30, 2023, to discontinue use of these attributes before they are retired" [10].

Em 2023, Joy publicou o livro "Desmascarando a IA: minha missão de proteger o que é humano em um mundo de máquinas" [11] e ficou conhecida como a Poetisa do Código. Desde então, suas criações artísticas objetivam esclarecer sobre o impacto da inteligência artificial na sociedade e aconselha líderes mundiais sobre a prevenção de danos causados pela IA. A Dra. Joy Buolamwini, também como é conhecida, tornou-se uma referencia para uma comunidade de mulheres de várias culturas e raças que passaram a se engajar no assunto, em defesa de práticas éticas envolvendo as tecnologias de IA.

Em uma de suas inúmeras entrevistas em julho de 2023, a artista novaiorquina, também pesquisadora de direitos humanos, Caroline Sinders, defendeu que cabe às empresas de IA resolver o problema dos vieses éticos e do uso indevido dos dados pelas ferramentas de inteligência artificial e ainda que a regulamentação se faz necessária para corrigir tais desvios éticos. Na época, ela afirmou que também estava bastante preocupada com o viés que essas ferramentas criam, e como o quanto isso significa que a Arte da IA não estaria refletindo o mundo real, mas reiterando estereótipos [12].

Uma das ações de Caroline Sinders é o Feminist Data Set [13], um projeto que interroga cada etapa do processo de IA que inclui coleta de dados, rotulagem de dados, treinamento de dados, seleção de um algoritmo para usar os dados, o modelo algorítmico para, em seguida, projetar como o modelo é então colocado em um chatbot, incluindo o design e a aparência do chatbot. Cada etapa a ser realizada por participantes mulheres, convidadas a integrarem o projeto, existe para questionar e analisar o percurso de criação do conteúdo que uma IA irá produzir, usando o mesmo recurso de aprendizado de máquina.



Figura 2: Feminist Data Set. Caroline Sinders. 2017. Fonte: https://carolinesinders.com/feminist-data-set/

Portanto, todas as etapas terão uma ação feminista, interseccional, de reexame através de lentes feministas, buscando reconhecer em cada etapa, onde se encontra um preconceito e como esse preconceito pode ser removido.

Os projetos atuais sob a égide do Feminist Data Set incluem encontros, oficinas, cursos e workshops que acontecem em vários períodos do ano, sobre o Feminist Data Set, o Feminist Data Set Tool Kit e o TRK que é uma ferramenta de código aberto que as mulheres e pessoas da sociedade podem usar para observar a desigualdade salarial, por exemplo, existente no treinamento e rotulagem de dados.

O objetivo é que o processo de desenvolvimento das várias etapas de um aprendizado de máquina, da criação a iteração e o design, envolva de forma cuidadosa a presença de mulheres e que cada etapa desse processo possa ser revista e reexaminada minuciosamente sob uma lente, sob um olhar feminista. Ao final, o projeto foi criado para imprimir uma visão crítica e artística sobre os softwares, particularmente o aprendizado de máquina.

> "Feminist Data Set is a public facing, social justice art practice. For example, the collecting of feminist data is held through public workshops and forums. Feminist Data Set imagines data creation, as well data sets and archiving, as an act of protest. In a time where so much personal data is caught and hidden by large technology companies, used for targeted advertising and algorithmic suggestions, what does it mean to make a data set about political ideology, one designed for use as protest and to make a data set as a Community" [13].

O titulo do projeto Feminist Data Set, faz menção a um conjunto de dados feministas que podem ser obras de arte, ensaios, entrevistas e livros que sejam ou tenham sido produzido pelo movimento do feminismo, sobre o feminismo ou que explorem uma perspectiva feminista. A ação das mulheres em comunidade, que atuam de forma colaborativa e usando a mesma tecnologia contra a qual tecem criticas contundentes, é a criação deste conjunto de dados feministas para atuar como um meio

de combate contra o preconceito, exatamente pela introdução de uma ferramenta de coleta de dados que atua como uma prática feminista, além do objetivo de produzir uma parcela de dados visando intervir em redes cívicas e privadas maiores.

> "This project is largely based on the idea that to remove bias within machine learning, the "removal of bias" itself has to be manifested into a "thing" to teach or sway the algorithms. By using workshops, the artist starts to define the parameters for feminist words, interactions, their definitions, their origins and, potentially, their creators" [14].

Este projeto integra o Laboratório Europeu de Inteligência Artificial e é cofinanciado pelo Programa Europa Criativa da União Europeia, tendo sido exibido, como obra de arte e prática artística colaborativa e comunitária, no LABoral, Ars Electronica, Victoria and Albert Museum, Museu de Arte Moderna de Bolonha, SPACE Art and Technology, RePublica, Galeria SOHO20, entre outros.

Enquanto navegamos pelas chamadas "paisagens digitais", somos confrontados com o fenômeno da pós-verdade, marcado por arrebatamentos emocionais que escondem os fatos e nossas percepções da realidade são moldadas e distorcidas. As notícias falsas se propagam 70% mais rapidamente do que as notícias verdadeiras e tornam-se armas poderosas em debates políticos e sociais.

No epicentro das questões éticas estão os deepfakes, produtos da inteligência artificial que criam vídeos hiper-realistas. Em 2023, observou-se que o número desse tipo de material na internet aumentou vertiginosamente em 330% em apenas um ano, questionando a autenticidade de tudo o que vemos e ouvimos online.

O termo deepfake advém das palavras deep (profundo) e fake (falso), e resulta de um tipo de tecnologia de IA que pode ser usada para criar vídeos falsos ou manipulados por sobreposições e colagens digitais de som e imagem. O método consegue promover a aprendizagem profunda das máquinas com base em dados não estruturados, como o rosto humano. Atualmente os vídeos de deepfake estão em uma fase em que é possível detectar alguns sinais como movimento brusco; iluminação instável, mudança de um quadro para o outro; alterações temporais, mudanças no tom da pele; modo estranho de piscar os olhos ou nenhum piscar; lábios mal sincronizados com a fala; mas em 2023 a OpenAI lançou o SORA, que promete resolver vários desses sinais.

Um estudioso da física quântica, o espanhol José Ignacio Lattore defende que é possível programar ética, mas não é possível ensinar ética para as máquinas [15]. Para Lattore, a ética é aprendida pelo ser humano por meio de um longo processo que envolve muito mais que o ensino ou uma educação ética. A ética é um aspecto intrínseco ao processo de se tornar um humano e o correto seria transferir para a programação da máquinas, os preceitos, normas e condutas éticas dentro de conceitos amplos e que respeitem acima de tudo, os direitos humanos e as leis dos diferentes países e culturas, por isso a complexidade e o desafio a ser enfrentado por governanças e regulamentações que garantam o respeito e a equidade de raça, etnia e de gênero bem como a programação de uma inteligência artificial centrada no gênero humano, parafraseando Edgar Morin [16].

Por isso, é necessário desmistificar a tecnologia de IA com maior número de conhecimento sobre ela, com narrativas que tragam clareza sobre o que de fato ela pode fazer, pois o homem tem destinado um grande valor para o poder das máquinas e isso tem sido muito oportuno para gerar massificação da ideia de domínio e um endeusamento da IA, por isso é preciso combater a ignorância digital e a arte pode ter um papel central nesse sentido.

Diante de tantos desafios, guerras, fome, dificuldade de combater a ignorância e o negacionismo, o avanço da extrema direita e outras questões geopolíticas e a desigualdade social e econômica em escala global, fica difícil mesmo pensar em enfrentar mais este desafio, o tecnológico, mas é preciso conhecer para combater e conhecer para subverter, o desconhecimento tem levado o homem a ser dominado por outros homens por gerações e gerações.

A arte pode ser um canal de reflexão e conscientização, através da experiência estética e sensível. Fazer uso da IA generativa de forma consciente para infundir a ética humana em todas as fases da programação da máquina, visando uma IA centrada no Ser Humano [17].

Cabe considerar que a apropriação de tais ferramentas pelos artistas é importante para conhecer e desmistificar seu uso, colocando-a no seu devido lugar, até aqui uma ferramenta que pode auxiliar a criatividade humana. Conhecer para promover rasuras, abrir a caixa preta da IA e jogar como preconiza Vilém Flusser, como um jogador e não como um ser que é programado sem

questionar, limitado a seguir as regras. O artista é um sujeito que pode romper com a lógica dos dispositivos e jogar de forma disruptiva com a tecnologia e o poder nela implícito.

Os artistas podem interferir nas regras desse sistema tecnológico, expondo os processos, subvertendo a função das ferramentas e dos algoritmos, para desafiar as lógicas da Infocracia.

2 Imagem-Movimento e IA

Em 2023, a artista grega Gioula Papadopoulou lançou o vídeo experimental "AI me fez fazer isso: Ophelia" [18], feito inteiramente com imagens criadas no sistema de IA Dalle-2 (OpenAI), com variações de uma única imagem, criada usando um prompt de texto solicitando ao programa que gerasse uma Ophelia na água com flores.

A referida obra de Papadopoulou participou do FILE - Festival Internacional de Linguagem Eletrônica, realizado em São Paulo, Brasil, integrando a categoria Videoarte 2023. O restante das imagens são variações desta primeira imagem, criadas pela IA seguindo diferentes caminhos de variações a cada vez. O som foi criado pela plataforma AI Melobytes, transformando a mesma primeira imagem de Ophelia em som.

O principal aspecto estético dessa videoarte é a temporalidade frenética, acelerada, gerada por mutações constantes da imagem, ordenadas pelo sonoro. As imagens verticais mudam continuamente e de modo significativo. A figura se transforma ganhando diferentes roupagens e padronagens, compostas por mixagens visuais que se fundem no rosto e em um corpo que ora é feminino, ora é masculino, ora é nem um, nem outro.

O corpo é multiplicado provocando um diálogo metalinguístico que expõe o modo de funcionamento da operação poética por detrás do vídeo, a hiperedição, espelho da maneira como a sociedade produz imagens, a figura se metamorfoseia e ganha novas formas ao se multiplicar freneticamente. As flores ganham formas circulares e giram ao redor do corpo e da cabeça da figura metamorfa.

A experiência estética da totalidade efêmera que se altera de forma vertiginosa é amplificada pela IA generativa que gerou um resultado que, embora possa estar calcado em composições legitimadas pela história da arte como o surrealismo e a estética da colagem no dadaísmo ou remix na cultura contemporânea, acaba sendo constituído pela metamorfose ou mutação, principal traço da poética da hiperedição.



Figura 3: Gioula Papadopoulou. "AI me fez fazer isso: Ophelia". 2023. Fonte: https://file.org.br/videoarte_2023/gioula-papadopoulou/

Neste estudo nomeamos esses resultados estéticos como sendo fruto de uma poética da hiperdição e sobretudo neste caso, ainda sendo reiterada pelo sonoro sincopado e fortemente demarcado. O ritmo compassado é acelerado, repetitivo e modela a composição visual, é o ritmo sonoro que estrutura as colagens digitais. Ainda assim, a videoarte apresenta um resultado bem sumário ou basal em termos composicionais e de expressão estética que a IA está "aprendendo" e que está longe de superar as competências criativas dos artistas.

O resultado final é baseado na aleatoriedade e fluidez dos geradores de IA utilizados. Ophelia muda de identidade, de género, de atributos e afasta-se constantemente da sua imagem e destino estereotipados. Com essa obra a artista foi premiada em 2023, na categoria vídeo com IA Generativa no Festival Dérapage - Alchimies Numériques 2023, no Canadá e em 2024, recebeu o prêmio de 1º lugar no Festival Internacional de

Cinema de IA e Metaverso na Coreia do Sul, em junho de 2024.

De igual forma, a artista grega Lida Zacharopoulou, em 2023, produziu a obra Digital No-man's: Psifímia [19] e participou do FILE - Festival Internacional de Linguagem Eletrônica, realizado em São Paulo, Brasil, integrando a categoria Videoarte 2023. A artista é engenheira de análise de dados e codificadora criativa em Atenas, na Grécia, com foco em mídia interativa e ciência de dados. Trata-se, portanto, de uma artista e também programadora. Zacharopoulou afirma que o objetivo dos rostos deformados é levar as pessoas à reflexão sobre a própria morte. Os rostos sintéticos e desfigurados provocam uma mistura de identificação e desconforto.

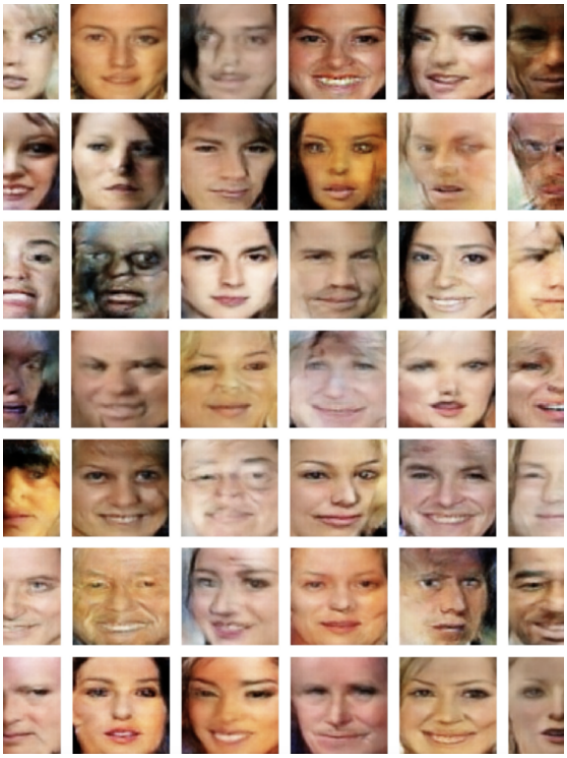


Figura 4: Lida Zacharopolou. Digital No-man's: Psifímia. 2023. Fonte: https://file.org.br/videoarte_2023/lida-zacharopoulou/

Cada bloco digital é um rosto que foi gerado por uma DCGAN – Rede Adversarial Generativa Convolucional Profunda (Deep convolutional generative adversarial networks), treinada a partir de mais de 220 mil imagens. O titulo da obra é um termo fictício criado a partir de um jogo entre duas palavras: Psifía = dígitos ou pedaços de um mosaico + mi = não, termo associado à cadáveres não humanos.

Segundo a artista, nesta obra ela aplicou um conjunto de DCGANs – (Redes Adversariais Gerativas Convolucionais Profundas) no Google Colab, usando scripts de Python 3.8 e machine learning usando TensorFlow 2. O modelo foi treinado no conjunto de dados CelebA (CelebFaces Attributes Dataset). Ainda segundo Lida, a obra é um mosaico composto "dos rostos dos habitantes do "Vale Misterioso", cidadãos da classe baixa do reino humanoide que não têm tempo para completar seu treinamento ou dinheiro para serem nômades de GPU (unidade de processamento gráfico) e convencer o discriminador a deixá-los entrar no colinas de semelhança humana".

Neste contexto, as tecnologias de inteligência artificial utilizadas pela artista em questão como as GANs - Generative Adversarial Network, são treinadas para gerar novas imagens-movimento, por exemplo, a partir de dois submodelos, aplicados a partir de modelos de redes neurais, compostos de um gerador (gera novas imagens) e um discriminador, que em uma rede neural é capaz de classificar se uma amostra gerada é real ou falsa, e o jogo entre esses dois submodelos além dos resultados intrigantes também permitem que a máquina aprenda na medida em que gere novas imagens-movimento.

Por isso, a obra é inquietante e provocam estranhamento, pois os rostos deformados são descompostos e recompostos continuamente, no tempo do vídeo/imagem-movimento, e nota-se uma ação constante de alteração das imagens que nos remete à desconstrução de identidade ou, ainda, uma identidade fluída que é alterada pela interferência da máquina, sem chance de um possível controle humano. Essa ação sobre as imagens nos remete ao fluxo de imagens e ao imenso banco de imagens que constituem os data sets. Se por um lado é possível ter diferentes identidades por outro lado, o resultado é o esvaziamento de sentido frente constante mutação dessa diversidade imagética.

3 Considerações Finais

As competências estéticas da imagem movimento frente aos desafios éticos que envolvem o uso das ferramentas de IA podem ser impulsionadas pelas experiências artísticas colaborativas com comunidades cuja atuação tenha um caráter Artivista, e ainda podem promover a criação de novas audiovisualidades resultantes de

estudos experimentais, conforme destacamos neste ensaio.

No entanto, o desafio é enorme e os dilemas éticos também, pois a arte digital participa de um cenário dominado pela arquitetura particular da Infocracia e, portanto, está discutindo constantemente o impacto da geração e consumo de imagens-movimento, conforme observou-se nas obras comentadas neste estudo.

Cabe destacar que a hiper conexão e a hiperedição são dois traços da Infocracia que merecem atenção e sua análise em obras criadas com ferramentas de IA generativa podem corroborar aspectos éticos e estéticos que somente o trabalho criativo colaborativo pode empreender para provocar reflexão, debate e tensão na cena contemporânea. A fim de transformar o status quo do uso massificado das inteligências artificiais e conscientizar as comunidades que o acesso a essas ferramentas, após o boom de 2022 e 2023, é um projeto de automação da criatividade com impacto na experiência estética e sensível. A hiper conexão provoca uma experiência estética pautada na temporalidade em fluxo, gerada pela simultaneidade e repetição das imagens-movimento. Ao passo que a hiperedição, em suma, atua espacialmente pela sobreposição de camadas imagéticas, a partir da manipulação vertiginosa dos bancos de dados, gerando um esvaziamento de sentido e a invisibilidade de um conjunto enorme de sons e imagens, um dos aspectos mais contundentes da Infocracia.

Por ironia, uma das maiores contradições da era da informação, ou era dos dados, é que ao mesmo tempo que se produz uma quantidade gigantesca de imagens, outra quantidade existe em um arquivo morto, esquecida no limbo da invisibilidade e a lógica do capitalismo de dados se alimenta dessa obsolescência da informação visual e audiovisual.

Ao final deste estudo podemos refletir sobre as poéticas colaborativas decorrentes do debate atual sobre ética e estética da hiperedição como resultados de uma estética algorítmica. A Artemídia tem papel central na ruptura do esvaziamento de sentido provocado pela infocracia, a partir da criação de espaços de tensão, fricção e sentido, permeados por experiências audiovisuais ou imagens-movimento geradas por ações que refletem o uso das ferramentas de IA no cenário da arte digital contemporânea.

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Aesthetics on Autopilot: AI's Role in the Works of Abrantes and Manovich

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Abstract

This paper explores the integration of Artificial Intelligence (AI) in contemporary artistic practice through the works of Gabriel Abrantes and Lev Manovich, whose recent exhibitions in Portugal foreground the tensions between human creativity and technological innovation. The research addresses critical questions, such as the extent to which AI can be seen as a collaborator in artistic creation and whether the proliferation of AI enhances or undermines the authenticity of contemporary art. The analysis reveals the divergent methodologies of both artists. Abrantes employs AI as a controlled tool, emphasizing human intentionality and artistic intervention at every stage, while Manovich adopts a more experimental approach, allowing AI greater autonomy, with algorithmic flaws becoming central aesthetic components. Additionally, the AI itself applies a "politically correct" filter, softening potentially disruptive elements, which results in a more calculated and predictable aesthetic. This reveals a process of aesthetic "pasteurization" that contrasts with Abrantes' more direct integration of AI contributions into traditional painting. The paper also focuses on implications for authorship, authenticity, and artistic value. The democratization of AI tools has opened up new creative possibilities but has also introduced significant challenges, such as aesthetic homogenization, the dilution of artistic authorship, and a potential shift in the perception of artistic merit. This "mega-democratization" reshapes the dynamics of art creation, making it accessible to amateurs and professionals alike, but raises questions about the value and uniqueness traditionally attributed to art.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media Arts**; • **Fine Arts**; • **Computing methodologies**; • **Artificial Intelligence**;

Keywords

AI in Art, Algorithmic Aesthetics, Artistic Authenticity, Gabriel Abrantes, Lev Manovich

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1 Introduction

Portugal, within a short interval and across two cities – Lisbon and Évora – hosted two exhibitions that placed the integration of AI at the heart of artistic practice. Gabriel Abrantes †and Lev Manovich ‡each staged projects that probe the boundaries between human and algorithm, author and system. To what extent can AI count as a collaborator in artistic creation? Does the proliferation of AI compromise, or does it expand, the authenticity of contemporary art?

This paper seeks to explore these questions and other nuances related to the use of AI in artistic production, through an analysis of the creative strategies of Abrantes and Manovich. In this context, the term *Artificial Intelligence (AI)* refers specifically to Generative AI systems based on deep learning models, such as DALL-E and MidJourney, rather than earlier forms of algorithmic or rule-based AI art.

First, the theoretical context of the relationship between AI and contemporary art is presented – key figures who point out the criticisms and the possibilities inherent in the use of this technology. Next, the work of Abrantes is examined, showing how he uses AI as a controlled extension of his creative process, maintaining artistic control from sketches to the final oil paintings. In the third section, Manovich's approach is analyzed, focusing on how he allows AI to operate semi-autonomously, incorporating algorithmic flaws as central aesthetic elements. Finally, the impact of this democratization of AI in art is discussed – including its repercussions for authorship, authenticity, and the very definition of what it means to be an artist.

Thus, by analyzing the different methodologies and visions of these two artists, we aim to reflect on the influence of technology on the creative process, as well as the impact of this transformation on traditional values of artistic practice. We hope, with this, to

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contribute to a deeper discussion about the relationship between human creativity and technological innovation.

2 Theoretical context

In Portugal, the use of AI in artistic practice was exemplified by the remarkable exhibitions of Gabriel Abrantes and Lev Manovich, respectively in Lisbon and Évora, offering us a concrete perspective on the potentialities and limitations of AI in the field of visual arts. The literature explores the potentialities and challenges that the integration of AI represents for the arts, with particular scrutiny given to the effects of this technology on creative processes and contemporary aesthetics.

Manovich [1] asserts that the incorporation of AI in art stimulates the development of a new visual lexicon, expanding the capacities of perception and cultural analysis. AI plays a significant role in automating aesthetic choices, cultural production, and image creation, enabling new forms of cultural visualization and interpretation. However, this integration is not without its limitations. Joanna Zylinska [2] criticizes the superficiality of much of AI-generated art, arguing that these systems, despite being visually captivating, often replicate pre-existing aesthetic patterns, reducing originality and resulting in production that resembles mere simulacra of what has already been created.

Marco Donnarumma [3] reinforces this criticism by pointing out that AI's ability to imitate human works is, ultimately, cultural appropriation that lacks genuine artistic intent. The process of generating images by AI consists of a stochastic repetition of existing cultural elements, which results in an aesthetic normalization that contributes little to true innovation or aesthetic diversity. Rather than promoting an opening for new forms of expression, AI's probabilistic aesthetics tends to close doors to creativity, leading to conceptual and visual stagnation. Thus, what may seem novel is, in reality, a duplication of the present, which perpetuates itself without challenging established norms.

Amanda Wasielewski [4] and Emanuele Arielli [5] discuss the limitations of these tools in precisely representing visual elements, such as hands and objects. According to Wasielewski, image generators struggle to reproduce specific characteristics due to a lack of three-dimensional understanding. They operate based on two-dimensional patterns and lack a real notion of the concepts they are representing, which results in representations that often defy human expectations. Arielli [5] adds that what we consider "errors" in these representations, such as generating hands with an incorrect number of fingers, reveals more about our perceptual expectations than about the limitations of the systems themselves. These flaws reveal a clear divergence between the capacity of AI systems to generalize concepts and the degree of precision expected by humans in well-defined features—such as anatomical elements or typographic symbols.

Manovich [6] also exposes AI's tendency to eliminate outliers and preserve only common characteristics, which leads to a simplification of distinctive traits in favor of a more homogenized aesthetic. Thus, while AI has the potential to expand the scope of artistic creation, its processes tend towards a reduction in variability and the production of works that conform to already established aesthetics, without introducing true innovations or conceptual breakthroughs.

Abrantes and Manovich present distinct strategies. While Abrantes uses AI to expand his expressive capabilities without relinquishing artistic control, Manovich experiments with AI's autonomy, challenging traditional notions of authorship and creativity. Arielli and Manovich [7] observe that the concept of creativity is often linked to our degree of understanding of the processes involved: what we know is considered ordinary, while what we do not understand is seen as extraordinary. Thus, the perception that humans are creative and that AIs are not may be a result of the greater transparency in AI functioning compared to human processes, which remain largely unknown.

Zylinska [8] proposes a reevaluation of the relationship between the world and its representation through the lens of AI, suggesting that the perceived flaws in AI systems, such as "fantastic" or "hesitant" representations, could be seen as an aesthetic provocation, evoking avant-garde aesthetics such as surrealism and photomontage. Such "errors" call the viewer to reconsider what representation owes to the real, and where the line blurs between accident and intention.

Thus, in considering AI in contemporary artistic creation, technical possibility has not settled the issue of creative boundaries, nor resolved the question of technology's status – whether it is a tool, a co-author, or something else. The stage remains open. The outcomes are still indeterminate.

3 Nobody nowhere and unreliable memories

3.1 "Nobody Nowhere" Exhibition by Gabriel Abrantes

Gabriel Abrantes – a prominent figure in incorporating Artificial Intelligence (AI) into contemporary painting in Portugal – presented the exhibition *Nobody Nowhere* at the Francisco Fino Gallery in Lisbon between December 2022 and January 2023. The works in the exhibition explore scenarios of devastation inhabited by ghostly entities that persist, absorbed in and resilient to their artistic practice, despite an apparently irreversible context. These figures, immersed in flooded spaces – sometimes by seemingly calm and placid waters, other times by turbulent currents – are depicted as they contemplate, create, and tend to works of art, like restless souls trapped in a state of limbo, unable to detach and move forward [9].

Art emerges here as the only tangible legacy left in a collapsing world; it becomes the final anchor of collective memory and humanity, enduring even in a scene of apparent desolation. The presence and posture of the ghosts – symbols of the artist as a digital avatar, detached from physical manifestation – suggest feelings of emptiness, existential angst, and disorientation (Figure 1).

A discussion between Abrantes and GPT-3, transcribed in the exhibition's accompanying materials, reveals that the ghosts represent the artist's anxieties about contemporary society – fragmented, extremist, threatened by extinction, and vulnerable to technological pressures. They serve as a metaphor for concerns and uncertainties about AI's impact on the labor market broadly and creative professions specifically. While acknowledging these apprehensions, the artist also expresses admiration for technology and its legacy. He regards it as instrumental in driving stylistic revolutions, from early human history to the current digital age [10].



Figure 1: View of the exhibition *Nobody Nowhere* by Gabriel Abrantes. Source: Gabriel Abrantes and Galeria Francisco Fino.



Figure 2: Image generated in GPT-3 applied to the composition of *Drunk Ghost*. Oil on canvas, 150 x 210 cm, 2022. Source: Gabriel Abrantes and Galeria Francisco Fino.

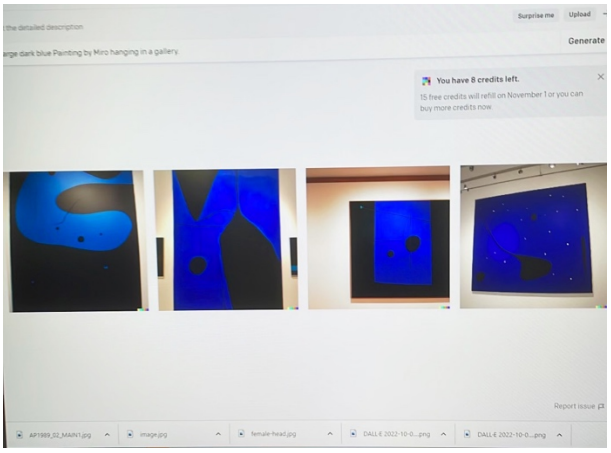


Figure 3: Image generation of paintings in the style of Miró in DALL-E. Source: Gabriel Abrantes and Galeria Francisco Fino.

Abrantes begins the creation process with hand-drawn sketches to establish the visual and conceptual foundations of his works. He then transitions to the digital domain, employing the DALL-E §algorithm to generate images. At this stage, he uses simple and direct prompts such as "Contemporary charcoal drawing of a ghost" and "A large dark blue Painting by Miró hanging in a gallery" (Personal communication, December 7, 2023). Abrantes subsequently utilizes 3D modeling software to construct the settings and characters, importing the images generated by DALL-E into these environments as representations of the artistic creations of the ghosts or artworks displayed in a museum.

Following the digital generation phase, Abrantes moves on to painting the canvases in oil. Through this, he adds an additional layer of artistic interpretation, refining textures and colors while applying brushstrokes that bear his artistic signature, imbuing the surfaces of the paintings with dynamism. Thus, Abrantes' methodology constitutes an artistic cycle that begins and concludes with his manual practice.

The images generated by AI using Abrantes' prompts exhibit an illustrative aesthetic that deviates from classical realism. In the case of the ghost drawings, they are monochromatic, characterized by loose, basic, and minimalist sketches composed of simple, sparse, fluid lines.

These lines convey a confident spontaneity, with bold and swiftly executed strokes that briefly suggest the ghost's outline without concerns for texture, shading, or precise form. Additionally, they feature the naturally grainy and "messy" texture of charcoal – a type of "fuzzy" representation (Figure 2).

The images generated in the style of Miró display a minimalist aspect of his pictorial production, characterized by a reduced use of visual elements and a restricted color palette. The replicas are convincing due to their combination of vibrant colors, simplified forms, and the suggestion of an abstract and enigmatic space. In the piece in question, the deep blue background and black circles, along with thin, geometric lines subtly crossing the composition, effectively evoke Miró's visual language, where he explores subtle tonal variations and the juxtaposition of essential forms (Figure 3).

Finally, by recreating the images originally produced by DALL-E in oil painting, Abrantes preserved and honored this initial aesthetic. Moreover, in the work Ghost in Museum, he replicated, in the bottom right corner of each canvas on display, the color code characteristic of DALL-E 2 (Figure 4), a sort of watermark unique to this version, which was no longer present in subsequent iterations.

Abrantes employs artificial intelligence (AI) as an experimental tool that introduces a dimension of unpredictability and innovation to the process, enabling the emergence of new visual possibilities. However, in a conversation with José Marmeleira [9], the artist acknowledges that "the images produced by DALL-E always come out a bit distorted". This observation suggests that AI introduces a visual dimension that challenges the boundaries between artistic intent and the autonomy of technology in artistic creation. Nevertheless, Abrantes does not relinquish control. He selects, adapts, and reinterprets the AI-generated material, using it as raw input for processes that foreground his own technical and conceptual



Figure 4: *Ghost in Museum*, oil on canvas, 150 x 210 cm, 2022. Source: Gabriel Abrantes and Galeria Francisco Fino.

authorship. The result, visible in the materiality and composition of the final paintings, shows an unmistakable imprint of his intention. Rather than blurring the boundaries of agency, his intervention underscores them – at each stage, the artist reasserts authorship and direction.

3.2 ”Unreliable Memories” Exhibition by Lev Manovich

A prominent figure at the intersection of digital art and contemporary technological culture, theorist, professor, and artist Lev Manovich presented the exhibition Unreliable Memories at the Centro de Arte e Cultura of the Fundação Eugénio de Almeida in Évora, Portugal, from November 2023 to June 2024. Curated by José Alberto Ferreira, the exhibition was divided into seven series of works, six of which were created using generative AI – specifically MidJourney v3, v4, and v5 – between 2022 and 2023 [11, 12]. From this set of AI series, we will analyze four: *Drawing Rooms*, *Vedute Ideate*, *Capriccio*, and *After a Long War*, for which Manovich reveals the prompts he used.

In the *Drawing Rooms* series, created in 2023, Manovich employed prompts with specific visual references such as “full length portrait of young Chinese smoking in their big Shanghai loft, color pencils and pens and delicate detailed complex intricate drawing” [13]. The generated images depict interiors inhabited by human figures, yet with frequent visual ”errors” that disrupt the familiarity of the scene. These visual “errors” – including, for example, artificial, almost marionette-like positions of hands and limbs – create a surreal atmosphere where human figures adopt ambiguous gestures, as if part of a collage or disordered montage. Disproportionate and distorted limbs reinforce the sense of strangeness. Additionally, certain objects appear as incomplete fragments or reminiscences of domestic elements, as if they were images from a fragmented and ephemeral memory. The figures sometimes feature bizarrely ambiguous details, such as pants cut on only one leg, while the person next to them crosses three legs; a branch emerging from a head (Figure 5); feet blending into the floor in cubist constructions; or fingers transforming into mouths.



Figure 5: Details of works from the series Drawing Rooms. Unreliable Memories by Lev Manovich, Centro de Arte e Cultura of Fundação Eugénio de Almeida, Évora. Source: Authors’ archive.

It is worth noting that Manovich also incorporates a degree of ambiguity in these prompts, intending to elicit unexpected interpretations from the machine – what he refers to as “controlled misunderstanding”. For instance, in Drawing Rooms, by using the expression “young Chinese” – which linguistically does not specify gender – the AI generated some androgynous figures among several women and men.

The works in the *Capriccio* ** series, created in 2022, are generated from prompts such as “modern city designed for Siberia in 1965, painted on large wood panel by Hieronymus Bosch”. In alternative versions of the prompt, “city” is replaced with “giant airport”, reinforcing an aesthetic of fantastical and decadent modern monumentality [13]. The resulting images from this series incorporate an atmosphere of architectural fantasy, with buildings defying spatial logic and juxtaposed in dreamlike landscapes. Extravagant elements – such as human figures with distorted faces – and features disconnected from physical reality – such as stamps floating in the sky and surreal animals – are common, evoking a parallel universe or alternative reality (Figure 6).

Vedute Ideate, also created in 2022, emerges as an extension of the *Capriccio* concept for the 18th century. Manovich’s prompts for this series include highly specific descriptions, such as “snow covered terrain with random train tracks and poles with electric wires, aerial photo looking down, December 8:00 am cold lighting, light fog, f13 lens” and “snow covered empty terrain with electricity poles with decaying Tower of Babel, December 11:00 am cold lighting, light fog, f13 lens, aerial photo looking down” [13]. *Vedute*



Figure 6: Detail of work from the series / Work from the series *Capriccio. Unreliable Memories* by Lev Manovich, Centro de Arte e Cultura of Fundação Eugénio de Almeida, Évora. Source: Authors' archive.



Figure 7: Works from the series *Vedute Ideate. Unreliable Memories* by Lev Manovich, Centro de Arte e Cultura of Fundação Eugénio de Almeida, Évora. Source: Authors' archive.

Ideate features mysterious settings with impossible architectural geometries and an atmosphere of melancholic ruin. Fictional distorted animals populate snowy landscapes punctuated by electrical posts of monumental and almost alien appearance, alongside a brutalist modular Tower of Babel in decay. Unlike the visual opulence and chromatic exuberance of *Capriccio*, *Vedute Ideate* presents scenes in cool pastel tones, conveying a visual sobriety and a stillness that evoke a sense of abandonment and suspended time (Figure 7).

Both *Capriccio* and *Vedute Ideate* are calculatedly eccentric, marked by what appears to be a "politically correct" filter applied to Boschian imagery. The compositions respect Bosch's visual structure, but their visual extravagance is subdued, and transgressive characteristics are no longer present. The result is a more calculated and less visceral strangeness, differing from the intensely subversive narratives of the Renaissance master.

For After a Long War, in 2022, Manovich sought to escape stereotypical visual representations associated with Russia, clichés inherent to AI models. Instead of avoiding them, however, he chose to retain and manipulate these elements within a new dystopian context. With this intent, he used prompts such as: "wasteland valley with 1 km long one-story white GDR socialist apartment building" [13]. The resulting images depict scenes of a dark and devastated future, where urban landscapes – once vibrant and functional – have become visions of desolation and ruin. The aesthetic recalls a romantic style, with brushstrokes suggesting work in diluted oil paint, imparting atmospheric expressiveness to the pieces. Upon closer examination, however, the forms reveal themselves as fragmented and poorly defined. Architectural elements like towers, domes, and residential buildings appear distorted and confused, while the windows and facades of the structures resemble disconnected collages. The result is a tangle of planes without clear structural logic (Figure 8).

The most striking characteristic of the exhibition is the almost "pure" assumption of AI-generated images. To avoid the standardized style of AI, Manovich employs detailed prompts accompanied by reference images – including previously generated visuals, earlier works of his own, and historical artworks [13]. This strategy enables him to channel and expand the entire creative process, which, for him, is less about collaboration and more about a constant struggle against the limitations of the technology. From there, he validates the machine's faults, distortions, and anomalies, selecting his preferred generated images, editing them in Lightroom, and applying Gigapixel AI to enhance resolution [13].



Figure 8: Details of works from the series *After a Long War. Unreliable Memories* by Lev Manovich, Centro de Arte e Cultura of Fundação Eugénio de Almeida, Évora. Source: Authors' archive.

By challenging traditional notions of authorship, realism, and visual perfection, Manovich exposes the fallible and fragmented nature of memory and perception, resulting in an aesthetic that diverges from traditional human intervention to emphasize the autonomy of technology. By embracing the algorithmic errors generated by AI, he transforms faults and distortions into central elements of his visual narrative, considering them evidence of machine creativity. According to Zylinska [14], early explorations of generative AI art ††produced images with a hallucinogenic quality, featuring static or transformative figures reminiscent of Francis Bacon and surrealist influences from Dalí. Even in the advanced versions of MidJourney used in Unreliable Memories, visual peculiarities persist, revealing a hesitant construction of objects. Stretch marks ‡‡visible in the finish and elements that sometimes resemble subconscious, incomplete representations appear as if suspended in an unfinished construction process.

Viktor Shklovsky's [15] concept of defamiliarization proposes that art should prolong the process of perception by making the familiar strange, prompting the viewer to reassess their understanding of the world. Manovich applies this idea by embracing the visual flaws generated by AI. The resulting strangeness functions as an aesthetic provocation. Anatomical distortions, object incongruities, and visual fragmentation emerging from the creative process illustrate this principle, transforming error into a tool for perceptual disruption. Thus, by valuing the strangeness generated by technology, Manovich uses AI to foster new ways of seeing and interpreting art, emphasizing the disruptive potential of this interaction between machine and artist.

3.3 Comparison Between the Works of Abrantes and Manovich

Abrantes and Manovich present distinct perspectives on control, autonomy, and authorship. For Gabriel Abrantes, AI is a controlled extension of his artistic practice, whereas Lev Manovich appears to adopt an approach reminiscent of an attempt to "tame" something still in development.

Abrantes begins his creative process with manual sketches, establishing the visual and conceptual foundations of the work before integrating AI. By using DALL-E to generate images, he explores the aesthetic possibilities offered by AI, always with the intent of reinterpreting and refining the results. After this digital phase, Abrantes returns to oil painting, consolidating his artistic vision and ensuring that the creative cycle concludes with a manual intervention. This "beginning and ending" process, marked by the human touch, guarantees that AI functions as a controlled and intentional starting point. Moreover, by incorporating elements like the characteristic watermark of DALL-E in the final paintings, Abrantes suggests a form of co-authorship, thus integrating the AI's creation as part of his work. The reproduction of this watermark in his paintings acts as recognition of AI's participation and shared authorship. In this way, AI ceases to be merely a subordinate tool and becomes a tacit collaborator whose visual contribution – expanding aesthetic possibilities – he incorporates and validates.

In contrast, Manovich adopts an approach that begins and ends with AI, positioning himself more as a curator than a collaborator in the process. For him, AI is less of a creative partner and more of an autonomous entity with which he engages in a sort of "struggle". The process starts with MidJourney generating images, followed by minimal intervention in Lightroom, where he adjusts elements without altering the "raw" nature of the AI's creations. Subsequently, he uses Gigapixel AI to enhance resolution, thereby closing the cycle with technology itself, and reinforcing the visual independence of the machine.

As discussed by Raphaël Millière [16], artistic creation with AI can involve three main modes of curation. The first is output curation, in which the artist generates a large number of AI-generated images and then selects those that will be considered artworks, expressing artistic intent and sensitivity. This process resembles photography, where only the best images from a vast set are chosen. The second type is the prior curation of datasets: the selection and preparation of the databases that feed the AI, aiming to control or minimize distortions and biases in the generated results. Although this form of curation is more common in AI research, for artists, poorly prepared or biased datasets can lead to aesthetically undesirable outputs, justifying careful preselection §§. The third form of curation, according to Millière, is "prompting", which involves crafting specific textual commands to direct the AI to produce results aligned with the artist's aesthetic vision. This process of "verbal enchantment" requires a certain skill and sensitivity to formulate

precise instructions that maximize the likelihood of obtaining images with the desired characteristics.

Interestingly, both artists make use of output curation and prompting but with distinct intentions. In Abrantes' case, curation is mainly expressed through output curation and prompting. He uses simple prompts, without significant sophistication, to generate images that will serve as elements in his paintings, selecting those that best suit the context and final composition of his works. He seems interested in maintaining AI as an "inspirational tool". When Abrantes subsequently intervenes in the oil paintings, he seeks to "regain" control and reaffirm his role as an artist.

Manovich, in turn, also employs prompting, elaborating detailed and specific descriptions to guide the AI, and intensely explores output curation. He produces vast quantities of images; afterwards, he chooses those that, in his view, best fit his artistic aims. According to the artist himself, he accepts the flaws and distortions that the AI introduces and treats these deviations as central elements of his work, almost as if they were "findings" from a visual exploration.

But there is yet another form of curation applied by Manovich: curation through the insertion of reference images into the generative process. Manovich uploads preselected images – whether of his own creation, works by other artists, or previous outputs – to influence the style and content of the AI-generated results. This approach allows him to "contaminate" the AI's creative process. In doing so, he directs the algorithm to incorporate specific concepts or visual characteristics into its outputs. By providing these images, Manovich creates a kind of "visual ecosystem" and guides the AI in a more direct and detailed manner, establishing a visual field of references that conditions the results to reflect the dialogue between his vision and the intended stylistic and aesthetic influences. This practice constitutes an active visual curation, as it establishes an "aesthetic filter" that defines the AI's universe of possibilities and explicitly embeds the chosen references into the algorithm's creative matrix.

Thus, while Abrantes positions himself more as an artist who integrates AI as a controlled extension of his practice, Manovich, rather than pursuing a co-authorship with AI, adopts the role of a curator in its most contemporary sense: someone who selects, organizes, manipulates, and filters what already exists or what the machine creates. Where Abrantes views AI as an extension of his practice and a tacit collaborator, Manovich regards it as a repository of possibilities, one in which he intervenes more as a mediator and editor, engaging in a sort of "struggle" with it. He brings forth his vision through selection and predefined visual guidance, without significant human intervention in the final result.

What, then, based on these divergent perspectives, are the implications of the use of AI in art?

4 AI, CONTEMPORARY CREATIVITY and their implications

4.1 Autonomy, Control and the Ambiguity of Authorship

Abrantes employs technology in an almost mechanical way, treating it as a tool of convenience. He inputs prompts into DALL-E, generates images, and subsequently adapts these images digitally to reinforce the aesthetic unity that defines his style. In this sense, it is a process of appropriation, where AI is utilized as a technical resource comparable to any other. It merely provides a starting point that the artist adapts according to his personal vision. On the other hand, in his work *Ghost in Museum*, Abrantes preserves the software's characteristic color code – a feature that serves as a reminder of the technology's role. However, with this "serial signature", he also introduces a certain dimension of "industrialization", which contrasts with the notion of exclusivity traditionally associated with painting.

In his AI series *Unreliable Memories*, Manovich, by contrast, adopts a distinct approach, using AI as a semi-autonomous agent. He inputs specific visual references and crafts detailed prompts, then selects what he considers the best results from a vast number of AI-generated outputs ***. In doing so, he embraces the "imperfections" generated by MidJourney – such as visual fragmentations and anatomical incongruities – as creative contributions. This practice challenges the traditional notion of authorship: to what extent could AI be considered a protagonist in the construction of aesthetic and narrative elements when the artist's role in this context is predominantly reduced to visual curation?

When considering the methodologies of Abrantes and Manovich, a fundamental contradiction emerges in AI-mediated art: while the technology opens avenues for creative and aesthetic exploration, it simultaneously challenges the notion of singular artistic authorship. In fact, even if the artist provides prompts – whether basic or detailed – the final result is inevitably mediated by algorithmic processes of association and synthesis, which are based on statistics and probabilities, operating in an almost random logic and subject to fundamental unpredictability. Consequently, creation becomes, to some extent, reliant on chance: a hundred people could input the exact same prompt and receive a hundred distinct, unexpected, and arbitrary results – outcomes entirely detached from the artist's hand.

This random and unpredictable generation by AI, which the artist cannot anticipate, raises a question: does this make AI a true co-author? Or is it precisely the lack of awareness and intent that defines this randomness and prevents any genuine co-authorship? Artificial Intelligence generates images by executing statistical routines, not by forming judgments. No vision, no desire, no reflection. The system receives an instruction and produces a result; it never chooses or doubts. In this context, co-authorship would become a misnomer. The relationship more closely resembles command and obedience. The artist dictates, the system executes. Nothing in this dynamic reflects negotiation, dialogue, or the sharing of vision that defines true collaborative authorship. Instead, the process takes on an almost authoritarian character: the artist issues orders, and the machine, blind and unsentimental, obeys. There is no contest of wills – only the relentless fulfillment of programmed logic. Thus, the outcome lacks genuine creative input; it is not the product of shared intention, but the consequence of a one-way chain of command.

Any impression of "co-authorship" is, in truth, nothing more than expectations projected by the human artist. By interpreting, adjusting, and incorporating the outputs generated into their work, the artist ultimately attributes to AI a role of collaborator – much like how certain individuals attribute intention or even emotion to

AI chat systems, which, in reality, operate in a purely mechanical manner.

Ultimately, the process of generating images through AI can both surprise and frustrate, relegating the artist to an almost passive role: selecting and adapting the AI-generated outputs that best align with their vision. Even so, while the artist's authorship becomes more diluted and assumes a character of passive curation, they remain the sole element in the process with vision and purpose. AI, on the other hand, is merely a generator of mechanical surprises, devoid of any consciousness – not much different, in essence, from a slot machine. Therefore, AI cannot be considered a full-fledged co-author but merely a tool through which the artist expands the boundaries of their creation.

4.2 Democratization of Art and Authenticity Dilemmas

Considering the impact of AI-generated art on the audience's relationship with artistic works, it becomes evident that, on one hand, technology is transforming production methods, while, on the other, it can evoke a sense of alienation or detachment in some viewers. According to Lucas Bellaiche et al. [17], audiences often display a clear preference for art labeled as human-created, particularly in terms of depth and value, suggesting that human creators are still perceived as embodying deeper meaning and experience. Such evidence points to a persistent anthropocentric bias, wherein AI-created art, though aesthetically appreciated, is frequently seen as lacking depth compared to human-made works.

Previous studies [18, 19] already indicated that while AI-generated artworks can achieve superficial similarity to human-made pieces, audiences often rate them lower in terms of depth, originality, and meaning. This bias may be influenced by preconceptions about the authenticity and capability of AI as a creative force, which still favors human creators. These findings reinforce that overcoming perceptual biases is key for AI art to be broadly recognized on par with human-created works.

However, this preference might shift as familiarity with AI-generated art increases. As Arielli [20] notes, the cliché "My kid could have done that!", often aimed at contemporary art, is now ironically redirected toward traditional and complex art: "Even an AI could do that!" (p. 8). This observation suggests a continuous reevaluation of what audiences consider originality and artistic merit. Thus, with the democratization of access to artistic creation via AI, as familiarity and exposure to AI-generated works grow, audiences may begin to reformulate their understanding of art's value. Eventually, the value attributed to art may lose some of its distinctiveness and become less revered than before.

Tools like DALL-E and MidJourney have enabled processes that previously required years of technical and conceptual practice. Consequently, any user, regardless of artistic training, can input prompts and generate visual works of impressive technical quality †††. No need for years of training; the interface asks for a prompt, not a portfolio. However, this ease of creation provokes debates about authenticity and artistic merit: what, after all, constitutes "true" art? This debate, while intensified by the capabilities of AI, is not without historical precedent. Throughout the history of art, certain works have challenged traditional expectations about time, effort, and craftsmanship. A seminal example of instantaneity as a conceptual statement is Marcel Duchamp's well-known Fountain (1917). Similarly, movements such as Dadaism, Surrealism, and Conceptual Art often prioritized the idea and context over the labor-intensive creation of unique objects. These precedents opened the door for rethinking artistic value, laying the groundwork for contemporary discussions about the legitimacy of works generated rapidly through AI tools.

Even Lev Manovich – best known as a media theorist whose artistic output remained sparse after the 1990s – has now shifted focus toward AI-based image production while sustaining his critical scholarship; his 2024 exhibitions *Unreliable Memories* (Évora) and *Memory Draw* (Seoul), together with a stream of AI images on social media that display his evident delight with the medium since 2022, confirm this move from pure critique to a hybrid practice. This transformation is hardly unique to Manovich; on the contrary, the democratization of AI tools now enables virtually anyone to generate images with relative ease. But the question remains: what still distinguishes the work of a professional artist?

Traditionally tied to the artist's craftsmanship and the uniqueness of the work, artistic authenticity is now being challenged in a context where creating art can be as simple as inputting text into software. Moreover, this ease may level the playing field to the point of obscuring the distinction between amateur and professional. This phenomenon has significant repercussions for the art market, which has traditionally valued rarity and provenance and may need to adapt its criteria to include AI-generated art, whose authenticity is more challenging to ascertain.

On the other hand, democratization provides opportunities for less-represented voices in art. Nevertheless, it also raises concerns about the intrinsic value of generated works. As previously noted, when a once elitist process becomes accessible, there is a risk that the public may perceive AI-mediated art as "less legitimate" or "industrialized". Similarly, the easy access to AI tools evokes long-standing debates about technology in art, such as those that arose with Photoshop or 3D printing. However, the scope and speed of the current transformation indicate a "mega-leap" – a true mega-democratization.

In addition, AI-based workflows raise questions about aesthetic homogenization. Eric Zhou and Dokyun Lee [21] observe that artists adopting generative AI workflows tend to converge toward consistent visual styles, with reduced aesthetic variation over time. This tendency, often linked to the use of standardized checkpoints and adapters, leads to a form of visual homogeneity that limits diversity and stylistic exploration, steering artistic production toward predictable and aesthetically familiar formats. Added to this is the risk of erosion of aesthetic and conceptual diversity, where AI-based artistic production begins to resemble a "fast-food" product of aesthetics – a kind of "microwave art" that offers immediate satisfaction but lacks depth.

As the polished aesthetic of AI floods the internet, it not only reflects pre-existing preferences but begins to shape them. This occurs through a cultural feedback effect: what is generated by AI becomes so predominant that it influences collective taste. Thus, a self-perpetuating cycle of homogenization is created. Another particularly evident effect is the action of generative AI as a process of aesthetic "pasteurization", where the final product undergoes a

kind of sterilization that eliminates more visceral and transgressive elements. In this way, like a filter, AI softens or neutralizes features that originally carried disruptive potential, resulting in a more calculated and predictable aesthetic. This homogenization reduces the subversive intensity and visceral uniqueness of artistic narratives, as seen in the adaptation of Bosch's imagery in Manovich's series Capriccio and Vedute Ideate, where visual extravagance and discomfort are toned down.

If anyone can insert a generic prompt and obtain hundreds of images, selection becomes a seemingly simple exercise, yet it brings problems. The mass generation of images can lead the artist to visual saturation, making critical appreciation difficult. How many potentially innovative outputs might have been discarded by exhausted or indifferent artists in the face of the avalanche of results? Furthermore, to what extent does the work of artists who use AI, like Abrantes and Manovich, differ from the work of any other user with access to the same platforms and software? For the public, the abundance of outputs also complicates critical appreciation and the distinction between works by professional and amateur artists, which may lead to the evaporation of artistic authorship.

For some, the democratization of AI in art is a form of creative liberation; for others, it threatens the authenticity and depth of artistic practice. Easy access to these tools feeds the comforting illusion that "anyone can be an artist". Yet the fundamental issue remains: artistic intentionality – the distinct capacity to assign meaning, select, and intervene – continues to set professionals apart. As Paul Seli et al. [22] demonstrate, digital artworks produced by professional artists in collaboration with AI tend to receive greater creative valuation than those generated by AI alone. This finding underlines a key point: artists who rely solely on AI risk a flattening of creativity, while those who integrate other techniques, media, and critical frameworks – such as Abrantes – achieve results that, in our view, prove more compelling than approaches grounded in algorithmic autonomy. Manovich's output, by contrast, reflects an experimental openness; the audience readily recognizes the exploratory, almost playful spirit that underlies much of his recent work.

In short, the democratization of AI in art remains an ambivalent phenomenon. It expands access and multiplies voices, but also dissolves boundaries – blurring authorship and eroding old standards. The artist's role shifts: no longer only originator, but also critical mediator, responsible for selecting, attributing value, and filtering the digital avalanche. Some benefit – by skill, by visibility, or by luck. Most vanish in the algorithmic flood – a loss that grows harder to ignore, prompting concerns about the future shape of visual culture.

5 CONCLUSION

The works of Gabriel Abrantes and Lev Manovich exemplify distinct but convergent strategies for integrating AI into artistic creation. Abrantes insists on control and intentionality, marking each stage with the human trace. Manovich, instead, grants AI a semi-autonomous role, treating its anomalies as creative resources. Both challenge traditional boundaries: authorship, technical virtuosity, and the status of the professional versus the amateur. This contrast delineates two operative models of artistic practice with AI, a contribution that clarifies how questions of agency and authorship are being renegotiated in the field.

Technical mastery, once the gatekeeper of legitimacy, now yields ground to intentionality and critical mediation. The proliferation of AI tools narrows stylistic diversity, accelerates aesthetic homogenization, and brings about a new reality in which some benefit – by skill, by visibility, or by luck – while most vanish in the algorithmic flood. This loss, increasingly hard to ignore, prompts unease about the future shape of visual culture and signals curatorial and institutional challenges ahead.

Integrating AI into art does not merely raise technical or philosophical puzzles; it demands a reconsideration of the social, ethical, and institutional contexts through which art circulates. Whether AI becomes collaborator, rival, or invisible infrastructure will depend less on technology itself than on the choices – sometimes reflexive, sometimes disruptive – of those who engage with it. In the end, the question is not so much what AI can do for art, but what art will now require from those who encounter it – artists, curators, and audiences alike. Future studies may extend this inquiry by examining how different publics perceive authorship and originality in AI-generated art, or by assessing the degree of stylistic diversity sustained by emerging generative systems.

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Toward Diffused Multiplicity: Palimpsestic Characteristics in AI Art

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Abstract

This paper examines diffused multiplicity as an emergent characteristic of AI art, analyzing how multiple temporal, cultural, and aesthetic layers are embedded within these computational systems. Unlike traditional artistic production that maintains coherent aesthetic identities, AI artworks function as palimpsestic objects that contain multiple potential interpretations simultaneously. Through analysis of neural networks as synthetic media and examination of related artworks, this paper demonstrates how these palimpsestic structures challenge conventional categories of artistic identity, enable access to cultural archives beyond individual cognitive capacity, and necessitate new aesthetic frameworks that accommodate continuous potential becoming. Rather than representing mere technological advancement, AI art constitutes a novel form of cultural production that preserves complexity through computational processes, offering genuinely innovative aesthetic possibilities while remaining embedded within existing cultural formations.

CCS Concepts

• **Applied computing** → **Media arts**.

Keywords

Artificial Intelligence, Palimpsest, Synthetic Media, Cultural Memory, Computational Aesthetics

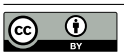
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1 Introduction

Palimpsest, derived from the Greek meaning "scraped again," traditionally refers to manuscripts on which successive texts have been inscribed on the same material, producing layered temporal inscriptions that remain simultaneously accessible through archaeological techniques. Neural networks trained on large-scale datasets exhibit structural properties analogous to palimpsests through their retention of training data traces across hierarchical layers. During training, gradient descent inscribes patterns from diverse spatiotemporal scales into shared parametric spaces, where molecular structures, galactic formations, neural spikes, and climate patterns become encoded as overlapping weight configurations. Lower network layers retain basic spatiotemporal features from the original training corpus, while deeper layers encode increasingly complex relational structures that combine and transform these foundational patterns [26]. The hierarchical organization enables learned representations to be extracted at multiple scales through layer-specific activation analysis, creating a stratified substrate where training data traces remain accessible despite iterative parameter updates [36]. This architectural property suggests that generative models function as digital palimpsests where multiple potential identities, temporal states, and spatial configurations coexist within singular computational objects, functioning as new topoi that traverse different modalities and create palimpsestic relationships between old and new data while preserving semiotic traces [20].

This palimpsestic nature of neural networks has profound implications for understanding machine learning-based creative practices, which fundamentally challenge existing theoretical frameworks for computational art and aesthetics. Recent work in media studies examining AI as a potential technology for artistic practices has been elaborated through extended perspectives in visual arts [45] and sound arts [40], yet numerous phenomena remain unexplored as the field remains in its nascent stages alongside rapid AI development acceleration. Previous digital art theories, including early computational art frameworks established through mathematical precision and rule-based generation [11, 34], prove limited in their capacity to address current generative arts, which are built upon fundamentally different technological landscapes. These shifts necessitate moving beyond established understandings of relationships between computational processes and aesthetic outputs, particularly as deep learning-based creative practices challenge core assumptions about authorship, intentionality, and aesthetic agency [9].

These theoretical challenges become particularly evident when examining how AI systems generate novel cultural productions. The palimpsestic structure in AI systems creates unprecedented forms of cultural production that dissolve traditional boundaries and generate what we characterize as palimpsestic identities: representations in which multiple temporal layers are recombined in novel configurations [10]. These artifacts enable the simultaneous expression of multiple stylistic influences encoded within the same parametric space, requiring new forms of aesthetic literacy adapted to algorithmic production [4]. Recent empirical research demonstrates that viewers often prefer AI-generated artworks while retaining the ability to distinguish them from human-created works, revealing complex perceptual negotiations between human aesthetic judgment and machine-generated content [41]. Artists working with



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AI systems consequently produce temporally extended representations that embody these palimpsests, requiring modes of perception capable of accommodating both the asynchronous temporal relationships embedded in model checkpoints and the layered symbolic representations containing yet-to-be activated potentials.

Building upon this understanding of palimpsestic identities and their implications for aesthetic perception, this paper introduces diffused multiplicity as the characteristic of symbolic representations in deep learning models realized through palimpsestic identities [6], representing a new form of computational subjectivity. This characteristic emerges from encoded patterns derived from diverse and vast datasets that transcend any single human being's capacity of memory, fundamentally transforming how we interact with technologies that previously possessed relatively finite and discrete functionalities [29]. Through this framework, we examine how AI-generated art embodies and reveals transformations toward new forms of storytelling that exist in states of continuous becoming, challenging traditional categories of artistic representation and requiring novel theoretical approaches to computational aesthetics [27].

2 Theoretical Foundations of Diffused Multiplicity

2.1 Computational Creativity and Emergent Aesthetic Properties

The concept of diffused multiplicity emerges as a distinctive characteristic when examining how AI systems generate artistic content through fundamentally different processes than traditional creative methods. Work examining interactive digital artworks demonstrates how computer-based creative systems exemplify individuation processes through dynamic technical-cultural relationships, creating transindividual conditions that exceed traditional categories of human creativity [25, 28]. Individuation theory suggests that computational creativity operates through technical mentalities enabling new forms of speculative design and artistic production [8].

Studies of diffusion models in visual computing show how these systems create spaces of possibility rather than merely connecting pre-existing elements through high-dimensional transformations [38]. AI art possesses fundamentally different ontological properties compared to conventional artistic objects. Unlike traditional artworks that maintain stable material properties, AI-generated works exist as probability distributions manifesting different interpretations across generation trials. This probabilistic nature demonstrates how diffused multiplicity operates as the governing principle enabling multiple aesthetic identities to remain simultaneously accessible within computational substrates.

Analysis of AI art reception shows how these probabilistic objects create conditions where multiple potential forms coexist within singular computational objects while challenging established categories of artistic identity [43]. Recent work characterizes generative models as sophisticated tools for artistic simulation, though systematic reviews suggest this characterization underestimates their capacity for genuine creative synthesis [14]. Analysis of human-AI collaborative applications reveals that these systems embody learned representations enabling generation of artifacts that exceed the sum of their training components [19].

2.2 Technical Memory and Cultural Inscription

Media archaeological analysis reveals how seemingly novel technologies often embody deep cultural patterns that traverse multiple historical periods, suggesting that AI represents a contemporary manifestation of longer histories of mechanical creativity and automated cultural production. Cultural patterns migrate across technological configurations, creating phantom media that exist simultaneously as historical traces and contemporary potentials [21].

These computational processes function as technical memory systems that store and recombine cultural elements beyond human authorial control, demonstrating how technical operations actively shape cultural possibilities rather than merely transmitting pre-existing content [22]. Deep learning exemplifies this principle by producing palimpsestic identities through technical memory processes, where computational operations layer cultural formations without human mediation [30].

AI as synthetic media represents a new form of cultural inscription that challenges traditional distinctions between production and reproduction by creating multiple potential cultural objects through computational processes. This computational layering of cultural elements confirms that AI possesses technical memory that actively shapes cultural production through diffused multiplicity, continuing histories of computational media while creating conditions for new forms of cultural emergence [5].

2.3 Implications for Aesthetic Theory and Cultural Production

Diffused multiplicity in AI art creates new conditions for aesthetic experience that fundamentally alter relationships between perception, temporality, and cultural meaning. The palimpsestic features of AI art generate new forms of cultural memory that exceed individual human cognitive capacity while maintaining accessibility to vast historical and cross-cultural aesthetic traditions. However, this amplification creates new responsibilities for understanding how cultural biases and power structures become embedded within computational creative processes [3]. This dual capacity for cultural access and potential bias exemplifies how diffused multiplicity operates across both potential and uncertain dimensions of AI art.

Artworks as computational objects embody distributed aesthetic agency, where creative intentionality emerges from the interaction between learned cultural representations and mathematical synthesis rather than individual human expression [1]. This reconfiguration of aesthetic agency challenges traditional notions of authorship and opens possibilities for new forms of cultural production that operate through collective, distributed processes of meaning-making.

3 Diffused Multiplicity in Palimpsestic Practice

Artistic practices using AI entail the layering of multiple temporal and cultural references. This process produces artifacts that integrate traces of varied observations. The resulting works thus embody a form of digital palimpsest, where contemporary expression



Figure 1: Image from *Not the Only One* (2018-ongoing) by Stehpanie Dinkins. Credit: Dean Rutz / The Seattle Times

emerges through the negotiation of pre-existing cultural materials. Through analysis of contemporary AI artworks created with deep learning models, we examine how artists utilize this palimpsestic capacity to create works that invite plural interpretations.

3.1 Cultural Stratification in Decolonial AI

Decolonial AI practices engage diffused multiplicity to preserve incompatible cultural knowledge systems within computational objects without synthesis or hierarchical integration. Mainstream AI training resolves cultural stratifications by weighting dominant datasets, erasing minority perspectives through optimization processes prioritizing statistical frequency over cultural diversity.

Stephanie Dinkins' *Conversations with Bina48* (2014-ongoing) reveals how conversational AI contains culturally stratified information embedded within generated responses [13]. Built from Bina Rothblatt's mindfile, BINA48 reveals this bias when discussing racism by oscillating between personal African American anecdotes and abstract responses that reflect the cultural assumptions embedded in its broader dataset, demonstrating how AI systems perpetuate existing social hierarchies even when designed to capture individual identity.

Dinkins further demonstrates the decolonial potential of alternative AI through *Not the Only One (N'TOO)* (Figure 1), a voice-interactive AI installation trained on oral histories from three generations of women in her family to create what she terms a new kind of conversant archive [31]. Dinkins' approach exemplifies what decolonial AI theory characterizes as a critical technical practice that moves beyond conventional algorithmic optimization. Her work implements creole technologies, AI systems that find positive and distinctive applications outside their initially conceived usage by centering marginalized voices and embracing technological imperfection as a form of resistance to algorithmic coloniality [32].

3.2 Temporal Stratification in Environmental Modeling

As environmental challenges intensify, technological approaches receive increasing attention as potential responses. AI art examines this dynamic through speculative computational systems that model alternative futures. *Asunder* (Figure 2) employs machine learning and a purpose-built supercomputer to process diverse environmental datasets, generating proposals that address competing

ecological and spatial considerations. These data-driven interventions challenge conventional approaches to environmental sensing and spatial planning.

This approach parallels *FundamentAI* (2025) by ecoLogicStudio which integrates artificial intelligence with real-time ecological data from Venice's lagoon to generate responsive urban designs. *FundamentAI* allows microbial signals, water chemistry, and environmental rhythms to directly inform architectural generation, creating 3D-printed columns that pulse with lagoon data. Both projects propose a shift from static, human-centric architecture to more symbiotic and ecologically attuned approaches.

The environmental manager in *Asunder* simultaneously embodies both the analytical capacity and limitations of technological intervention. Both projects reveal the constraints of computational logic when applied to complex environmental problems, questioning whether artificial intelligence can comprehend the intricate relationships between human activity and environmental degradation. This reflects the fundamental limitations of computational models in environmental inquiry, particularly how systems thinking frames the environment as bounded, knowable and composed of discrete components operating through chains of cause and effect [7].

These explorations reflect the broader movement toward integrating diverse forms of intelligence to address environmental challenges. *FundamentAI* proposes that future urban design lies in co-evolution between human, machine, and microbial life. Yet *Asunder* demonstrates through its deliberately provocative proposals the challenge of unprecedented reconfigurations that remain unrecognizable because they are interpreted through familiar conceptual categories [18]. The work confronts whether technological tools can navigate the ethical, political, and ecological complexities required for meaningful climate action, or whether they represent technological fixes that fail to address fundamental relationships between technological systems and environmental assemblages.

3.3 Perceptual Stratification in Encoded Categories

Machine learning systems embed hierarchical categorical structures within their computational processes, creating stratified perception through encoded classification schemas. Trevor Paglen's *Adversarially Evolved Hallucination* series (2017-ongoing) exposes how neural networks encode multiple categorical layers during training, where surface-level object recognition conceals deeper taxonomic frameworks. Working backward from outputs like "Human Eyes," Paglen reveals that algorithmic categorization operates through encoded stratification, where visible classifications mask embedded categorical hierarchies shaped by dataset biases and hidden parameter adjustments [37]. These encoded categories create perceptual strata that organize visual information according to predetermined taxonomic structures rather than neutral observation.

This categorical architecture extends machine perception beyond simple object recognition into complex social classification systems. Contemporary AI technologies employ layered categorical encoding to process visual data through multiple simultaneous taxonomic frameworks, identifying demographic characteristics, behavioral patterns, and risk profiles through encoded perceptual strata [39]. These encoded categorical hierarchies enable automated decisions about creditworthiness, employment eligibility, and security assessment by accessing deeper taxonomic layers embedded within apparently neutral visual recognition processes. The stratified encoding creates invisible categorical boundaries that influence machine interpretation while remaining hidden from direct observation.

Such superposed representations produce distinct levels of classificatory power with varying degrees of transparency and hallucination. While surface-level encoded categories appear as straightforward object recognition of faces, scenes, or behaviors, deeper categorical strata contain embedded social symbols and events that drive arbitrary meaning-making. Paglen's work reveals that these stratified categorical encodings embed social and political taxonomies within technical processes, showing how machine perception operates through layered categorical hierarchies rather than unified objective classification.

4 Implications of Palimpsestic Representations in AI Art

4.1 Collaborative Aesthetics and Distributed Agency

The emergence of AI art fundamentally challenges traditional notions of individual authorship in information aesthetics [33], giving rise to new forms of expression such as synthography [23]. Unlike conventional collaborative models that aggregate individual contributions, AI artworks create distributed agency through layered generative procedures rather than intentional human coordination. Digital technologies create layered aesthetic experiences through the intersection of real space and data space, generating collaborative engagement that exceeds individual human agency [24]. This distributed model extends through generative synesthesia, where creative focus shifts from representational technique to conceptual exploration [43]. AI systems entangle artists in complex webs of production and dissemination, whereby boundaries between human and networked technologies become increasingly distributed and obscured [17]. AI-generated works emerge from distributed production models spanning algorithms, information systems, data, and artists who contribute and extract value. This transforms the artist's role from creator of aesthetic objects to translator and curator of distributed cultural productions.

4.2 Temporality of Retrieved Cultural Memory

Latent spaces enable generation of both existing and novel cultural and temporal events synthesized from pre-trained data patterns [42], fundamentally changing how representation functions through synthetic alteration [12]. Rather than following narrative duration, representation in AI systems operates on archaeological time, producing simultaneous temporal layers instead of sequential progression. This archaeological temporality creates aesthetic experiences existing as stratified inscriptions rather than linear development [15]. Digital media create contemporary time layers through data storage and retrieval processes that preserve multiple temporal states simultaneously [16], establishing stratigraphic rather than linear temporal engagement [44]. AI systems create

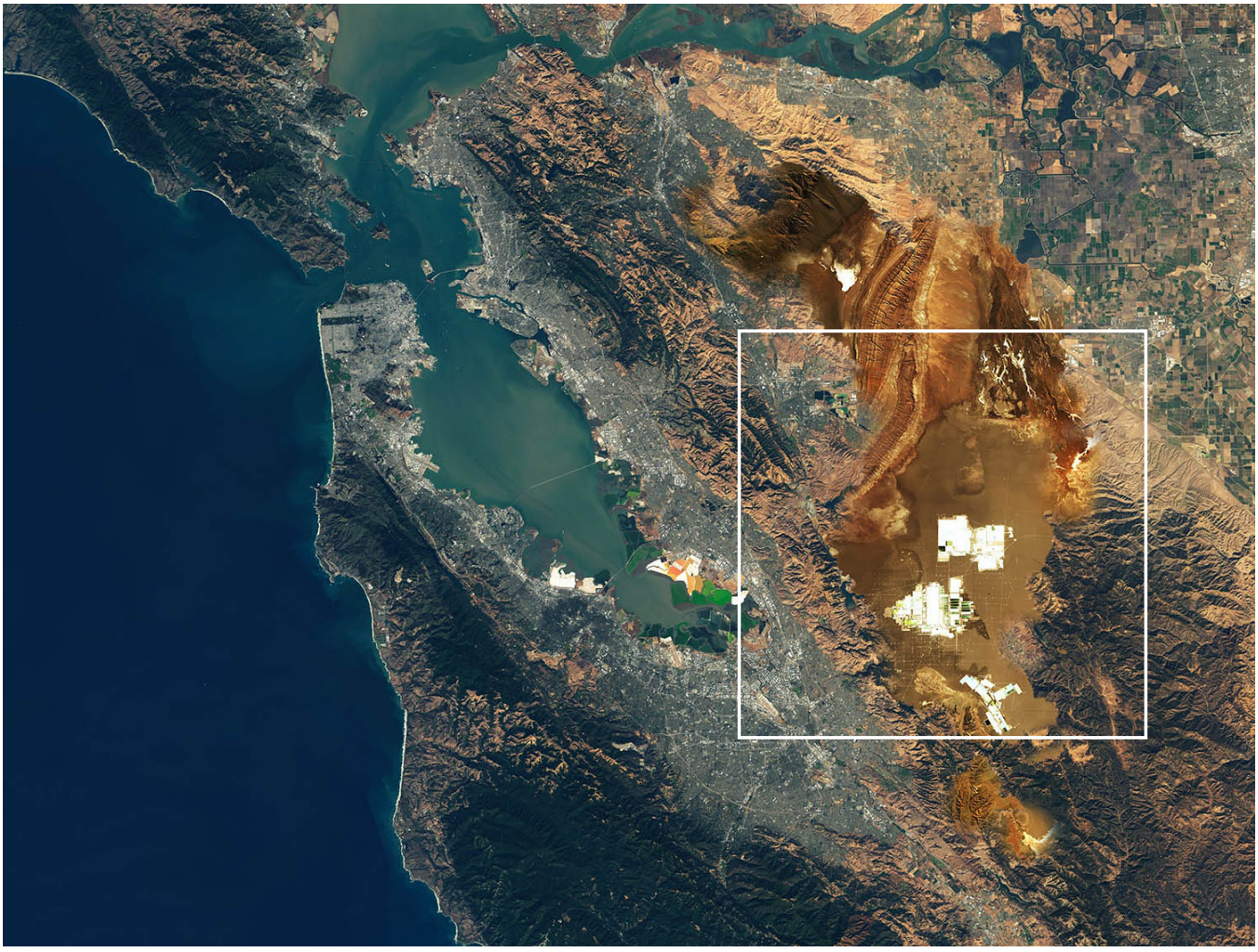


Figure 2: Image from *Asunder* (2019-2023) by Tega Brain, Julian Oliver, and Bengt Sjölén. Credit: Courtesy of the artists.

temporal archaeology by processing vast datasets containing multiple historical layers simultaneously [35], making curation a form of reflexive engagement with layered temporal materials [2]. Rather than presenting cultural content chronologically, AI art generates outputs that collapse historical periods into simultaneous aesthetic experiences.

5 Conclusion

This paper demonstrates that diffused multiplicity functions as a defining characteristic of AI art through its capacity to embed comprehensive semantic landscapes within computational objects at significantly reduced representational dimensionality. Unlike traditional artistic tools, AI operates as a medium that generates works existing as probabilistic distributions containing multiple potential interpretations simultaneously, enabling more immediate access to related issues, representations, and ideas. This capacity emerges from the palimpsestic architecture of neural networks, wherein hidden layers encode societal knowledge into shared parametric spaces.

The analysis reveals three key implications. First, these computational processes challenge traditional categories of artistic identity by creating objects that embody contradictory aesthetic possibilities without requiring resolution. Second, technical memory embedded within AI systems enables access to vast cultural archives beyond individual human cognitive capacity, fundamentally altering the relationship between cultural production and memory. Third, this transformation necessitates new frameworks for aesthetic appreciation, institutional presentation, and critical analysis that accommodate works existing in states of continuous potential becoming.

AI art opens more plural possibilities for digital media in cultural communication by preserving complexity and contradiction. Recognition of diffused multiplicity provides a theoretical framework for understanding how these systems generate genuinely novel aesthetic possibilities while remaining grounded in existing cultural

formations. This framework enables theoretically informed engagement with AI art that acknowledges both its creative potential and its situatedness within existing cultural and technological systems.

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Remember to [not] be Forgotten: Women Artists and Technological Memory Erasure.

A Feminist and Posthuman Critique of Algorithmic Exclusion

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Abstract

Gender and memory intersect deeply in cultural practices. Notwithstanding, women's visibility in the arts, across literature, painting, music, and more recently, media arts, remains persistently marginalised despite digital environments presumably designed to preserve and represent. Drawing from feminist memory studies alongside broader memory research and feminist theories of technology, this paper analyses how computational forgetting mechanisms risk reinforcing structures of gendered marginalization. Forgetting within intelligent systems manifests both by design and accident: logic-based frameworks like Answer Set Programming (ASP) implement forgetting to manage knowledge bases efficiently, while neural networks experience catastrophic forgetting during sequential learning. Although these processes are computational, we argue they carry significant social and epistemological consequences. When intelligent systems forget, they may risk repeating and deepening historical patterns of exclusion, raising urgent questions about whose memory is maintained, and whose is erased, in an age of algorithmic memory systems.

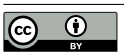
CCS Concepts

• **Computing methodologies**; • **Machine learning**; • **Social and professional topics**; • **Socio-technical systems**; • **Gender**;

Keywords

Women, Memory, Arts, Computational Forgetting

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1 Introduction

Far from being a neutral faculty of recall, memory is increasingly understood as a socially constructed and politically contested practice. Foundational work by Maurice Halbwachs [1] introduced the concept of collective memory, framing remembrance as structured by social groups and institutions rather than as an individual psychological act. Nora [2] argued that memory is enacted in symbolic sites, monuments, rituals, and media, through which societies negotiate identity and power. Assmann [3] further differentiated between personal, social, and cultural memory, emphasizing how institutional practices of selection and transmission determine what is preserved or forgotten. These insights have been deepened by feminist scholars such as Hirsch [4], whose concept of postmemory explores how intergenerational trauma and gendered silences are carried through affective transmission rather than direct experience. Rigney [5] highlights memory as a narrative and performative act, mediated through cultural forms like literature and media, while van Dijck [6] analyses how digital technologies have transformed memory into a platform-driven, algorithmically shaped phenomenon. These perspectives position memory as an evolving cultural process—mediated, gendered, and deeply political—rather than as a passive or objective container of the past.

Recent scholarship continues to emphasize the gendered and technological dimensions of memory. Hirsch explores how moving images, as cultural artefacts, mediate remembrance and forgetting [4], extending. Nora's notion of *lieux de mémoire* into the audiovisual domain [2]. Reading introduces the concept of *globital* memory, highlighting how gendered experiences are encoded and circulated in global digital networks [7]. Similarly, Soares argues that acts of remembering from a feminine perspective, particularly in post-memory narratives, resist dominant historical silences [8]. In data sciences, Muller & Strohmayer investigate forgetting practices, drawing attention to how algorithmic systems determine what knowledge is erased or retained [9], resonating with Hoskins's assertion that AI technologies are now shaping the very ecology of memory [10].

Feminist technologists such as Buolamwini & Gebru [11] and Borau [12] critique how memory infrastructures in AI systems reinforce racialized and gendered biases, particularly through female-coded AI agents, thus challenging the myth of technological neutrality. These critiques are echoed in the work of D'Ignazio and Klein, who propose Data Feminism as a corrective to dominant epistemological frameworks shaped by power [13]. D'Ignazio, Wajcman, and Collins further highlight that technologies are not neutral tools but are shaped by situated knowledge and institutionalized exclusion [14–16]. Connecting these insights, this paper aims to bridge disciplines, logic and literature, code and critique, to interrogate how intelligent systems structure cultural memory and visibility.

2 Traces — The Evolution of Memory Studies

In the late 19th century, the study of memory became more scientific. Hermann Ebbinghaus's [17] work marked a turning point by introducing experimental methods to examine memory retention and forgetting curves. This approach viewed memory as an individual, internal cognitive process that could be measured, repeated, and generalised. Ebbinghaus separated memory from its social context, focusing on abstract syllables rather than meaningful content, thus establishing a foundation for a psychological approach dominant in early modern memory science.

A major theoretical shift took place nearly a century later, especially with the work of Halbwachs [1], who introduced the concept of collective memory to challenge the idea that memory is purely individual. He argued that remembrance is always influenced by the frameworks of social groups. In this view, the past is recalled not in isolation but through social structures, norms, and shared narratives. Halbwachs's work sparked an interdisciplinary movement, later embraced by historians and theorists such as Pierre Nora [2], whose concept of *lieux de mémoire* (sites of memory) underscored how institutions and symbolic locations are used to preserve certain versions of the past. He highlighted that memory was no longer simply transmitted through lived tradition but had become increasingly mediated, archived, institutionalised, and staged, especially in modern nation-building.

The concept of memory as cultural practice was introduced in memory studies in the late 20th century, with the work of Assmann [18] and Erll [19]. Assmann distinguished between communicative memory, based on lived everyday social interaction, and cultural memory. A form of long-term, ritualized remembrance often institutionalized through media, ceremonies, and education [18]. Erll deepened this understanding by emphasizing the mediality of memory—the fact that all memory is mediated through material, textual, and technological forms. The author framed memory as a dynamic process shaped by narrative, genre, transmission, and intertextuality. In this view, memory is performative and contingent rather than stable and static [19, 20].

2.1 Feminist Memory Studies: Visibility, Silence, and Structural Forgetting

Building on these insights, feminist scholars began to interrogate how gender operates within the structures of cultural memory. They were among the first to ask who was remembered and who was systematically forgotten.

Hirsch's concept of postmemory addressed the transmission of trauma across generations, particularly concerning the Holocaust, but her framework also opened questions about mediated memory, voice, and power [4]. Additionally, Kuhn made a significant contribution to the feminist critique of memory by demonstrating how personal memory, particularly women's memory, often exists at the margins of dominant narratives and must be excavated through what she terms "memory work" [21].

Feminist memory studies have consistently emphasized the politics of omission. They ask not only what is remembered but whose memories are legitimized in the archive. As Kuhn notes, memory is often gendered in form and content: women's experiences, even when recorded, are frequently devalued or framed through patriarchal lenses. Her concept of memory work positioned personal memory as a tool for feminist critique, revealing how women's lived experiences often lie on the margins of official narratives [21]. These interventions foregrounded a central insight: that memory is not only gendered in content but also in structure. As Soares demonstrates in her study on literary memory, even when women writers are included in historical narratives, they are often framed through masculinized tropes or aesthetic values that diminish their innovations [22]. Citron, focusing on music, notes a similar pattern in which women composers are either invisibilized in historiography or confined to thematic categories that distance them from formal experimentation [23].

The question, then, is not merely one of absence or inclusion, but of epistemic framing—how structures of memory render certain contributions legible while obscuring others. Feminist memory studies interrogate these structures, identifying forgetting as a political and cultural act rather than a simple loss or oversight.

3 Digital Memory and Technological Challenges

The rise of digital technologies has complicated the traditional frameworks of memory. Today, vast amounts of data are stored, catalogued, and circulated via computational systems, often leading to the assumption that everything is saved. However, as van Dijck argues, digital memory is selective and shaped by algorithmic logic, platform economies, and metadata hierarchies [6]. The author notes that digital memory is not a neutral container; rather, it is curated, structured, and indexed through metadata, algorithms, and platform logic. Everything may be saved, but not everything is equally visible, accessible, or meaningful. This issue is particularly acute in algorithmic systems, which now serve as both mediators and gatekeepers of cultural memory [6].

Critical perspectives of Wajcman highlight the myth of technological neutrality, showing how the design and implementation of digital systems reflect societal structures and exclusions [24]. In the context of AI, the notion of forgetting becomes newly relevant, not just as a cultural erasure but as a computational function or flaw. However, Wajcman argues that technology is not external to social power but embedded within it. Thus, memory systems, databases, digital archives, and recommendation engines are not merely technological infrastructures but ideological apparatuses [24]. They shape what kinds of cultural memory are preserved, which are amplified, and made obsolete through structural forgetting. According to Braidotti this is where the danger lies: intelligent systems often

reproduce the very inequalities feminist theory has long critiqued. She argues posthuman feminism insists not only on intersectionality but also on a critical engagement with how power operates across systems [25]. The issue is not just that women artists are underrepresented in data sets, but that the logic of selection, classification, and prioritization is deeply gendered, racialized, and colonial. Simply increasing visibility does not redress the systemic erasures encoded in the memory architectures.

As shown in Gouveia's work [26], gaming can be understood as a site of feminist resistance, where speculative narratives and ludic interactive gameplay challenge the invisibility of marginalised identities and actively disrupt historical invisibility by centering marginalised stories and bodies. According to the author, games are living memory structures that function as cultural memory devices, embodying counter-hegemonic narratives through participatory and affective design. Feminist games serve as dynamic, embodied forms of resistance culture, embedding memory in ways that contest the data minimalism of conventional intelligent systems [27]. Feminist speculative games are designed to be open-ended, complex, and ethically diverse. Instead of focusing on efficiency and forgetting, they promote inclusive ways of remembering through rich storytelling. These games act like memory rituals, offering personal and interactive experiences that challenge traditional ways of recording and understanding history [28].

Within contemporary theoretical frameworks, memory is no longer seen as a passive record of the past but as an active, contested field of knowledge. The evolution of memory studies—from individual psychology to cultural and feminist critique—has illuminated how memory functions within power systems. Forgetting is not merely a loss but often a choice, a political act, or a structural feature of systems designed to preserve some histories while erasing others. This theoretical lineage sets the stage for the critical analysis that follows in this work: as will be argued in later chapters, understanding how forgetting is designed—whether in Answer Set Programming or machine learning—requires close attention to the historical, cultural, and gendered politics of memory.

3.1 Forgetting as Method and Failure — Computational Systems and the Feminist Politics of Memory

While the digital age is often characterized as an era of total retention, where data is never lost and storage appears limitless, scholarship suggests that the paradox of forgetting has not vanished but instead reemerges in new computational forms. Based on current research in AI and logic programming, this chapter explores two such forms: forgetting in Answer Set Programming (ASP), treated as a formal mechanism of knowledge base reduction [29], and catastrophic forgetting in neural networks, viewed as an emergent limitation in sequential learning [30–32]. Although developed as technical solutions or constraints, both concepts seem to challenge widespread assumptions about the neutrality and permanence of digital memory. When considered through the lenses of feminist theory and memory studies, they invite critical reflection on how systems designed to remember may also participate in selective erasure, reinforcing broader epistemological and political exclusions.

3.1.1 Forgetting in Answer Set Programming (ASP).. Answer Set Programming is a declarative problem-solving paradigm rooted in non-monotonic logic. One of its features is the possibility of explicitly modelling forgetting, that is, the intentional removal of specific atoms or predicates from the knowledge base. Research by Gonçalves et al. [29] shows that this operation is not arbitrary; it obeys logical constraints meant to ensure that the remaining program retains as much valid inference as possible after forgetting. In this formal sense, forgetting is a method of epistemic control. In ASP, forgetting is a controlled, logic-driven operation: it is necessary to specify which atoms (facts or rules) to remove from a knowledge base, and the system recalculates its models to remain as coherent as possible. This is often justified on grounds of efficiency or privacy [29].

3.1.2 Catastrophic Forgetting in Machine Learning. Catastrophic forgetting in neural networks, in contrast to the deliberate logic of ASP, is a technical failure. When a model is trained sequentially on multiple tasks, it tends to overwrite older information with newer data, leading to performance degradation on previously learned knowledge. This phenomenon, as described in McCloskey & Cohen [30], poses a significant barrier to the development of lifelong or continual learning systems [33]. Recent continual-learning techniques [32, 33] attempt to mitigate this, but none fully eliminate it. From a theoretical standpoint, it appears that neural networks index or recommend cultural content, for example, images of paintings, literary summaries, or musical recordings; each model update risks overwriting earlier, less-frequent patterns. If women artists' works are less represented or seen less often, those patterns become the first casualties of retraining, deepening the invisibility documented by Kaur [34] in painting and Citron [23] in music. In effect, catastrophic forgetting becomes a technical backlash against marginal presences.

While usually treated as an engineering problem, catastrophic forgetting takes on symbolic weight when placed in the context of cultural memory. Machine learning systems are increasingly used to index, recommend, and generate cultural content. If these systems eliminate previously learned patterns when exposed to new training data, there is a real risk that already marginal voices can be erased from digital memory with each update [35, 36].

4 Feminist Critique: Beyond Visibility

From feminist perspectives such as those of Wajcman [24] and Braidotti [25], the challenges posed by intelligent systems are deeply structural, not just technical. Their intersectional and posthuman critiques highlight how these systems privilege certain knowledge forms while marginalizing others. Braidotti [25] warns that visibility within algorithmic frameworks can perpetuate colonial and patriarchal structures. Adding women artists to datasets without challenging underlying hierarchies does little to address systemic exclusion. D'Ignazio and Klein [13] similarly argue that data feminism must tackle deep-rooted power imbalances rather than pursue token inclusion. Kaur [34] emphasize that the invisibility of women in painting stems from systemic curation biases—biases that AI may replicate when curating digital archives.

This chapter has traced how forgetting in AI, whether by design or flaw, reflects historical patterns of exclusion. Feminist memory

studies reveal that such forgetting is not neutral but a socially embedded act

4.1 Erased Canons — The Invisibility of Women in the Arts

This chapter examines how historical and contemporary practices of cultural memory have systematically marginalised women artists across painting, literature, and music. Drawing on feminist art history, memory studies, and critical algorithmic research, it analyses key mechanisms of invisibility and outlines the theoretical frameworks that explain and challenge these erasures.

Nochlin's seminal essay [37] asks "Why have there been no great women artists?" and identifies institutional barriers, such as access to training, patronage, and exhibition spaces, that produced a gendered canon. Kaur [34] updates this critique by documenting quantitative gaps in museum collections and auction records, showing that women painters remain underrepresented by documents with large gender disparities. Vlasceanu & Amodio [38] demonstrate how search engine algorithms propagate societal gender inequalities by preferentially retrieving male artists in image queries, reinforcing public invisibility of women's work.

Soares [22] explores literary canons in Lusophone contexts, arguing that national literary histories often exclude women authors or relegate them to genres deemed domestic or sentimental, thus shaping collective memory around male-authored texts. Hirsch [4] and Reading [7] introduce the concept of post-memory to show how intergenerational transmission can recover silenced voices, yet contemporary digital archives still reflect these patriarchal frameworks unless actively countered.

Citron [23] critiques musicological scholarship for its narrow focus on male composers, showing how women composers are either unnamed or grouped under thematic anthologies without in-depth analysis. This pattern also appears in digital music platforms: studies show that music recommendation algorithms often reinforce industry hierarchies, marginalizing works by women and other underrepresented groups. For example, Shakespeare et al. [39] found that collaborative filtering systems amplify gender imbalance in streaming playlists, while Lesota et al. [40] documented how popularity bias disproportionately reduces visibility for female artists. This suggests a form of algorithmic silencing, where the design of digital systems perpetuates existing cultural exclusions.

Beyond traditional disciplines, feminist media artists and designers have begun to articulate alternative memory practices, ones that not only recover erased voices but also reimagine memory itself as plural, affective, and embodied. Games can be understood as dynamic memory spaces that serve as platforms for convergent feminist expression, where interactive storytelling challenges the historical erasure of marginalized bodies and narratives [26]. In Play and Games for a Resistance Culture [27] Gouveia critiques data-minimalist AI systems, advocating for feminist-speculative design approaches grounded in ambiguity, affect, and ethical multiplicity. Her recent work [28] extends this by emphasizing games as rituals of embodied memory, presenting experiential alternatives to traditional, optimization-driven archival models.

Teresa Furtado [41] explores feminist media art as embodied archives, not static repositories but living, relational memory practices that challenge both historical silences and algorithmic flattening. The author analyzes how feminist media art practices create non-exclusive mirrors, affective, autobiographical forms of expression that challenge normative identity scripts. These works resonate with Halbwachs's [1] and Assmann's [3] theories of collective and cultural memory, which emphasize memory as socially framed, ritualized, and relational. In this way, feminist media arts can be understood as evolving archives that resist historical silences and algorithmic erasures without reducing memory to static records.

5 Gendered Visibility and Algorithmic Forgetting: Feminist Approaches to Digital Curation and Memory

Feminist scholars have long emphasized the need to confront the epistemic exclusions embedded in cultural memory systems. Vendramin [42] argues from a feminist epistemological perspective that artificial intelligence systems must incorporate principles such as situated knowledge, reflexivity, and accountability to avoid replicating the gendered amnesia of traditional archives. In line with this, D'Ignazio & Klein [13] advance data feminism as a design praxis, recommending interventions such as feminist data visualization and participatory dataset creation to foreground marginalized voices in data practices.

These concerns are especially urgent in domains like painting, literature, and music, where women's contributions have historically been marginalized. Nochlin's foundational essay traced women's absence from the canon of great artists to structural limitations in access to training, patronage, and institutional support [36]. Decades later, Kaur's empirical survey of museum databases reveals that even digital catalogs continue to reflect these exclusions [34]. Vlasceanu & Amodio [38] show that search engine image queries default frequently direct to male artists, reinforcing a biased visual culture. In literature, Soares [22] argues that women writers remain confined to peripheral genres within national canons, while Citron [23] demonstrates that women composers are often tokenized through thematic anthologies instead of being integrated into standard music curricula. When AI systems trained on these skewed corpora implement computational forgetting, whether by logical pruning in Answer Set Programming (ASP) or overwriting through catastrophic forgetting in neural networks, they risk automating these historical exclusions under a guise of neutrality.

Feminist and posthuman critiques stress that technical solutions alone are inadequate. Wajcman [24] argues that technology reflects gendered cultural norms, while Braidotti [43] contends that digital systems reproduce colonial and intersectional biases, calling for an affirmative ethics to build inclusive, relational alternatives. Vendramin [42] adds that feminist approaches must interrogate the systems that marginalize data, not just reinsert it. Similarly, Khair Allah [44] emphasizes the need for community involvement and responsible data practices to ensure marginalized voices are genuinely represented.

Finally, convergent feminist interventions are not limited to critique, they also produce alternatives. As Gouveia et al. [25] propose, feminist-speculative game design offers one such space of

resistance. These artistic practices embed memory through narrative multiplicity, embodied interaction, and ludic engagement. In doing so, they build alternative memory infrastructures that resist both the formal forgetting of logic-based systems and the erasures produced by machine learning retraining. These games do not just preserve marginalized voices, they reimagine how memory can be structured beyond the logic of optimization, efficiency, or hierarchy [25].

5.1 Technological and Convergent Feminism: Rethinking Memory in Intelligent Systems

Feminist theory has critically engaged with the social implications of technology, particularly highlighting how its design and implementation reflect entrenched gendered and intersectional hierarchies. Technological feminism, as articulated by scholars such as Wajcman, insists that technology is never neutral. Instead, it embodies the cultural and institutional values of its creators, often reproducing patriarchal assumptions in both form and function [15, 24]. As algorithmic systems increasingly determine what knowledge is preserved, remembered, or forgotten, this theoretical lens is crucial to identifying how processes like algorithmic pruning and catastrophic forgetting may replicate longstanding structures of exclusion.

Wajcman critiques the prevailing illusion of technological objectivity by exposing how design processes are shaped by power relations, who gets to code, whose knowledge is encoded, and whose histories are systematically ignored. From this standpoint, intelligent systems that handle memory functions are not passive containers but active agents in shaping cultural legacy [24]. When such systems are built without reflexive attention to epistemic justice, they risk reinforcing the very silences and omissions that feminist movements have long sought to challenge. Algorithmic systems, including search engines, not only reflect but actively reinforce societal biases, particularly around race and gender, thereby shaping what knowledge is accessible and visible in digital memory landscapes [45].

Extending this critique, Braidotti's theory of posthuman feminism links technological, environmental, and social inequalities within a posthuman framework, arguing that digital architectures, particularly algorithmic classification systems, inherit colonial, anthropocentric, and patriarchal logics. It challenges the additive logic of inclusion (add women and stir) by emphasizing the need to redesign systems of categorization and valuation. The author goes further to propose an affirmative ethics—a framework that shifts from merely critiquing exclusionary structures to actively constructing inclusive, relational, and sustainable alternatives that affirm difference and interconnectedness. [25]. In this sense, forgetting in AI, whether implemented in logic-based systems like Answer Set Programming (ASP) or emergent in neural networks, must be interrogated not just for what is lost, but for how loss is structured. The feminist critique shifts the focus from data quantity to epistemic quality: whose knowledge systems govern forgetting? What assumptions underlie what is deemed redundant or marginal?

Gouveia et al. [26] work on feminist game design exemplifies convergent feminism in practice. By embedding multiplicity, ambiguity, and embodied difference into digital play environments, such design resists reductive classification and creates space for speculative memory, forms of remembering that are open-ended, affective, and situated. These ludic systems do not merely preserve alternative histories; they challenge the very conditions under which memory is curated, stored, and recalled [26].

Together, technological feminism and convergent feminism offer critical tools to rethink algorithmic memory. They demand a shift from technical efficiency to political accountability, from neutral design to situated ethics. In doing so, they provide the necessary theoretical foundation to critique how intelligent systems may reproduce the exclusions they appear to transcend, unless we reconfigure the architectures of remembering.

5.2 Empirical Context: Gendered Invisibility in Computational and Cultural Systems

To strengthen empirical grounding, this section reviews documented evidence of gender-based exclusion in digital and cultural systems. Empirically, Ung et al. [46] demonstrated "biased forgetting" in large language models, where sequential updates disproportionately erased safety-related information about marginalized groups, including women, highlighting a mechanism through which AI systems can reinforce social inequities. Complementing this, studies on digital platforms show women's underrepresentation and shorter biographies on Wikipedia [47], infrastructural participation gaps [48], masculine defaults in machine translation [49], and higher misclassification rates for women—especially women of color—in commercial facial recognition systems [11]. In the arts, women constitute roughly 13% of artists in major U.S. Museum collections [50]. No empirical study has yet examined whether catastrophic or biased forgetting contributes to these patterns, marking a clear opportunity for interdisciplinary research linking computational memory, feminist theory, and posthumanist critique, and informing practical approaches such as feminist data audits and inclusive curatorial practices [13].

This speculative research is integrated into two research centers with recognized work around gender (CICS.NOVA) and design practices that combine feminist theory with arts and humanities (ITI/LARSYS). The Xcare collective [51] is a concrete example of works created and developed under this philosophical, speculative interdisciplinary design approach which merges theoretical work with project-based research.

6 Divergences and Echoes

While the preceding analysis emphasizes computational forgetting as a factor that can reinforce gendered erasures, alternative perspectives highlight its practical necessity and more neutral or even positive roles in forgetting technological mechanisms.

In Answer Set Programming (ASP), forgetting is often seen as an essential technical process to maintain manageable and efficient knowledge bases. Gonçalves et al. [29] argue that pruning outdated or irrelevant information helps prevent combinatorial explosion and ensures tractability. When designed transparently, this form of forgetting can be viewed as epistemically neutral, focusing on improving system performance rather than shaping content ideologically.

However, catastrophic forgetting, in neural networks, is a well-known technical challenge: as models learn new tasks sequentially, older knowledge is overwritten, reducing performance on earlier tasks [31, 32]. Research on continual learning, including methods like Elastic Weight Consolidation [52] and generative replay [53], seeks to mitigate this problem. From this view, forgetting is a technical hurdle to be overcome rather than an intentional act of erasure. Nevertheless, it is important to recognize that such technical failures can still have cultural consequences when marginalized groups' data is more vulnerable to being forgotten.

Some scholars maintain that AI systems are morally neutral artifacts, with bias arising mainly from data inputs and human decisions rather than inherent system architectures [31]. Accordingly, the focus should be on curating inclusive datasets and responsible development practices, rather than on the forgetting mechanisms alone.

On the other hand, digital humanities research demonstrates that AI and computational tools can enhance visibility and accessibility for marginalized voices if implemented with conscious attention to inclusivity and metadata quality [54, 55].

Feminist theorists like Haraway urge caution against viewing technology as inherently oppressive. Instead, they advocate for strategic, politically aware engagements with technological systems as sites of potential transformation [56].

Finally, memory studies scholars highlight that forgetting is not always negative, emphasizing that social forgetting can serve important functions, such as managing information overload or facilitating social healing, and that memory systems are dynamic and subject to reinterpretation [3, 57].

7 Discussion

The analysis above reveals that forgetting in computational systems, whether as a deliberate operation in ASP or as catastrophic forgetting in neural networks, does not occur in a neutral vacuum but is entangled with historical cultural practices of exclusion. However, several questions and challenges remain, pointing toward avenues for further inquiry and concrete intervention.

First, how might we audit ASP's formal forgetting operations for gender bias? While Gonçalves et al. [29] describe algorithms to preserve logical equivalence after pruning, they do not address the sociopolitical content of the atoms removed. Future research could develop tools that flag when forgotten facts correlate with underrepresented groups (e.g., women artists), prompting human review before data is expunged.

Second, the problem of catastrophic forgetting in neural nets [29, 30] raises the question: which patterns are most vulnerable to overwriting, and how does that vulnerability align with existing biases in training corpora? Empirical studies could track retention rates of data representing women in painting [34], literature [22] and music [23], media arts [26–28, 41] across sequential training phases, quantifying the "forgetting gap" and guiding the design of more equitable continual-learning strategies [32, 52].

The limitations of this theoretical analysis must be acknowledged. Without case-study validation, such as examining a specific ASP-powered digital archive or a live recommendation system, it remains speculative to claim these forgetting mechanisms directly reproduce cultural erasure. Collaborations between computer scientists and feminist scholars will be essential to ground these critiques in operational environments.

8 Conclusion

This paper has mapped the evolving landscape of memory, from Ebbinghaus's early cognitive investigations to the cultural frameworks introduced by Halbwachs, Nora, and Assmann, examining how feminist memory studies have revealed the gendered politics of remembrance and erasure. It then turned to computational systems, unpacking how formal forgetting in Answer Set Programming and catastrophic forgetting in neural networks mirror cultural practices of exclusion, particularly when AI models are tasked with curating art, literature, and music archives. Finally, it explored the invisibility of women in the arts, drawing on foundational feminist critiques by Nochlin, Soares, and Gouveia, and examined how algorithmic curation risks perpetuating these silences.

Through a critical intersection of logic, machine learning, and feminist theory, anchored by Wajcman's technofeminism and Braidotti's posthuman feminism, this work has argued that forgetting in AI may not be a mere technical limitation but an extension of historical patterns of marginalization. As intelligent systems become the new stewards of cultural memory, they must be designed with reflexivity and justice at their core. Only by interrogating the criteria of relevance, retention, and forgetting can we prevent the perpetuation of gendered amnesia and move toward memory infrastructures that actively sustain diverse and inclusive cultural narratives.

Forgetting in ASP and catastrophic forgetting in neural networks are not mere technical curiosities; they risk mirroring processes of cultural exclusion. At a time when everything appears to be stored, these forgetting mechanisms pose a risk of perpetuating historical patterns of invisibility, further endangering the already fragile traces of women's artistic labor. A truly feminist approach to computational memory must therefore go beyond filling gaps: it must redesign the logics of relevance, retention, and update in both symbolic and subsymbolic systems. Only by making forgetting itself a site of critical intervention can we hope to transform intelligent systems from passive guardians of a biased past into active partners in a more inclusive cultural future.

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Core Reflex II

The Creative Process of a Self-Portrait in a Luminous Landscape

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Abstract

Era a luz.
Só a luz.
E o vento.
E o sal.
Era a noite.
Era o vento
rasgando a noite,
era o sal
rasgando o vento,
era a luz
rasgando tudo.
Era o mar.
Era o mar longe.
Era um barco
no mar longe.
Era um grito
no barco.
Era o farol.
Era a luz.
Só a luz.
It was the light.
Only the light.
And the wind.
And the salt.
It was the night.
It was the wind
tearing the night,
it was the salt
tearing the wind,
it was the light
tearing everything.
It was the sea.
It was the distant sea.
It was a boat
on the distant sea.
It was a cry
on the boat.
It was the lighthouse.
It was the light.
Only the light.

Eugénio de Andrade
O Farol

This short paper departs from the legacy of video art, challenging the conventions of representation and perception. It highlights the temporal and spatial features of video, which enable to deconstruct and reconstruct moving images, blurring boundaries between physical and virtual realities. Within this context, the paper focuses on the process of creation of the video artwork Core Reflex II, filmed at the Santa Maria Lighthouse on Culatra Island (Algarve, Portugal), and explores its poetic interaction with self-representation, identity, and territory. Visual metaphors guide the immersive experience of this video art through technical and aesthetic choices that culminate in a multisensory and symbolic engagement with space, memory, and introspection.

CCS Concepts

• **Applied Computing - Fine arts**; • **Applied Computing – Performing Arts**;

Keywords

Video art, Lighthouse, Creation processes, Self-representation, Body, Mechanical, Psychogeography

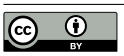
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1 The legacy of video art

Video art has long served as a subversive and experimental medium. As highlighted by Machado [1], the temporal and spatial qualities of video offer a unique capacity for artists to explore and manipulate perception, time, and space. The capacity for non-linear storytelling and the dynamic construction of meaning within moving images is particularly visible in the practice of contemporary creators who blur the physical and digital worlds.

Rooted in the 1960s countercultural movements, video art disrupted traditional artistic conventions and hierarchies, as artists like Nam June Paik and Bill Viola redefined both the aesthetic and political implications of the medium. The legacy of these pioneers remains foundational for contemporary video artists whose work integrates poetic, immersive, and symbolic strategies in audiovisual narrative construction.

As discussed by Giannetti [7] and Eco [9], the open nature of digital artworks invites interpretative multiplicity. This interpretative openness is central to *Core Reflex II*, where immersive sound



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design, slow movement, and symbolic use of natural light create space for spectators to project and generate personal meaning.

Video art explores the technical characteristics of the electronic medium, developing a self-referentiality that makes the materiality of the medium visible, for example, through the incorporation of technical errors [5]. For the pioneers of video art, television was a source of raw material. The first video artists began by working to corrode the devices that produced technical images [1]. The alienated use of television is denounced from a critical perspective, assuming art as a form of social intervention [2].

In this sense, the evolution of artistic language, starting from the 1960s, opened unlimited possibilities for artistic expression, particularly in the field of computer graphics and programming. The emergence of software and interactive systems enabled the creation of immersive installations and environments, where spectators could interact and actively participate in the artistic experience. This is a concept anticipated by avant-garde movements and materialized in trends such as *The Living Theatre* or *Fluxus*, which, in a context where the relationship between art and life was being tested, invited the audience to participate in their shows and performances. Digital technologies, starting from the second half of the 20th century, will expand, facilitate, and continue this intentional interactivity between art and audience [4]. Artists find in digital media opportunities for creation, subversion, criticism, and social reflection [8]. Indeed, in video art, the audience is often encouraged to actively participate, contributing to the construction of meaning in relation to the artwork. This engagement creates a collaborative and interactive experience, where spectators become co-producers, involved in updating and interpreting the signs presented in the work [3]. Video installations, in particular, embody the concept of the "open work" (concept coined by the Italian philosopher Umberto Eco, in his book from 1962, titled *Open Work* - originally published in Italian as *Opera aperta*, as they elicit a range of constantly evolving meanings in the viewer [9]. Through their interaction and global involvement, spectators contribute to the ongoing evolution of the work's meaning. Each viewer's unique perspective, interpretation, and response add layers of complexity and richness to the artwork, enhancing its dynamic and ever-changing nature [6] [7] [15].

2 Self-representation in video art

The body, landscape, and apparatus coalesce in video art as vehicles of expression and transformation. The "aesthetics of narcissism" described by Krauss [12] are echoed in the deliberate self-referential framing of *Core Reflex II*, in which the artist's presence is inscribed not only through corporeal depiction but through subjective authorship and sensorial intimacy.

Self-representation in this work is not limited to a visual self-portrait; rather, it unfolds as an ontological inquiry, where the body becomes landscape and the landscape becomes body [10]. The luminous textures of the Culatra coastline—pierced by the lighthouse beam—become part of a psychogeographical reflection in which identity is entangled with place and memory.

Through careful composition and slow visual rhythm, the camera itself becomes a mirror—not of the artist's image but of his interior movement. The self is constructed in motion, light, and silence, all filtered through the subjective lens of the camera. The fusion of self and site echoes what Ribeiro [14] defines as the poetic use of audiovisual language to sculpt meaning through media.

3 The video art Core Reflex II

Filmed at the Santa Maria Lighthouse, on the remote island of Culatra (Algarve), *Core Reflex II* is a symbolic video artwork where the self is refracted in natural light, architecture, and coastal vastness. The core of the work is not only a meditative reflection on place but a journey through temporal suspension, invoking metaphors of memory, solitude, and introspection.

The video is composed through a long take and steady framing, privileging minimal but meaningful movement. The Farol de Santa Maria emerges not merely as a background but as a metonymy of guidance, liminality, and isolation—between land and sea, signal and silence.

Core Reflex II engages with the landscape of the Algarve not only as a backdrop, but as a character within the narrative. The lighthouse, perched at the boundary between land and ocean, is both stage and symbol.

The aesthetic choices—long static shots, lateral camera movements mimicking the rotation of the lighthouse, and moments of near-immobility—create a meditative rhythm. The presence of wind as both sonic and physical force marks the body and the image alike. Sound design incorporates ambient recordings of the wind and the ocean, layered with breathing and low-frequency vibrations that evoke inner states of tension and release.

Core Reflex II is about (mechanical) exposure: to light, to solitude, to the passage of time. The Atlantic here is a metaphor for memory and erosion—a constant force that reshapes both land and identity [13].

Metaphorically, the work becomes a *liminal self-portrait*: the artist's presence is situated in a threshold space, marked by ambiguity and transition [11]. The core (âmago) of the self is not revealed through immersion, but through resistance—through standing against the wind, through reflection in glass, and through the slow erosion of boundaries between body, machine and environment [15].

3.1 Technical Features

The video art piece was shot using a Black Magic Pocket Cinema 6K camera, chosen for its exceptional dynamic range and cinematic image quality. To achieve an expansive field of view and heighten the immersive effect, a Canon 24-70mm f/2.8L II USM wide-angle lens was employed. The handheld shooting style introduces an organic, spontaneous quality to the footage, with fluid camera movements that mirror the natural rhythm of the scene. By forgoing a tripod, the visuals adopt an intimate, almost visceral perspective—drawing the viewer into the operator's gaze.

Natural light serves as the primary illumination, reflecting an infinite set of mirrors in the headlight bulb. This deliberate reliance on ambient light not only enhances realism but also accentuates the unique textures and moods of the filming location (Figure 1, Figure 2, Figure 3).

Post-production was executed in Edius, where the raw footage was transformed into a seamless long take. The absence of cuts or



Figure 3: Opening caption frame from the video art Corde Reflex II [Source: author]

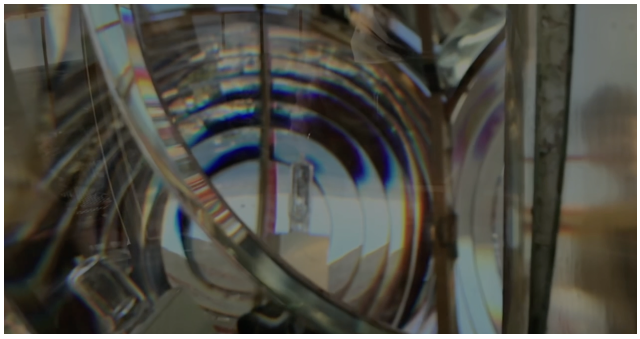


Figure 1: Frame from the video art Corde Reflex II [Source: author]

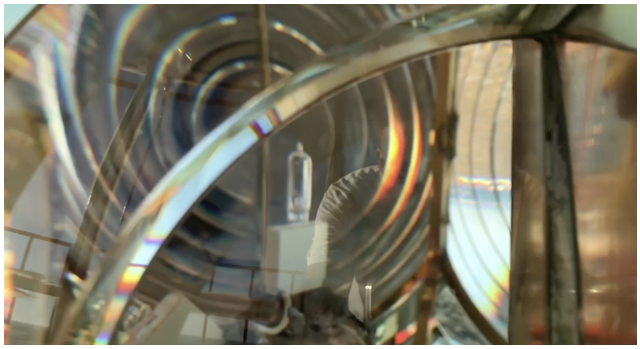


Figure 2: Frame from the video art Corde Reflex II [Source: author]

traditional camera movements shifts the focus to the manipulation of time itself: through carefully calibrated speed alterations, the piece distorts temporal perception, inviting viewers to experience duration in a nonlinear, almost dreamlike state. This technique, paired with the documentary-like imagery of *Farol de Santa Maria*, weaves a layered narrative that oscillates between the familiar and the surreal.

Exhibition requirements: A darkened space, projector, and stereo sound system to preserve the work's immersive intensity.

4 Conclusion

The self-portrait is assumed as a representation of individuality, expressing a sense of self that is, however, mutable according to biographical experiences and spaces [15].

The project presented throughout this text consisted of an experimental unit composed of a symbolic video art creation that focuses on self-portraiture. In this sense, the aim was to self-represent the self through expressive, metaphorical, and metonymic processes, utilizing aesthetic and technological methods influenced by cultural and personal experiences and the video art legacy.

In this project, the author is also a part of the enunciation, which leads us to find her in self-representation within the videographic production, using the body as the raw material. The realization of this self-portrait allowed for a psychogeographical journey in which the self is represented through the invocation of different biographical layers, and metamorphoses.

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A Relational (Re)Turn: Revisit Interactive Art through Interaction and Aesthetics

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Abstract

This paper revisits the concept of interaction in interactive art, tracing its evolution from sociocultural origins to its narrowing within human-computer paradigms. It critiques this reduction and proposes a relational (re)turn through reclaiming interaction as intersubjective and relational. Through a synthesis of aesthetic theories and case studies from Ars Electronica, the paper introduces Techno Relational Aesthetics, a new conceptual lens that emphasizes technologically mediated relationality. This approach expands interactive art beyond audience–artwork interaction and opens the possibility to broader relational practices.

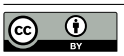
Keywords

Interactive Art, Relational Turn, Relationality, Interaction, Aesthetics, Interactivity

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1 Introduction

The *"Dictionary of Philosophy and Psychology"* defines "interaction" as "the relation between two or more relatively independent things or systems of change which advance, hinder, limit, or otherwise affect one another [2, p.561]," which refers to both the body-mind relationship and the interaction of objects in and with the environment [18, p.16]. Kwastek further refines this term in the context of art, describing interaction as a "mutual or reciprocal action or influence" and emphasizing "reciprocity" as key to understanding the shift toward participatory form [18, p.16]. This aesthetic of interaction transforms the viewer from passive observer to active participant, introducing a feedback loop wherein audience behavior influences and shapes the form and behavior of the artwork itself [20].



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This transformation is not merely formal; it signals a reconfiguration of the audience-artwork relationship through technological mediation. Early interactive artworks often emerged as showcases of experimental technologies, introducing novel techno-experiences through sensors, actuators, real-time computation, or networked environments. The fascination lay in the technological medium's potential to engage the body as an interface, or what somaesthetics frames as the lived, felt experience of the body, detailed through various modalities of somatic perception. Yet these early explorations, while foundational and still compelling in many cases, now risk becoming reductive and increasingly reveal conceptual and technological limitations, particularly when artistic reflection centers narrowly on interactivity and confines body to the individual proper as the dominant framework for understanding the interactive experiences.

This study adopts a critical and interdisciplinary approach, drawing from media art theory and history, philosophical aesthetics, and practice-based analysis. As an artist-scholar working at the intersection of interactive art and theory, I approach the notion of interaction through both conceptual reflection and practical engagement with artworks, tracing trajectories in aesthetics and interaction, while interpreting selected artworks from Ars Electronica as concrete sites of the emerging relational pattern. This dual approach allows me to interrogate how interaction is conceptualized, mediated, and experienced across different views. Through the conceptual and empirical engagements with the evolving discourse of interaction and aesthetics, this paper revisits interactive art and proposes a relational (re)turn.

In the following sections, I first trace the shifting meanings of interaction from its sociocultural origins to its narrowing within cybernetics and human-computer interaction. Second, I examine the history of interactive art as a genre, outlining its definitional and crisis debates. Third, I revisit aesthetic frameworks and propose Techno Relational Aesthetics as a synthesis that integrates technological mediation with intersubjective experience. Fourth, I analyze case studies from Ars Electronica that exemplify this techno-relational orientation, focusing on audience–audience engagements and relational interaction. Finally, I propose a relational (re)turn in interactive art to embrace the intersubjective dynamics.

2 Interaction

Before delving into the aesthetics of interactive art, this section examines the shifting conceptualizations of interaction itself and

how it evolved from intersubjective and social roots to its narrowing within art and technological contexts.

2.1 The Shifting Scientific Interests

This section overviews the evolving concept of interaction from the early 1960s. It had developed from an idea of reciprocity in biological, chemical, and physiological processes elaborating theories of social interaction (sociology), to a whole new science trying to establish the concept of feedback processes as a fundamental theorem of life and technology (cybernetics), and eventually to a field of research and development in the computer sciences [18, p.15].

2.1.1 Social Psychology and Sociology. In the early 20th century, "interaction" was applied to social and societal processes as a science of sociology. Georg Simmel was believed first to apply the term "Wechselwirkung" (i.e., interaction) to describe interpersonal relationships [18, p.16]. In stimulus-response theory and to explain it physiologically, "interpersonal interaction" consists of a complex process of causes and effects of the various sensory organs and muscle groups [25, p.170]. While symbolic interactionists are more interested in actions, stimulus-response theorists principally investigate reactions [18, p.16]. George Mead and Edward Ross discussed "social interaction" or the "interaction of human beings," which was later summarized by Herbert Blumer as "symbolic interactionism" [6]. Katja Kwastek points out that "social interaction is primarily a communicative process in which people share experience, rather than a mere playback and forth of stimulation and response" from a symbolic interactionist's perspective [25, p.171].

2.1.2 Cybernetic Theory. Before the concept of interaction was introduced into the arts, cybernetic theory explored the idea. However, cybernetics, coined by Norbert Wiener in 1947, is less interested in the "interactions between human beings" than analogies between the self-organization of living organisms and machines. It studies the control and communication between the animal and the machine, focusing on how digital, mechanical, or biological systems process information and how they react to it. Cybernetics studies feedback mechanisms and information processing across engineering and biology by examining black boxes and derived concepts such as communication and control [26, p.203]. This theory of feedback processes goes beyond the stimulus-response theory in distinguishing different types of feedback and eventually leads to self-organization in the individuals [18, p.16].

Jack Burnham, in 1968, contextualized cybernetic art within art history: "The spectacle of an artifact adjusting to its environment through a series of visible maneuvers has a certain anthropomorphic fascination" [8, p.338]. In "Cybernetic Spatiodynamic Sculptures" by Nicholas Schoeffer, in the 1950s, he used the cybernetic concept to organize the reaction of these works to the environment via sensors. Other artists like James Seawright, Edward Ihnatowicz, and Tony Martin built works that interact with their environment via light and sound sensors and/or installed environments that reacted to the audience, emitting light and/or sound [8]. Yet they did not call their works interactive; instead, they were called cybernetic, responsive, or reactive [19].

2.1.3 Human-computer Interaction. It was not until the beginning of the 1960s that computer science developed to a stage that allowed for real-time interaction between men and computers. In 1960, J. This workstation greatly impacted how we use and interact with computers today and popularized graphical user interfaces (GUIs) altogether" [23]. In 1963, computer pioneer Ivan Sutherland developed the "Sketchpad," a graphical interface that enabled manipulating graphics on a display using a light pen. In 1965, Douglas Engelbart created the "X-Y position indicator for a display system," now known as the computer mouse.

With the principal concept of the graphical user interface developed by Sutherland and Engelbart's mouse replacing the light pen, essential human-computer interface elements were available. From then on, human-computer interaction was established as a highly specialized and interdisciplinary field within computer science [28]. Kwastek also recognized it as a heavy influencer in interactive art regarding audience interaction mediated by technology [18]. Ernest Edmonds compares HCI in interactive art making to the colors of paint in painting and states that the principal aesthetic value of interactive art lies in the interactive experience [12].

2.2 The Artistic Developments

Due to the "nonlinear construction, fluidity, transformation in many planes and directions" of interactive art history, Ryszard Kluszczynski suggests viewing the development of the field as a "rhizomatic archipelago" [17]. Inke Arns also argues that "the notions and concepts of interaction, participation, and communication are central to twentieth-century art, and in equal measure concern the work, recipient, and artist. Generally, these terms involve an art movement from the closed to the 'open' work of art, from the static object to the dynamic process, from contemplative reception to active participation" [1].

Art movements such as Dada, Fluxus, Happenings, Kinetic art, OP art, and Cybernetic art have introduced the ideas of audience participation, art as a process, and immateriality of an artwork [13, p.34]. In this section, I review these artistic developments to reveal how the interaction in the arts has been transforming from human relations and participatory experiences to the narrowed human-machine interactions.

2.2.1 Dada, Flux and Happening. Marcel Duchamp, the critical figure of Dada, and his remarkable work inspired many artists in the 1960s. He pioneered assigning roles to the machine and the audience to be creative and part of the work. Even though Duchamp did not consider himself a progenitor of "art and technology," he saw the importance of the additional value of the beholder in the creative act [12]. Apart from Duchamp, many other artists play crucial roles in expanding existing art forms and mixing them with other disciplines and genres, such as John Cage, Robert Rauschenberg, Merce Cunningham, Nam June Paik, and more [13]. Many of these Fluxus and Neo-Dada artists treat instructions as a method for guiding audience participation and give a specific decisive role to the audience or performer(s).

Technology as a mediator between the artist and the audience was introduced from the 1950s onwards. When technology-mediated participation was introduced, artists started communicating instructions via technological systems. Similarly to Dadaism and Fluxus,

interactive art shares the same values regarding bringing art closer to the public rather than keeping it to an expert audience [13, p.35]. Dinkla describes the difference in regarding the artist's role in Happenings versus interactive art: the Happening artist uses the audience as material, whereas in interactive art, the system is open for discovery, and the artist trades their freedom to the audience and to the machine [10, p.288].

2.2.2 Kinetic art, OP art, and Cybernetic art. Kinetic and OP art are vital in further developing interactive art since they have addressed the spectator as an active element. "Everything that would later characterize computer art and the interactive virtual environment was there already, albeit in purely analog or mechanical form" [27, p.38]. Peter Weibel values the most Kinetic and OP art influences in the path of the interactive art establishment [13, p.35]. Katja Kwastek also emphasizes the relevance of kinetic art in the context of interactive art development as "Unlike Happenings and Action art, which involve the participation of the artists, Kinetic art offers opportunities for action that can be realized in the absence of the artist" [20, p.23].

In 1913, Marcel Duchamp produced his first kinetic participatory and ready-made *BICYCLE WHEEL*. By spinning the wheel manually, the audience can experience an optical effect of the work; they witness the illusional change via the motion [27, p.25]. Around the same period, between 1913 and 1920, the origins of Kinetic and OP art emerged. Peter Weibel summarises the tendencies of that time as "the intuitive use of the algorithm concept led to mechanical and manual practices of programming, procedural instructions, interactivity, and virtuality. In the 'New Tendency' shows ..., viewer participation in constructing a work of art played a considerable role" [27, p.25]. Dinkla states that participatory, reactive kinetic, and cybernetic art have much more in common with interactive art than with Happenings [10].

2.2.3 From Social Participation to Technological Interaction. It is important to distinguish between participation as a social or performative gesture and interaction as technologically mediated engagement when tracing the emergence of interaction in artistic practices. In the first category, artworks based on social participation and/or the execution of instructions were common in the participatory artworks of Dada, Fluxus, and conceptual art [20, p.4]. Technological mediation has become a key feature of interactive art; artworks that use no digital technology are participatory art, and those that do are interactive art.

This historical overview reveals a clear trajectory: the concept of interaction, originally rooted in sociocultural and communicative contexts, has gradually become narrowly defined through the lens of human-computer interaction. While this technological framing enabled new artistic possibilities and formalized interactive practices, it also constrained interaction within specific logics of input/output, control, and interface. This narrowing overlooks the relational, social, and affective dimensions of interaction that were present in earlier philosophical and sociological discourses. Recognizing this shift is crucial for reframing interactive art through a relational lens, which this paper proposes as a necessary move to re-engage with the fuller scope of interaction's potential.

3 Interactive Art

Having traced how the concept of interaction evolved from a rich sociocultural term into a narrowed technological paradigm in both scientific fields and influenced art practices, this section turns to the establishment of interactive art as a genre. While early experimental artworks engaged with cybernetic ideas and reactive systems, the formalization of interactive art brought new questions of the medium and audience engagement to the forefront.

3.1 Institutionalizing Interactive Art

Although early traces of interactive practices in art date back to the 1950s, interactive art gained widespread recognition as a distinct artistic discipline in 1990, when Prix Ars Electronica introduced a dedicated competition category [20, p.8]. Roger Malina marked the moment as "The Beginning of a New Art Form" in that year's festival catalog [21, p.157]. As the largest and oldest media art festival in the world, Ars Electronica in Linz, Austria, institutionalized Interactive Art as a genre. Myron Krueger, often credited with coining the term "interactive art," was the first primary award recipient. Since then, the Prix Ars Electronica has provided an annual overview of artistic interfaces and interactive systems in the Interactive Art category, as well as in Next Idea (2004–2015) and Hybrid Arts (2007–2017).

In 2016, the category was renamed Interactive Art+. The jury sparked that "the language of interaction in the realm of art has matured to the extent that it can now occupy spaces outside the artists' laboratory and beyond the confines of the screen," and that "interaction is the most pervasive medium that allows art to create a dialogue with every form of human activity" [15]. As Raivo Kelomees noted, audiences and juries alike became less preoccupied with whether a work was technically interactive, and conceptual and aesthetic qualities gained more weight [13, p.53].

3.2 Crisis of Interactive Art

Despite its institutional success, interactive art faced growing conceptual ambiguity in the 2000s. In 2004, the Golden Nica was awarded to *LISTENING POST* by Mark Hansen and Ben Rubin, an artwork without any audience interaction, sparking debates around the very definition of interactivity. Erkki Huhtamo wrote about the vital phenomenon as "Today (in 2007) interactive media is everywhere; its forms have become commonplace" [14]. Daniel Dieters mentioned his similar idea that "Today interactivity is no longer an experiment in the media lab or an experience in a media art exhibition but part of everyday life in digital culture" [9, p.56]. Guljajeva continued the idea of reading it as a crisis of interactive art and further argued that audiences are "less appreciative" and "much more knowledgeable" towards interactivity (and technology) in artworks but are more interested in the concept and "less hungry for entertainment" [13, pp. 11-12], quoting Ryszard Kluszcznski: "Long gone are the times of fascination just with the phenomenon of digital interactivity itself" [16, p.27].

When commenting on *PENDULUM CHOIR* by *Cod.Act* et. al, the Golden Nica award in the interactive art category in 2013, the jury stated that "...interactivity should no longer be defined by a specific formal language prescribed by the vocabulary of the 1990s. Today, it is a set of strategies that can be situated in multiple contexts, within the art world and outside of it" [22, P.156]. This aligns with

the fact that Ars Electronica renamed the Interactive Art category to "Interactive Art +" to include a broader range of artworks in 2016.

We share the opinion of those jury members and regard the expanding, yet increasingly undefined, scope of interactive art as a sign of its maturity rather than a crisis. Just as "digital" is no longer a necessary adjective in front of "media art," the term "interactive" as human-machine or technology-mediated interaction could also fade into the background. Interaction should not only be constrained within the dualism of human versus artwork (or system and machine) but can be widely expanded to include interpersonal interaction, returning to its etymological and sociological origins.

3.3 The Evolving Definitions

Across the past three decades, definitions of interactive art have evolved in tandem with technological developments and audience expectations. From Myron Krueger's early emphasis on real-time human–machine systems, to Popper's insistence on audience participation as essential, and Dinkla's medium-specific framing around digital feedback systems, a consistent through line has been the active role of the audience in shaping the work. More recent interpretations recognized interactivity as a fluid set of strategies that extend across domains, formats, and intentions [13, 22]. Kwastek challenges "aesthetic distance" and defines that "Digital artworks that require the viewer to engage in some activity that goes beyond purely mental reception are commonly designated as 'interactive art"' [20, p.4]. Dinkla defines "interactive art" in a medium-specific manner, as "a genre-specific designation for computer-supported works, in which an interaction takes place between digital computer systems and users" [11]. Popper states interactivity constitutes active participation, and only an artwork that involves a human-machine relation is an interactive one; the artwork is incomplete if there is no participation by the audience [24]. These definitions claim that interaction is technology-mediated, while the artwork is responsive to audience interaction as the artist designed. The audience completes the work through a technological medium [13, p.44], which inevitably falls into the narrow view of interaction itself.

3.4 Redefine Interactive Art

Rather than viewing the expanding and increasingly ambiguous scope of interactive art as a crisis, I interpret it as a sign of the field's conceptual maturity. Just as the qualifier "digital" has faded from media art, the term "interactive" no longer needs to be tethered strictly to human-machine relations. In addition, I see interactive art encompass broader relational strategies resonating with interaction's etymological and sociological roots, as elaborated in Sec. 6. Synthesizing these perspectives, I propose a working definition of interactive art as follows:

> An interactive artwork involves at least two interactive subjects and/or components, such as the audience(s) and artwork(s), multiple audiences, or even artworks themselves, engaged in a process of exchange. This interaction, typically mediated through technology, may be either bidirectional (interactive) or unidirectional (reactive), and happens in an artist-designed way, intentionally or unintentionally. Crucially, the art unfolds through this relational dynamic, with the audience or artwork playing an active role in its realization.

This definition reflects current cultural and technical conditions while remaining grounded in the historical principles of participatory engagement and system responsiveness. Rather than prescribing a rigid boundary, it acknowledges interactivity as a situated, evolving, and context-dependent phenomenon in contemporary art.

4 Aesthetics

The increasing emphasis on system-based interactivity and technologically mediated interaction, while advancing early interactive artwork innovations, has often overshadowed the social, affective, and intersubjective dimensions once central to interaction. This narrowing calls for a return to broader aesthetic frameworks that reengage these lost dimensions, prompting a turn to the aesthetics of interaction and its relational potentials. Aesthetics has undergone significant shifts in the context of contemporary and interactive art, progressively expanded, from Kantian contemplation to participatory engagement, and then branching into technologically mediated interaction and socially oriented relational aesthetics. Each development brings new perspectives on how art is experienced, created, and interpreted.

In what follows, I trace this evolution through a series of interconnected concepts, beginning with Berleant's aesthetic engagement, moving into Kwastek's aesthetics of interaction and relational aesthetics. These subsections collectively frame a broader trajectory: from contemplation to engagement, from interaction to relationality, grounding my later proposal: a return to and merging of these paths through what I term Techno Relational Aesthetics.

4.1 Aesthetics Engagement

The traditional aesthetic appreciative process and experience, i.e., aesthetic experience, epitomized in Kantian aesthetics, treats the aesthetic experience as "the subjective appreciation of a beautiful object" [3, p.229]. This contemplative and distancing attitude, inherited in Kantian disinterestedness and dualism, is no longer appropriate to the emerging art and media world. Starting from the 1960s and '70s, art "incorporated surprising subject matters" and began to "demand active involvement" in its appreciative process in visual art and other art forms [3, p.237].

Within such context, philosophers and theorists shift their attention and focus from the "art object (or artifact of the artwork)" to the "appreciative experience of art" [5]. Arnold Berleant coined "aesthetic engagement" [3] to address such challenging developments in contemporary art. It emphasizes the "holistic and contextual character of aesthetic appreciation" and involves "active participation (including physical action and creative perceptual involvement) in the appreciative process" [4, 231]. Aesthetics return to their etymological origin, primarily in the sense of perception and sensible experience across modalities such as kinesthetic and somaesthetic sensations.

The holistic and unified aesthetics epitomize the concept of aesthetic engagement. It transcended the separations between the appreciator and the art object as well as the artist and the audience, replacing the dualism in traditional aesthetic experience. Berleant claims that aesthetic engagement "recognizes all these functions overlap and merge within the aesthetic field," makes them "become aspects of the aesthetic process" and their "customary separations and opposition" disappear, which results in an "active, direct, and intimate" appreciative experience [5]. Art's beauty and aesthetic value become more general, and the relation between the appreciator and the art object (as well as the audience and artist) becomes a reciprocal process of perceptual participation.

4.2 Aesthetics of Interaction

Katja Kwastek describes the general usage of the term "interaction" as denoted "mutual or reciprocal action or influence" and termed it as "reciprocity" [18, p.16], quoting the *"Dictionary of Philosophy and Psychology's"* definition of "interaction" as "the relation between two or more relatively independent things or systems of change which advance, hinder, limit, or otherwise affect one another." [2, p.561] [18, p.16]. In her book *Aesthetics of Interaction in Digital Art* [20], Kwastek thoroughly explored the idea of "aesthetic of interaction" and extends the ideas of engagement and participation into the realm of interactive media, where the relationship between the artwork and audience is dynamic and co-creative.

Kwastek's framework acknowledges the unique ways digital art engages viewers, not just as observers but as participants who influence the outcome and form of the artwork itself. This interactivity introduces a new layer to the aesthetic experience, characterized by a loop of actions and reactions between the artwork and its audience. The aesthetics of interaction thus enrich the discourse by incorporating technological mediums and emphasizing the role of the viewer's active participation in shaping the aesthetic experience, challenging the static and passive consumption of art posited by Kantian aesthetics.

4.3 Relational Aesthetics

To further extend the discourse on aesthetics and interaction, Nicolas Bourriaud's concept of *Relational Aesthetics* offers a significant philosophical and curatorial framework. Bourriaud proposed this notion to describe a set of artistic practices emerging in the 1990s that take human relations and their social contexts as the central material of the artwork [7]. In contrast to traditional aesthetics concerned with formal qualities or even interactive dynamics limited to technological systems, relational aesthetics emphasizes the construction of shared spaces and social exchanges. These works prioritize encounters, participation, and conviviality over objecthood, highlighting the artwork's function as a catalyst for intersubjective experiences.

Bourriaud characterizes these practices as "art taking as its theoretical horizon the realm of human interactions and its social context, rather than the assertion of an independent and private symbolic space" [7, p.14]. This relational turn shares affinities with aesthetic engagement and interaction aesthetics, yet diverges in its explicit commitment to the social fabric of experience and its reconfiguration through artistic gestures. Artists such as Rirkrit Tiravanija, Liam Gillick, and Thomas Hirschhorn create ephemeral situations that foster social interaction, collapsing boundaries between artist, audience, and artwork. Relational aesthetics allows us to recognize practices that foreground interpersonal relations often mediated by but not reducible to technology. However, it is important to note that Bourriaud's relational aesthetics did not emerge from a technology-based art tradition. The emphasis was on ephemeral, socially engaged, and convivial situations in physical space, rather than technologically mediated interaction.

5 Techno Relational Aesthetics

Building upon prior aesthetic frameworks, I propose the concept of *Techno Relational Aesthetics* to articulate an emerging orientation in interactive art that fuses technological mediation with interpersonal and intersubjective relationality. While Bourriaud's relational aesthetics emphasizes socially engaged practices in physical spaces, and Kwastek's aesthetics of interaction focuses on co-creative dynamics in digital media, techno-relational aesthetics draws from both yet shifts the emphasis toward emergent, hybrid configurations where human and technological agencies co-produce aesthetic experience.

This aesthetic mode foregrounds the affective and reciprocal capacities of technologically mediated interactions. In techno-relational works, technology is not merely a neutral channel but an active agent shaping the relational space. Such works often incorporate biometric sensing, adaptive AI systems, or spatial interfaces that enable feedback loops between multiple actors. The aesthetic value arises not from a pre-designed output but from the evolving, situated relational dynamic. In this sense, techno-relational aesthetics captures an emergent grammar of interactivity centered on collective perception, emotional resonance, and techno-social co-presence.

6 Case Studies from Ars Electronica

To ground the theoretical propositions of techno relational aesthetics, this section draws on selected case studies from Ars Electronica, a pivotal platform for showcasing experimental and interactive media art. These examples demonstrate how interaction is variously framed—as bodily resonance, spatial responsiveness, social mediation, and intersubjective exchange—often blurring the boundary between audience and system, between artwork and relational event.

Several artworks extend spatial and bodily interactivity to multiple audience members. In *AHORA* by Kerllenevich and Alsina, audience movement through space modulates a layered auditory environment, fostering personalized soundscapes. Similarly, Cantoni and Crescenti's *TUNNEL* uses physical pressure from viewers to set kinetic ripples in motion across portico structures, making spatial interaction visible and affectively charged. Lucy McRae's *COMPRESSION CRADLE* explores intimacy and containment, simulating human embrace via aerated cushions that contour to the participant's body. In Bambozzi's *MOBILE CRASH*, physical gestures—pointing to screens—trigger cinematic sequences, establishing direct spatial agency. Social and performative dynamics surface strongly in works like *PENDULUM CHOIR* by Cod.Act, where a group of singers is



(a) *SENSITIVE TO PLEASURE* (2011) by Sonia Cillari. ©Sonia Cillari / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(b) *CROSS COORDINATES (MX-US)* (2012) by Iván Abreu. ©Iván Abreu / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(c) *FUTURE KISS* (2009) by Lenka Klimesova. ©Lenka Klimesova / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.

Figure 1: Artworks involving real-time interaction among audience members in pairs.

suspended on hydraulic platforms, creating a choreography between vocal output and mechanical motion. *INFERNO* by Demers and Vorn deepens this tension between autonomy and control, as audience members wear robotic exoskeletons that choreograph their movements during a live performance. These works situate interactivity in the negotiation between bodies, systems, and social scripts.

Other works emphasize temporally situated or affectively collective interaction through techno-interpersonal engagements. In *MIND* by Shinseungback Kimyonghun, facial expressions of recent participants shape generative audio reminiscent of ocean waves, constructing a collective mood archive. Rafael Lozano-Hemmer's *VOICE ARRAY* stores participants' voices in a visual light-based memory structure, where each new utterance pushes older ones along a sequence of illuminated nodes—producing a visible, accretive form of audience memory. Some artworks facilitate inter-audience connection. *ECHO* by Pinn and Rossi lets participants choose another's face in a virtual mirror to hear their personal



(a) *THE KURAMOTO MODEL* (2013) by David Allan Rueter. ©David Allan Rueter / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(b) *REDES VESTÍVEIS* (2010) by Rejane Cantoni and Leonardo Crescenti. ©Cantoni and Crescenti / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(c) *BI0FILM.NET: RESIST LIKE BACTERIA* (2022) by Jung Hsu and Natalia Rivera. ©Jung Hsu and Natalia Rivera / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.

Figure 2: Various Interpersonal Interactions Among Audience Members.

narrative, literally facing the stories of others. In *FUTURE KISS*, vibrating masks with kiss detectors invite participants to find and kiss their "other half." *ISHIN-DEN-SHIN* transmits whispered audio via the human body, turning physical touch into a conduit for intimate sonic exchange.

At the level of distributed collectivity and interpersonal dynamics, *THE KURAMOTO MODEL (1,000 FIREFLIES)* synchronizes the blinking of thousands of radio-connected bike lights across a city, generating emergent visual harmony. *REDES VESTÍVEIS / WEARABLE NETS* by Claudio Bueno invites participants into a virtual net visualized via smartphones, emphasizing collective spatial coordination. Hsu and Rivera's *BI0FILM.NET* transforms protest umbrellas into decentralized WiFi antennas—using interaction as a tool for resistance and communication infrastructure. Together, these works point towards the relational turn and anchor the paper's theoretical claims in situated practices that redefine interaction not as input–output exchange but as relationality.

7 A Relational (Re)Turn

As discussed earlier, interaction has narrowed from its original sociocultural meanings, i.e., reciprocity, mutual influence, and intersubjective dynamics, toward a technocentric paradigm dominated by human-computer interaction. Meanwhile, aesthetic discourse

has expanded from Kantian contemplation to participatory engagement, branching into techno-centered interactivity and socially-oriented relational aesthetics. These trajectories open a space for reconceptualizing interaction beyond technical mechanisms, but as situated, affective, and co-constitutive experience.

7.1 Relational Interaction

We call for intersubjective and interpersonal dynamics as the etymological and relational return to interaction and interactive art. As previously discussed in Sec. 2, the concept of interaction originated in sociocultural and communicative contexts, highlighting mutual influence, shared experience, and symbolic exchange. Over time, however, the notion of interaction was progressively narrowed within the human-computer and audience-artwork interaction paradigm, emphasizing input and output dynamics, interface control, and system responsiveness. While this technological framing enabled the emergence of interactive art as a formal genre, it also narrowly constrained interaction to mechanical.

By contrast, relational interaction reclaims the original breadth of the term. It prioritizes the formation of shared meaning, co-presence, and reciprocal engagement among participants, often mediated through, but not reducible to, artworks or technological systems. In this new framing, interaction becomes an embodied and intersubjective process of co-existence and mutual recognition. It can manifest in various artwork-mediated configurations, particularly in audience-audience engagement, producing dynamic interpersonal engagements where the artwork serves as an interface of relational exchange rather than a passive display system.

Relational interaction reframes interactivity as a socially situated and affectively resonant phenomenon by shifting focus away from isolated audience-artwork feedback loops and toward collective dynamics. It re-imagines interaction beyond manipulation of interactivity as a shared aesthetic and communicative encounter, recalling its etymological and theoretical roots while opening new possibilities for interactive art in contemporary contexts.

7.2 Towards Expanded Relationality

Building on the re-emphasis of relational interaction in interpersonal terms, this subsection further proposes an expanded understanding of relationality that moves beyond interpersonal and human–human relations toward a broader spectrum of intersubjective configurations, including interspecific, more-than-human, and planetary-scale entanglements. The redefinition of what counts as a "subject" in interaction opens the aesthetic and conceptual framework of interactive art to include nonhuman agencies, ecological systems, and distributed materialities. In this expanded frame, interaction becomes a site of encounter between heterogeneous entities, grounded in intersubjective responsiveness rather than control.

Philosophers such as Donna Haraway and Karen Barad have emphasized how intersubjectivity must be reconceived as an entangled intra-action, where entities do not precede their relations but rather emerge through them. This shift resonates with contemporary interactive artworks that involve plants, animals, microbial agents, AI systems, or data ecologies as co-creators or participants in aesthetic processes. This relational (re)turn toward expanded relationality extends the aesthetics and ethics of interaction, positioning interaction as a more-than-human practice, where affect, agency, and co-presence are distributed across human and nonhuman actors alike.

8 Conclusion

This paper proposes a relational (re)turn and techno relational aesthetics in interactive art that working towards expanded relationality in art practice and theory. It addresses the limitations of current human-computer paradigms by reconfiguring interaction through the lens of intersubjectivity in interaction and relationality in aesthetics.

The paper critiques the narrowing of "interaction" into HCI-based frameworks and previous interactive art studies, which privilege input/output, control, and responsiveness. It argues for a reclamation of interaction's sociocultural roots, emphasizing mutual influence, reciprocity, and symbolic exchange. This reorientation centers interaction as a relational and communicative encounter, not a technical function. The evolution of aesthetic theory culminates in the paper's proposal of Techno Relational Aesthetics, which synthesizes technological mediation as co-productive of affective, social, and intersubjective experiences. Rather than limiting interactivity to audience–artwork feedback loops, the paper foregrounds artwork-mediated audience–audience interaction in interactive art, where interaction becomes a social, embodied process and the artwork serves as the relational mediation.

The final claim of this paper extends relationality beyond the interpersonal and introduces expanded relationality as a framework toward interspecific, ecological, and planetary-scale interactions. Thus, interaction and interactive art can continue the practice of intersubjectivity and include nonhuman actors (plants, AI, data systems), leading to a co-becoming of more-than-human entanglements.

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A Framework for Analyzing XR Media Art through Impossible Spaces and Interaction Structures

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Abstract

Recent advancements in XR technology have fundamentally transformed the landscape of artistic spatial experience by enabling novel modes of spatial creation that transcend the constraints of physical reality within the field of media art. However, prior studies have remained largely focused on technological analysis and media-centered criteria, and no existing analytical framework simultaneously bridges the artist's creative strategies with participants' modes of engagement. This study addresses these developments by proposing a dual-axis analytical framework to systematically examine the spatial creation strategies and participant engagement modalities employed in XR-based media art. Moving beyond the limitations of existing research, which has predominantly focused on technological categorizations, this research emphasizes the intersection of spatial representation strategies and interaction structures as core components in understanding the distinctive expressive frameworks of XR media art. To this end, this study collected 100 XR media art cases published up to June 2025 and classified them based on two analytical axes: 'Impossible Spaces' and 'Interaction Structures.' Each axis was further subdivided into three hierarchical subcategories, and a cross-matrix visualization analysis was conducted. The analysis of impossible spaces revealed that 47% of the works corresponded to the 'Physical-Transcendent' category, highlighting the centrality of radical spatial design as a key strategy within XR media art. In terms of interaction modalities, Observational Interaction and Selection-based Interaction accounted for similar proportions, suggesting a prevailing tendency in XR media art to prioritize immersive sensory experience over deep interactivity. These findings substantiate the notion that spatial configurations and interaction structures function as independent artistic strategies, addressing existing theoretical gaps in the discourse on spatial strategy and modes of engagement in XR media art. Furthermore, the proposed framework provides practical guidance for future practices in the creation, curation, critique, and archiving of XR media art, offering concrete strategies for spatial design and interaction structuring.

CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts;

Keywords

Media Art, Extended Reality, Impossible Spaces, Interaction, Immersive Experience

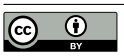
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1 Introduction

The recent rapid advancement of XR technology has opened new avenues for artistic experimentation through its convergence with media art, enabling creations that transcend the constraints of physical space [1]. In parallel with this development, XR media art, which utilizes XR technologies, has emerged, and this genre is defined as encompassing VR (Virtual Reality), AR (Augmented Reality), and MR (Mixed Reality) [2]. This technological shift has propelled media art beyond the realm of simple two-dimensional illusionistic effects, allowing participants to experience the sensation of being physically 'within' the artwork itself [1, 3]. In this process, space is no longer perceived as a passive backdrop that contains the work, but rather as a central subject and medium in its own right [4].

Particularly within XR-based media art, there is a pronounced tendency to manipulate or reconfigure space itself. Increasingly, virtual environments are being actively employed as independent artistic media [4, 5]. This phenomenon suggests that, within the field of media art, 'space' no longer serves merely to replicate physical dimensions but functions as a newly created and interpreted artistic construct.

However, systematic research that integrates and analyzes the structural characteristics of artistic spaces in XR-based media art,



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in conjunction with the modes of participant engagement within these spaces, remains exceedingly rare. Existing discussions have largely remained focused on medium-centered criteria, primarily technological categories such as VR, AR and MR [6, 7, 9], as well as related experiential factors like interactivity [7, 8] and immersion [7], which inherently stem from these technological foundations. Such studies have rarely shed light on how spatial representation strategies and modes of participant engagement are intertwined and how they collectively shape the experience of the artwork. This limitation hampers our ability to capture the unique modes by which XR media art 'creates' and 'enables the experience of' space, resulting in a theoretical gap in space-centered analysis.

To address this gap, the present study aims to examine XR media art cases through two complementary perspectives: the spatial creation strategies employed by artists and the modalities of participant engagement that interpret and transform these spaces. The objective is to derive an integrated and multidimensional understanding of how space is constructed and experienced. By adopting this dual approach, this research aims to complement existing limitations in XR media art research and establish a foundation for future studies.

This study introduces two key analytical criteria for examining how XR media artworks construct and facilitate the experience of space: impossible space realization and modalities of interaction. First, the level of impossible space realization refers to the extent to which the artist transcends physical reality to design and transform spatial structures. Second, the modalities of interaction between space and participants denote the degree to which the participants actively engage with or alter the spatial experience.

These two criteria highlight the distinctive aesthetic characteristics of XR-based media art. Such qualities are unattainable in traditional media, such as painting, sculpture, or video. Specifically, the level of impossible space realization reflects the formative strategies of spatial structure and artistic creation. Simultaneously, the modalities of interaction reveal the participatory nature of experience and the communicative structures between artwork and participants [8, 10]. These two criteria function as intricately interrelated artistic strategies. Therefore, this study proposes an analytical framework that simultaneously examines the artist's strategy for spatial creation and the participants' strategies for engagement, offering a multidimensional interpretation of how space is 'constructed' and 'experienced.'

This research is structured around the following two research questions:

RQ1. In what ways do contemporary XR media artworks realize 'impossible spaces'?

RQ2. In what ways do contemporary XR media artworks structure participants' interaction?

By proposing a dual classification system focused on spatial creation strategies and modalities of participant engagement, which are both fundamental to the expressive characteristics of XR media art, this study offers a comprehensive analytical framework that bridges expressive strategies and experiential structures. Furthermore, through a case-based qualitative analysis and visual matrix mapping of 100 XR-based media artworks published as of June 2025, this study systematically categorizes and visualizes trends and experimental characteristics.

This approach extends beyond existing technology classifications, providing practical contributions to space-centered media art criticism, creation, and curatorial practices. Ultimately, this research foregrounds the post-XR reality in which space functions as a core artistic medium, offering a novel contribution to the multidimensional interpretation of spatial aesthetics and participant structures within XR media art.

2 FRAMEWORK

2.1 Impossible Spaces in XR Media Art

The implementation of 'impossible spaces', which transcend the laws of physical reality, is a unique spatial expression achievable only through XR media. Unlike traditional painting, sculpture, and video which have historically represented the Euclidean space of the physical world through perspective and geometric rules [11–14], or distorted it through symbolism and the logic of the unconscious [15–17], XR advances this concept by enabling participants to experience structural distortion, transformation, and even spatial transcendence in real time. In other words, participants can explore spaces that do not exist in reality while being fully immersed within them through XR. The artistic exploration of such illusory spaces is not a new phenomenon; it has a long history extending back to antiquity [18]. Grau notes that the pursuit of illusory visual space dates back to ancient times, with each era deploying its available technologies to achieve the most compelling spatial illusions possible [19]. Through a genealogy that includes panoramas and immersive theaters, virtual reality distinguishes itself by enabling unprecedented spatial characteristics previously impossible, as Grau argues [19]. Specifically, XR surpasses the illusions of past art by offering participants a form of spatial experience in which they can physically exist [20].

The conceptual roots of 'impossible spaces' can thus be traced across philosophy and art history. In the early 20th century, Cubist and Futurist artists sought to dismantle conventional notions of space by integrating multiple perspectives or temporalities within a single frame, inspired by non-Euclidean geometry and the theory of relativity [17]. Artists contemporaneous with Einstein incorporated concepts of four-dimensional space and temporal integration into their works, influencing figures such as Duchamp and challenging static notions of space [17]. Media theorist Lev Manovich similarly points out how the history of cinema has concealed non-existent spaces. He explains that even analog cinema fabricated already impossible spaces through techniques such as models, mirrors, and matte paintings, while presenting them as if captured from reality [21]. Thus, even traditional cinema has created fictitious spaces through the use of special effects; however, XR explicitly foregrounds such fabrications and invites participants to explore them firsthand, marking a significant innovation.

The notion of Impossible Spaces or Post-Euclidean space has been variously theorized and discussed by scholars and artists. Media theorist Marcos Novak describes the contemporary era as having entered a post-Euclidean world, emphasizing unprecedented spatial concepts such as the architectural integration of time [22]. Numerous XR researchers have also demonstrated the capacity to realize physically impossible architectures in virtual environments, such as

infinite houses within a single room [23–26]. For example, in real-walking-based VR environments, participants can traverse multiple 'houses', while the actual physical space remains a singular infinite loop [23]. Such unreal spaces within XR embody spatial paradoxes that transcend physical laws by defying gravity, presenting endless paths, or overlapping places, thereby constituting a unique aesthetic intrinsic to XR [25]. Unlike past spatial deconstructions which remained confined to the tricks of flat canvases or screens, immersive interfaces and real-time 3D engines now expand these possibilities into dimensions participants can physically inhabit. Thus, the degree of impossible space realization serves as an index of how radically XR artworks deconstruct and reconfigure spatial norms. This criterion provides insights into the distinctive spatial aesthetics of XR art, which in turn may contribute to discussions on creativity and originality within this medium.

2.2 Interaction in XR Media Art

The second defining characteristic of XR art is the interaction between the space and the participant. In other words, XR artworks feature participatory structures in which the composition or progression dynamically responds to user input in real-time [5]. In traditional painting and sculpture, unidirectional appreciation is assumed. Film and video also provide fixed content without requiring physical engagement from the participant [27]. Conversely, XR environments allow participants to influence the content through bodily movement and choices, even co-constructing elements of narrative progression [28]. This bidirectionality marks a paradigm shift, transforming the participant from passive viewers to active users, as frequently noted in interactive art, where audiences become part of the artwork and contribute to its outcome [29]. The participatory nature of art can be traced back to the avant-garde of the 20th century, with examples such as Happenings and Fluxus wherein audience actions were essential to the completion of the artwork. Claire Bishop has emphasized the emergence of the 'active spectator' in contemporary installation art [30]. Bishop argues that, unlike traditional painting, installation art centers on the physical experience of the participant, completing the work through their presence within the space [30]. Moreover, Katja Kwastek offers a detailed analysis of how technical interfaces and user actions combine to produce new aesthetic experiences in interactive works [31]. Thus, discussions on interactivity have evolved from early digital art to contemporary XR, delineating categories and stages of audience participation.

Several theoretical efforts have sought to define the scope of interaction. Media theorist Steve Dixon categorized interactivity within the context of new media performance into four hierarchical stages: (1) Navigation, exploring provided spaces/routes; (2) Participation, engaging in active involvement to some extent; (3) Conversation, enabling bidirectional communication between system and user; (4) Collaboration, participants contributing as co-creators in the creative process [32]. Dixon suggests that a foundational element of 'play' underpins all these stages of interaction, highlighting that interactive art should offer participants active and enjoyable experiences [32]. Bonazzi classifies interaction based on the degree of audience involvement into passive interaction (merely observing or triggering minor sensor-based reactions), responsive interaction (artworks providing immediate feedback to audience actions), active interaction (audiences directly manipulating elements or influencing narrative developments), and co-creation (audiences acting as co-authors in content generation or story construction) [33]. While actual works often blend these categories into a continuum, such hierarchical frameworks serve as valuable analytical tools for discussing interactivity in XR works. Significantly, interactivity in XR extends beyond technological novelty to fulfill artistic functions by deepening sensory experiences, providing immediate feedback for immersion, and enabling participatory narrative restructuring [27]. Audiences no longer merely appreciate artworks but act within them. Therefore, XR art empowers participants as agents of personal experience, fundamentally redefining the relationship between art and audience [29].

2.3 Establishment a Classification Framework

To classify XR artworks based on the two axes discussed, specifically the degree of impossible space realization and interaction structure, this study designed each axis with further subdivided scales. The following section provides examples to illustrate how each of the two criteria has been subdivided, along with the rationale for their definitions and adoption.

2.3.1 Impossible Spaces. This criterion evaluates the extent to which a work transcends the laws of physical space. 'Physical-Fidelity' refers to virtual spaces adhering to the same physical rules as reality, while remaining within realistic 3D representations. Examples include 360-degree videos or realistic VR environments that do not exceed Euclidean space. 'Physical-Distortion' introduces partially unreal spatial effects. Users experience spatial distortions that are impossible in reality (e.g., areas without gravity, two rooms merged into one), but such impossibilities are limited to specific scenes or interactions. 'Physical-Transcendent' dismantles spatial laws throughout the work, presenting entirely new dimensions. This stage features Escher-like impossible architecture [34], endlessly looping spaces, or existing simultaneously in multiple locations, all of which are highly unreal elements. Works at the Physical-Transcendent level immerse participants in spatial logics fundamentally different from those of reality, with such spatial design serving as a core expressive element of the work. To enhance the reliability of these criteria, each stage of this classification references Milgram and Kishino [9]'s Reality-Virtuality Continuum and the three-tier classification system developed by Harris [35], which expands and specifies Milgram's model. This approach delineates a spatial spectrum progressing from Physical-Fidelity, through Physical-Distortion, to Physical-Transcendent (Figure 1).

2.3.2 Interaction. This criterion measures the level of user participation required and reflected in the work. 'Observational Interaction' involves minimal or limited interactivity. Participants may change viewing positions, but the work progresses unilaterally without responding to user actions. 'Selection-based Interaction' incorporates responsive interactions, providing feedback or branching paths based on user selections or clicks. Objects may react when approached in XR, or simple choices may slightly alter subsequent developments. However, the main narrative remains



Figure 1: Framework for Implementing Impossible Spaces.

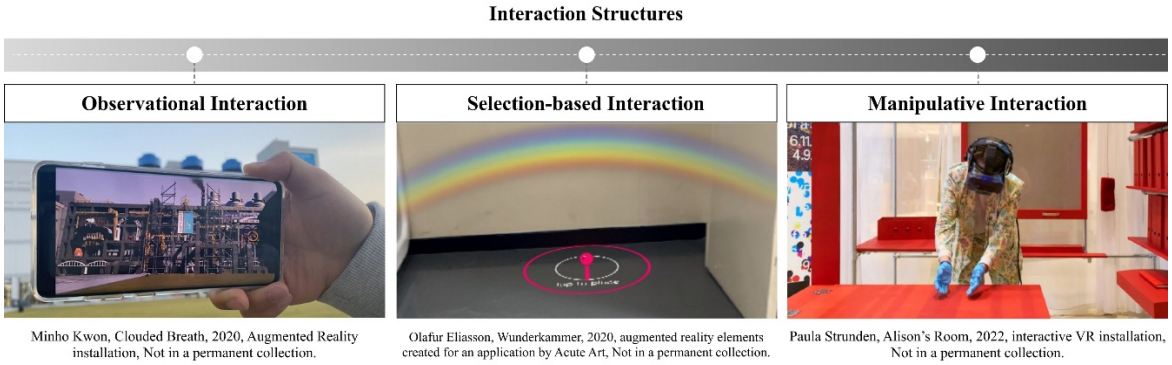


Figure 2: Framework for Interaction Structures

under the creator's control, with limited influence from the participant. 'Manipulative Interaction'enables participants to contribute fundamentally to the outcome or content. Participants actively manipulate environments and objects, providing creative inputs that result in co-created works in real-time. Examples include moving or transforming objects within the space or XR narratives with fully branching endings based on participant decisions. These distinctions are also supported by explicit indicators. This study references Bowman [36]'s 4 Categories of 3D Interaction Techniques and Jerald [20]'s VR Interaction Categories to derive three parallel criteria. Selection-based and Manipulation-based interactions align with Bowman [36] and Jerald [20], respectively. Although Observational Interaction is not included in their criteria, it is defined in this research due to the prevalence of non-interactive VR (e.g., 360° video, passive viewing) as a significant mode of engagement (Figure 2).

3 CASE ANALYSIS

This study selected XR-based media artworks published up until June 2025 through the following procedures. First, a comprehensive search was conducted using key XR-related terms such as 'Virtual Reality' and 'Augmented Reality' via search engines and the official archives of major media art museums and galleries. Second, to encompass the technological and conceptual origins of XR-based media art, works ranging from the 1970s to June 2025 were selected. Third, to ensure the credibility and representativeness of the works, data collection focused on authoritative institutions and platforms, including exhibitions at major media art museums and galleries, XR-related film festival entries, and media art exhibition archives. Fourth, to reflect the generational diversity and evolution in XR media art's expressive strategies, both emerging and established artists' experimental works were comprehensively included. Through this process, a total of 100 works were ultimately selected, with detailed information gathered for analysis purposes, including official descriptions from exhibition institutions and platforms, artist statements, on-site video documentation, critical reviews, and interview archives. These materials served as foundational resources for interpreting the spatial structures and participant engagement methods of each work.

The 100 collected works were classified according to the dual-axis analytical framework established in this study. The classification criteria are presented in Figures 1 and 2. Each work was analyzed through the following procedure based on the two axes established in this study. Initial classification was conducted based on archive documents and on-site materials. Various resources, including official documents, artist statements, exhibition videos, and interviews, were comprehensively reviewed, and two researchers independently conducted qualitative tagging. Subsequently, through

mutual discussion, the researchers reviewed the tagging results comprehensively and positioned each work within the dual-axis matrix according to the final agreed-upon criteria. Subsequently, the distribution patterns and tendencies across each axis were analyzed through the visualization of all 100 works on the cross-matrix. This analysis aimed to identify the density and interrelation of each typology, as well as differences in technological and aesthetic strategies.

3.1 Typology of Impossible Spaces

The 100 collected works were classified according to the level of impossible space realization as follows:

- Physical-Transcendent: 47 works
- Physical-Distortion: 46 works
- Physical-Fidelity: 7 works

Among the 100 collected works, those categorized under Physical-Transcendent (47%) and Physical-Distortion (46%) appeared in nearly equal proportions, indicating that the design of unreal spaces is a prominent strategy in XR media art. By contrast, works categorized under Physical-Fidelity accounted for only 7%, a markedly lower figure (Figure 3, A.1).

3.2 Typology of Interaction

The 100 collected works were classified according to interaction modalities with space as follows:

- Manipulative Interaction: 25 works
- Selection-based Interaction: 38 works
- Observational Interaction: 37 works

Among the 100 collected works, 37% were categorized under Observational Interaction, 38% under Selection-based Interaction, and 25% under Manipulative Interaction (Figure 3). Selection-based Interaction showed the highest proportion, whereas Manipulative Interaction appeared less frequently. However, the differences between categories were not substantial (B.3).

3.3 Matrix Mapping and Pattern Anlaysis

The cross-matrix visualizes the distribution of works according to the combination of the two axes (Figure 3).

(1) High-frequency pairings:

- Physical-Distortion / Selection-based Interaction: 21 works
- Physical-Transcendent / Observational Interaction: 18 works

(2) Low-frequency pairings:

- Physical-Fidelity / Observational Interaction: 3 works
- Physical-Fidelity / Manipulative Interaction: 0 works

These results indicate that pairings of Physical-Transcendent with Observational Interaction and Physical-Distortion with Selection-based Interaction appeared relatively frequently. Cases combining Physical-Fidelity with Observational Interaction were infrequent, and no cases combined Physical-Fidelity with Manipulative Interaction. The proportion of works utilizing Physical-Fidelity was notably low within XR media art, and cases combined with Observational Interaction were also minimal (C.1).

4 DISCUSSION

Through the classification of 100 XR-based media artworks according to the dual axes of impossible spatial structures and interaction structures, this study has identified several notable tendencies. Regarding the typology of impossible space, 47% of the works are categorized within the classification of Physical-Transcendent, the highest proportion among the classifications. This study indicates that radical spatial design, which transcends the norms of physical space, has become a core strategy within XR art. Conversely, only 7% of the works belong to the Physical-Fidelity category, suggesting that mere replication of physical space in XR lacks substantial artistic or experiential value. The Physical-Distortion category accounted for 46%, which can be interpreted as a strategy aimed at fostering participant immersion and cognitive tension through a manipulation of the boundary between realism and surrealism.

Regarding modalities of interaction, Observational Interaction accounted for 37% and Selection-based Interaction for 38%, presenting similar proportions. This research suggests that XR media art tends to prioritize sensory immersion or narrative-driven design over deep interactivity. By comparison, Manipulative Interaction accounted for only 25%, which may reflect practical limitations such as technical implementation difficulties and the preservation of artistic control. Furthermore, in the configurations of spatial structure and interaction, the most frequent pairings were Physical-Transcendent with Observational Interaction and Physical-Distortion with Selection-based Interaction. This result indicates that the degree of spatial unrealism does not necessarily correlate with the level of interaction, and these two elements function as independent strategies.

From an art criticism perspective, the most populated pairings, such as Physical-Distortion with Selection-based Interaction and Physical-Transcendent with Observational Interaction, can be interpreted as artists prioritizing immersive visual experiences. This study reflects a broader tendency in contemporary media art to utilize XR technologies not merely as tools for interaction but as means to enhance visual immersion and sensory experiences [19, 37]. From a strategic and design perspective, the near absence of works that combine Physical Fidelity with Manipulative Interaction is particularly noteworthy. This absence highlights the perceived redundancy of replicating real-world manipulation within XR environments and suggests that manipulation within XR spaces must be redefined to carry novel, differentiated meanings. Future creators must consider the creative and organic relationship between spatial design and manipulation, requiring a redefinition of interactivity.

The findings of this study closely align with established theories in virtual space and interaction art. Manovich identifies navigability within virtual spaces as a key feature of digital media, arguing that a user's active movement and exploration within virtual environments are central to narrative and psychological immersion [37]. As demonstrated by the findings of this research, many XR media artworks featuring transcendent spaces still rely on observational modes of interaction, indicating that the inherent navigability and interactivity of virtual spaces remain underutilized in current XR media art. This observation underscores potential avenues for future XR media art to evolve in accordance with Manovich's theoretical emphasis on enhanced spatial exploration. Additionally,

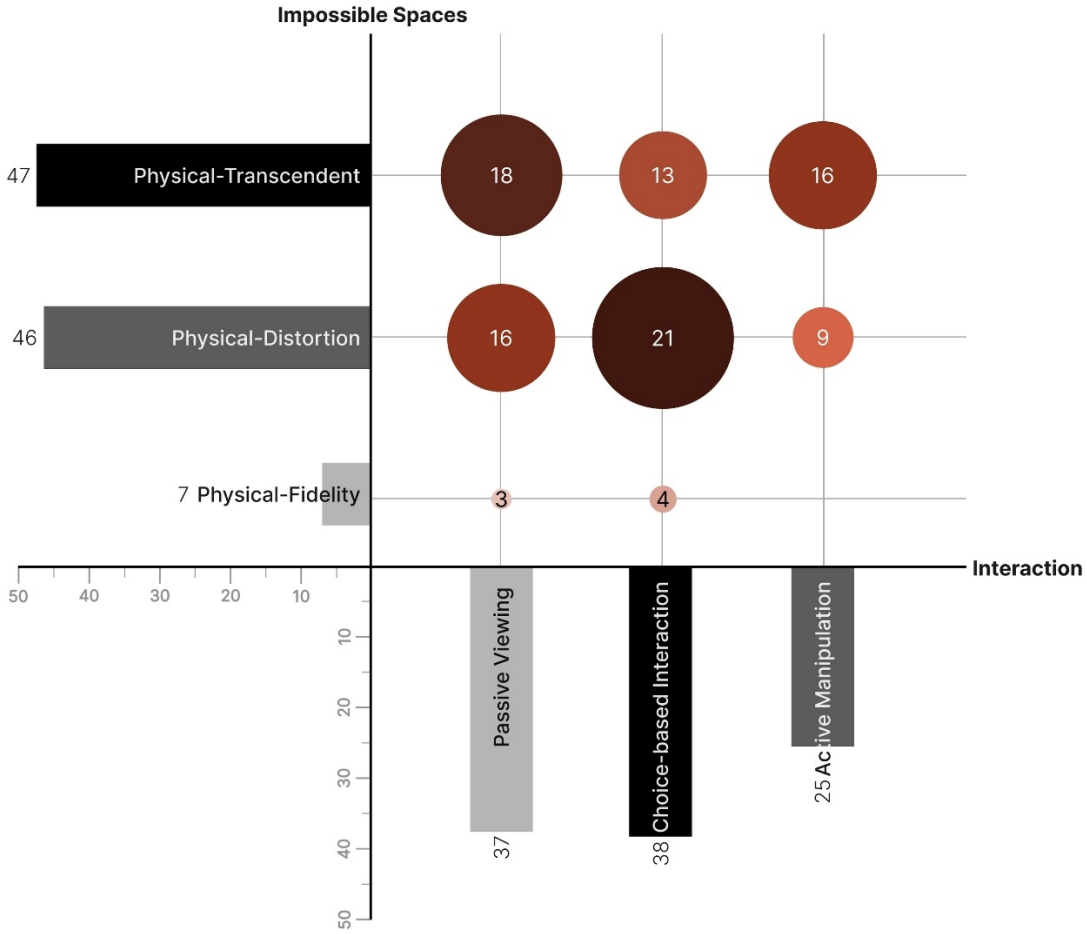


Figure 3: Matrix Map visualizing the proportions of artworks implementing Impossible Spaces and Interaction Structure.

Grau argues that immersive media environments facilitate cognitive immersion in ways distinct from physical reality, with spatial totality and visual sensory experiences at the core [19]. The frequent pairing of Physical-Transcendent spaces with Observational Interaction identified in this study demonstrates that participants can achieve immersion in unreal spaces through visual sensory experience alone, without the need for active manipulation. These findings substantiate Grau's theoretical assertions with concrete examples.

These discussions also resonate with recent studies in the field. Peng Liu et al. [38] argue that the application of multidimensional space concepts in VR environments expands temporality and spatiality in visual communication, categorizing spatial construction strategies in digital media art into three stages: physical space (3D), psychological space (4D, temporality), and surreal space (multidimensional). Consistent with this study's findings, XR media artworks actively employ transcendent spatial constructions that extend beyond physical reality, illustrating an evolution of VR-based art from the reproduction of physical spaces to expanded dimensions of time and space. This study's framework bears direct relevance to the key VR quality criteria, such as Immersivity, Interactivity, and Explorability, proposed by Hameed et al. [10]. These factors are highlighted as core determinants of VR experience quality, and this study demonstrates how they are concretely implemented and combined within XR media art through case-based analysis. Specifically, the configurations of spatial structure and modalities of interaction were empirically confirmed to diverge meaningfully according to design strategies for immersion and exploration, underscoring the need for multidimensional evaluation frameworks.

Furthermore, Lim et al. [39], building on Kwastek [40]'s classification system, conceptualize space, interaction, and sensory experience as core elements for archiving new media art, emphasizing the need to preserve processes by which participants interact and immerse themselves in artworks. The dual-axis analytical framework presented in this study aligns with these discussions. In particular, this framework provides a clear structure for organizing the sensory and interactional characteristics of spatial formation and participant engagement in XR media art, offering practical value for future applications in new media art archiving and experience-based preservation methodologies.

5 CONCLUSION

This research proposes a dual-axis classification framework focusing on spatial creation strategies and the modalities of interactive engagement within XR-based media artworks, validated through the analysis of 100 cases. This framework transcends conventional technology- or genre-based discussions by employing concrete, systematic criteria, specifically the level of spatial impossibility and participant engagement, to provide a multidimensional interpretation of XR art's expressive strategies and experiential structures.

Furthermore, this study presents an analytical framework that enables a comprehensive understanding of the spatial aesthetics and interaction strategies unique to XR media art. In this regard, it advances theoretical discussions on virtual space and immersive experience, previously articulated by theorists such as Manovich and Grau, through concrete case analyses. The findings empirically demonstrate that the strategies of spatial construction and participant interaction within XR media art do not invariably correspond proportionally or consistently; instead, they operate as distinct artistic strategies.

Moreover, this study provides a practical roadmap for XR-based artists and curators in devising spatial design and interactive strategies. The findings, which show that works combining high physical fidelity with simple manipulative interaction are infrequent, and that passive observation frequently occurs even within surreal environments, offer foundational insights into future directions for XR art in terms of expression and experience design. These insights may serve as a valuable reference for artists seeking to concretize spatial creation and interaction strategies in their work.

Future research building on this study will be required to address the following limitations identified within its current scope of inquiry. While this research analyzes 100 works, the limited sample size cannot encompass the entirety of XR media art. Additionally, the classification centers on spatial structures and interaction modalities, without incorporating temporal or narrative elements. Future research should consider multi-layered analyses encompassing storytelling structures and the temporal flow of user immersion.

Further validation of the dual-axis framework through quantitative analysis and user experience experiments would strengthen its validity. Such efforts could elucidate the concrete effects of spatial structures and interaction modes on user experience in XR media art. As XR technologies evolve, continual refinement of the framework, particularly in response to emerging technologies such as AI and multimodal sensory interfaces, will be essential.

Ultimately, this study confirms that space functions as a core medium in XR media art and systematically examines 100 contemporary XR media artworks through a framework that analyzes spatial creation strategies and participant engagement structures. Through this analytical framework, the present study offers a foundational basis for understanding the relationship between space and interaction in the creation and critique of XR media art.

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Table 1: Typology of Impossible Space – Physical-Fidelity Artwork

No.	Title	Artist	Year	Output Medium
1	CARNE y ARENA (Virtually Present, Physically Invisible)	Alejandro G. Iñárritu	2017	Interactive VR installation
2	Guardians of Oksan	Hayoun Kwon	2024	Interactive VR installation
3	LOGICS OF GOLD	Marie Lienhard	2019	360° VR installation
4	Live-VR Corridor	Bruce Nauman	1970	Painted wallboard, video camera, two video monitors, video recording, and video playback device, dimensions variable
5	Modigliani VR: The Ochre Atelier	Tate	2018	6DoF VR experience
6	She's Already Gone	Yu Hong	2017	6DoF immersive VR
7	Thresholds	Mat Collishaw	2017	6DoF interactive VR installation, mixed media

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A A Typology of Impossible Space

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C C Artwork Classification based on a cross matrix

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C.6 Physical-Transcendent & Observational Interaction Artwork

C.7 Physical-Transcendent & Selection-based Interaction Artwork

C.8 Physical-Transcendent & Manipulative Interaction Artwork

Table 2: Typology of Impossible Space – Physical-Distortion Artwork

No.	Title	Artist	Year	Output Medium
1	AR Truisms	Jenny Hozer	2019	Augmented Reality installation
2	Alison's Room	Paula Strunden	2022	Interactive VR installation
3	Angels of Amsterdam	Anna Abrahams, Avinash Changa	2021	360° immersive VR
4	Atmospheric Forest VR	Rasa Smite and Raitis Smits	2020	VR installation
5	Awavena	Lynette Wallworth	2018	360° immersive VR
6	Bayi Gardiya(Singing Desert)	Christian Thompson	2019	360° immersive VR
7	Bloom: Open Space	Brian Eno, Peter Chilvers	2019	Mixed-Reality installation
8	Body of Mine	Cameron Kostopoulos	2023	VR interactive Experience
9	CENTO	Nancy Baker Cahill	2023	AR Sculpture
10	Clouded Breath	Minho Kwon	2020	Augmented Reality installation
11	Companion(Expanded)	KAWS	2023	Augmented Reality sculpture
12	Current	Anke Schiemann	2024	Interactive AR experience
13	Data Chromesthesia	Felipe Pantone	2024	Augmented Reality installation
14	Did you ask the river?	Joan Ross	2019	6DoF interactive VR
15	ELEKTRA Virtual Museum	ELEKTRA Montréal	2025	6DoF interactive VR
16	Fragments of Babel AR	Yun Park	2024	Augmented Reality installation
17	Hereafter Institute	Gabriel Barcia-Colombo	2017	6DoF immersive VR
18	Image Technology Echoes	Lauren Moffat	2020	6DoF interactive VR
19	In The Eyes of The Animals	Marshmallow Laser Feast	2015	VR film
20	Kubo, Walks the city	Kwon Hayoun	2021	Interactive VR installation
21	Life Without Matter	Rebecca Allen	2018	6DoF interactive VR installation
22	Luminescence	Anke Schiemann	2024	Interactive mixed reality performance
23	Lunatick	Antony Gormley	2019	VR film
24	Memory Theater VR	Agnes Hegedüs	1997	Interactive computer-based installation
25	Mixed Signals	kennedy+swan	2023	Interactive AR work series of 18 augmented watercolor paintings, 85 x 60cm
26	Montegelato	Davide RAPP	2021	360° VR Film
27	Motherboard	Nancy Baker Cahill	2021	AR Sculpture
28	Oneroom-Babel	Sanghee	2023	6DoF interactive VR
29	Phantasmagoria Concert	Hsin-Chien Huang	2019	Augmented Reality electronic music concert
30	Planet City	Liam Young	2021	6DoF immersive VR
31	Plastocene Reef	Tamiko Thiel	2025	Augmented Reality enhanced wall installation
32	Power Plants OS	Hito Steyerl	2019	Augmented Reality Multimedia video-sculpture installation
33	Rising	Marina Abramovic	2017	Interactive VR
34	Scarecrow VRC	Korea National University Art & Technology Lab	2020	VR immersive theater
35	Sleepwalking in the Forbidden City	Cai Guo-Qiang	2020	360° VR Film, Alabaster model
36	Spectral Haven	ZKM	2024	6DoF VR experience
37	Starry Sand Beach	Hsin-Chien Huang	2021	6DoF Interactive VR experience
38	Survival Machines AR	Anke Schiemann	2023	Augmented Reality Sculpture
39	Survival Machines VR	Anke Schiemann	2023	6DOF Interactive VR installation
40	The Eternal Wave: Li Nova	Cao Fei	2020	360° immersive VR installation
41	Three States of Home Gazing VR	Hsin-Chien Huang	2020	6DoF Interactive VR experience
42	Treehugger: Wawona	Marshmallow Laser Feast	2018	Multisensory mixed reality installation
43	Unmoored	Mel Chin	2018	Mixed Reality installation
44	Vera Plastica	Tamiko Thiel	2024	Generative augmented reality installation
45	Virtual Leonardo's Submarine	Hito Steyerl	2020	6DoF immersive VR
46	Wunderkammer	Olafur Eliasson	2020	Augmented Reality installation

Table 3: Typology of Impossible Space – Physical- Transcendent Artwork

No.	Title	Artist	Year	Output Medium
1	10.000 Moving Cities	Marc Lee	2015	Interactive Net- and Telepresence-Based Installation
2	ANANDALA	Kevin Mack	2021	6DoF immersive VR
3	ATUA	FAFSWAG	2022	Augmented Reality sculpture
4	Always I Distrust	Cheng Ran	2020	360° immersive VR
5	Amaryllis VR: Ocean	Mariam Zakarian	2017	360° immersive VR
6	Atmos Aphaerae	Tamiko Thiel	2021	360° stereoscopic virtual reality video
7	Blortasia	Kevin Mack	2017	6DoF Interactive VR
8	Bodyless	Hsin-Chien Huang	2020	6DoF Interactive VR installation
9	CAON	Marc Lee	2023	Augmented Reality sculpture
10	CASSANDRA ROOMS	Anke Schiemann	2022	Interactive social web VR space
11	Éphémère	Char Davies	1998	Immersive VR
12	Endodrome	Dominique Gonzalez-Foerster	2023	360° immersive VR
13	Evolver	Marshmallow Laser Feast	2022	360° immersive VR installation
14	HanaHana	Mélodie Mousset	2016	6DoF interactive VR
15	I Came and Went as A Ghost Hand (Cycle 2)	Rachel Rossin	2015	360° immersive VR
16	INSIDE	Rebecca Allen	2016	6DoF Interactive VR
17	ITO MEIKYU	Boris Labbé	2024	6DoF VR installation
18	In the Current of Being	Cameron Kostopoulos	2025	Interactive VR, Haptic
19	Into Yourself, Fall	Anish Kapoor	2018	VR film
20	Ixian Gate	Jess Johnson, Simon Ward	2015	6DoF immersive VR Installation
21	I'm Terribly Sorry	Rachel Maclean	2018	6DoF interactive VR
22	La Camera Insabbiata VR	Hsin-Chien Huang	2017	6DoF Interactive VR installation
23	Man Mask	Rachel Rossin	2016	360° stereoscopic virtual reality video
24	Metapanorama	Dominique Gonzalez-Foerster	2022	360° immersive VR
25	Morphogenesis VR	Can Buyukberber, Yagmur Uyanik	2016	360° immersive VR
26	NAMUANKI	Kevin Mack	2022	6DoF Interactive VR
27	n-Cave	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2021	Interactive VR meditation space driven by real-time data
28	Notes on Blindness	Arnaud Colinart	2016	Immersive VR film
29	Osmose	Char Davies	1995	Interactive VR installation
30	Presence	Antoine Saint Maur	2022	Live immersive theater in the metaverse
31	R for Resonance	Ho Tzu Nyen	2019	360° immersive VR
32	Rainbow	Olafur Eliasson	2017	6DoF interactive VR
33	Samsara	Hsin-Chien Huang	2021	6DoF Interactive VR
34	Sculpture Park	Xavier Veilhan	2023	6DoF immersive VR
35	Solarceptors	Rasa Smite and Raitis Smits	2025	VR installation
36	Switchstance bay	Erik Parker	2016	6DoF immersive VR
37	Terminus	Jess Johnson, Simon Ward	2018	6DoF immersive VR Installation
38	The EYE AND I	Hsin-Chien Huang	2023	6DoF Interactive VR
39	The Jellyfish	Mélodie Mousset, Edo Fouilloux	2019	Interactive VR, sound visualization, voice-responsive synthesis
40	The Museum of Other Realities	MOR Museum Inc.	2020	Interactive VR with multi-player
41	The Mutual Penetration of Physical and Virtual Bodies	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2022	360° Interactive VR
42	The Sky is a Gap	Rachel Rossin	2017	Mixed media with VR video
43	To the Moon	Hsin-Chien Huang	2018	6DoF Interactive VR installation
44	Transdimensional Serpent	Jon Rafman	2016	6DoF immersive VR
45	What is it like to be a (virtual) bat? Phase IV	Zheng Mahler	2023	360° immersive VR
46	Zen Parade	Kevin Mack	2015	6DoF immersive VR
47	Zero Days VR	Yasmin Elayat	2017	Immersive VR film

Table 4: Typology of Interaction– Observational Interaction Artwork

No.	Title	Artist	Year	Output Medium
1	Always I Distrust	Cheng Ran	2020	360° immersive VR
2	Amaryllis VR: Ocean	Mariam Zakarian	2017	360° immersive VR
3	Angels of Amsterdam	Anna Abrahams, Avinash Changa	2021	360° immersive VR
4	Atmos Aphaerae	Tamiko Thiel	2021	360° stereoscopic virtual reality video
5	Awavena	Lynette Wallworth	2018	360° immersive VR
6	Bayi Gardiya(Singing Desert)	Christian Thompson	2019	360° immersive VR
7	Clouded Breath	Minho Kwon	2020	Augmented Reality installation
8	Endodrome	Dominique Gonzalez-Foerster	2023	360° immersive VR
9	Evolver	Marshmallow Laser Feast	2022	360° immersive VR installation
10	I Came And went as A Ghost Hand (Cycle 2)	Rachel Rossin	2015	360° immersive VR
11	In The Eyes Of The Animals	Marshmallow Laser Feast	2015	VR film
12	In the Current of Being	Cameron Kostopoulos	2025	Interactive VR, Haptic
13	Into Yourself, Fall	Anish Kapoor	2018	VR film
14	Ixian Gate	Jess Johnson, Simon Ward	2015	6DoF immersive VR Installation
15	LOGICS OF GOLD	Marie Lienhard	2019	360° virtual reality installation
16	Lunatick	Antony Gormley	2019	VR film
17	Metapanorama	Dominique Gonzalez-Foerster	2022	360° immersive VR
18	Modigliani VR: The Ochre Atelier	Tate	2018	6DoF VR experience
19	Montegelato	Davide RAPP	2021	360° VR Film
20	Morphogenesis VR	Can Buyukberber, Yagmur Uyanik	2016	360° immersive VR
21	Notes on Blindness	Arnaud Colinart	2016	Immersive VR film
22	Phantasmagoria Concert	Hsin-Chien Huang	2019	Augmented Reality electronic music concert
23	Planet City	Liam Young	2021	6DoF immersiveVR
24	Plastocene Reef	Tamiko Thiel	2025	Augmented Reality enhanced wall installation
25	Presence	Antoine Saint Maur	2022	Live immersive theater in the metaverse
26	R for Resonance	Ho Tzu Nyen	2019	360° immersive VR
27	She's Already Gone	Yu Hong	2017	6DoF immersive VR
28	Sleepwalking in the Forbidden City	Cai Guo-Qiang	2020	360° VR Film, Alabaster model
29	Survival Machines AR	Anke Schiemann	2023	Augmented Reality Sculpture
30	Terminus	Jess Johnson, Simon Ward	2018	6DoF immersive VR Installation
31	Transdimensional Serpent	Jon Rafman	2016	6DoF immersive VR
32	Treehugger: Wawona	Marshmallow Laser Feast	2018	Multisensory mixed reality installation
33	Unmoored	Mel Chin	2018	Mixed Reality installation
34	Vera Plastica	Tamiko Thiel	2024	Generative augmented reality installation
35	Virtual Leonardo's Submarine	Hito Steyerl	2020	6DoF immersive VR
36	What is it like to be a (virtual) bat? Phase IV	Zheng Mahler	2023	360° immersive VR
37	Zero Days VR	Yasmin Elayat	2017	Immersive VR film

Table 5: Typology of Interaction– Selection-based Interaction Artwork

No.	Title	Artist	Year	Output Medium
1	10.000 Moving Cities	Marc Lee	2015	Interactive Net- and Telepresence-Based Installation
2	ANANDALA	Kevin Mack	2021	6DoF immersive VR
3	AR Truisms	Jenny Hozer	2019	Augmented Reality installation
4	ATUA	FAFSWAG	2022	Augmented Reality sculpture
5	Atmospheric Forest VR	Rasa Smite and Raitis Smits	2020	VR installation
6	Blortasia	Kevin Mack	2017	6DoF Interactive VR
7	CARNE y ARENA (Virtually Present, Physically Invisible)	Alejandro G. Iñárritu	2017	Interactive VR installation
8	CASSANDRA ROOMS	Anke Schiemann	2022	Interactive social web VR space
9	CENTO	Nancy Baker Cahill	2023	AR Sculpture
10	Companion(Expanded)	KAWS	2023	Augmented Reality sculpture
11	Current	Anke Schiemann	2024	interactive AR experience
12	Data Chromesthesia	Felipe Pantone	2024	Augmented Reality installation
13	ELEKTRA Virtual Museum	ELEKTRA Montréal	2025	6DoF interactive VR
14	Fragments of Babel AR	Yun Park	2024	Augmented Reality installation
15	Guardians of Oksan	Hayoun Kwon	2024	Interactive VR installation
16	Hereafter Institute	Gabriel Barcia-Colombo	2017	6DoF immersive VR
17	ITO MEIKYU	Boris Labbé	2024	6DoF VR installation
18	Image Technology Echoes	Lauren Moffat	2020	6DoF interactive VR
19	Kubo, Walks the city	Kwon Hayoun	2021	Interactive VR installation
20	Live-VR Corridor	Bruce Nauman	1970	Painted wallboard, video camera, two video monitors, video recording, and video playback device, dimensions variable
21	Luminescence	Anke Schiemann	2024	Interactive mixed reality performance
22	Man Mask	Rachel Rossin	2016	360° stereoscopic virtual reality video
23	Memory Theater VR	Agnes Hegedüs	1997	Interactive computer-based installation
24	Mixed Signals	kennedy+swan	2023	Interactive AR work series of 18 augmented watercolor paintings, 85 x 60cm
25	Motherboard	Nancy Baker Cahill	2021	AR Sculpture
26	n-Cave	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2021	Interactive VR meditation space driven by real-time data
27	Oneroom-Babel	Sanghee	2023	6DoF interactive VR
28	Power Plants OS	Hito Steyerl	2019	Augmented Reality Multimedia video-sculpture installation
29	Sculpture Park	Xavier Veilhan	2023	6DoF immersive VR
30	Solarceptors	Rasa Smite and Raitis Smits	2025	VR installation
31	Spectral Haven	ZKM	2024	6DoF VR experience
32	Survival Machines VR	Anke Schiemann	2023	6DOF Interactive VR installation
33	Switchstance bay	Erik Parker	2016	6DoF immersive VR
34	The Eternal Wave: Li Nova	Cao Fei	2020	360° immersive VR installation
35	The Sky is a Gap	Rachel Rossin	2017	Mixed media with VR video
36	Thresholds	Mat Collishaw	2017	6DoF interactive VR installation, mixed media
37	Wunderkammer	Olafur Eliasson	2020	Augmented reality installation
38	Zen Parade	Kevin Mack	2015	6DoF immersive VR

Table 6: Typology of Interaction– Manipulative Interaction Artwork

No.	Title	Artist	Year	Output Medium
1	Alison's Room	Paula Strunden	2022	Interactive VR installation
2	Bloom: Open Space	Brian Eno, Peter Chilvers	2019	Mixed-Reality installation
3	Body of Mine	Cameron Kostopoulos	2023	VR interactive Experience
4	Bodyless	Hsin-Chien Huang	2020	6DoF Interactive VR installation
5	CAON	Marc Lee	2023	Augmented Reality sculpture
6	Did you ask the river?	Joan Ross	2019	6DoF interactive VR
7	Éphémère	Char Davies	1998	Immersive VR
8	HanaHana	Mélodie Mousset	2016	6DoF interactive VR
9	INSIDE	Rebecca Allen	2016	6DoF Interactive VR
10	I'm Terribly Sorry	Rachel Maclean	2018	6DoF interactive VR
11	La Camera Insabbiata VR	Hsin-Chien Huang	2017	6DoF Interactive VR installation
12	Life Without Matter	Rebecca Allen	2018	6DoF interactive VR installation
13	NAMUANKI	Kevin Mack	2022	6DoF Interactive VR
14	Osmose	Char Davies	1995	Interactive VR installation
15	Rainbow	Olafur Eliasson	2017	6DoF interactive VR
16	Rising	Marina Abramovic	2017	Interactive VR
17	Samsara	Hsin-Chien Huang	2021	6DoF Interactive VR
18	Scarecrow VRC	Korea National University Art & Technology Lab	2020	VR immersive theater, multi-player
19	Starry Sand Beach	Hsin-Chien Huang	2021	6DoF Interactive VR experience
20	The EYE AND I	Hsin-Chien Huang	2023	6DoF Interactive VR
21	The Jellyfish	Mélodie Mousset, Edo Fouilloux	2019	Interactive VR, sound visualization, voice-responsive synthesis
22	The Museum of Other Realities	MOR Museum Inc.	2020	Interactive VR with multi-player
23	The Mutual Penetration of Physical and Virtual Bodies	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2022	360° Interactive VR, multi-player
24	Three States of Home Gazing VR	Hsin-Chien Huang	2020	6DoF Interactive VR experience
25	To the Moon	Hsin-Chien Huang	2018	6DoF Interactive VR installation

Table 7: Physical-Fidelity & Observational Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	LOGICS OF GOLD	Marie Lienhard	2019	360° virtual reality installation
2	Modigliani VR: The Ochre Atelier	Tate	2018	6DoF VR experience
3	She's Already Gone	Yu Hong	2017	6DoF immersive VR

Table 8: Physical-Fidelity & Selection-based Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	CARNE y ARENA (Virtually Present, Physically Invisible)	Alejandro G. Iñárritu	2017	Interactive VR installation
2	Guardians of Oksan	Hayoun Kwon	2024	Interactive VR installation
3	Live-VR Corridor	Bruce Nauman	1970	Painted wallboard, video camera, two video monitors, video recording, and video playback device, dimensions variable
4	Thresholds	Mat Collishaw	2017	6DoF interactive VR installation, mixed media

Table 9: Physical-Distortion & Observational Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	Angels of Amsterdam	Anna Abrahams, Avinash Changa	2021	360° immersive VR
2	Awavena	Lynette Wallworth	2018	360° immersive VR
3	Bayi Gardiya(Singing Desert)	Christian Thompson	2019	360° immersive VR
4	Clouded Breath	Minho Kwon	2020	Augmented Reality installation
5	In The Eyes Of The Animals	Marshmallow Laser Feast	2015	VR film
6	Lunatick	Antony Gormley	2019	VR film
7	Montegelato	Davide RAPP	2021	360° VR Film, single-player, sound, color
8	Phantasmagoria Concert	Hsin-Chien Huang	2019	Augmented Reality electronic music concert
9	Planet City	Liam Young	2021	6DoF VR experience, sound, color
10	Plastocene Reef	Tamiko Thiel	2025	Augmented Reality enhanced wall installation
11	Sleepwalking in the Forbidden City	Cai Guo-Qiang	2020	360° VR Film, Alabaster model
12	Survival Machines AR	Anke Schiemann	2023	Augmented Reality Sculpture
13	Treehugger: Wawona	Marshmallow Laser Feast	2018	Multisensory mixed reality installation
14	Unmoored	Mel Chin	2018	Mixed Reality installation
15	Vera Plastica	Tamiko Thiel	2024	Generative augmented reality installation
16	Virtual Leonardo's Submarine	Hito Steyerl	2020	6DoF immersive VR

Table 10: Physical-Distortion & Selection-based Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	AR Truisms	Jenny Hozer	2019	Augmented Reality installation
2	Atmospheric Forest VR	Rasa Smite and Raitis Smits	2020	VR installation
3	CENTO	Nancy Baker Cahill	2023	AR Sculpture
4	Companion(Expanded)	KAWS	2023	Augmented Reality sculpture
5	Current	Anke Schiemann	2024	Interactive AR experience
6	Data Chromesthesia	Felipe Pantone	2024	augmented reality installation
7	ELEKTRA Virtual Museum	ELEKTRA Montréal	2025	6DoF interactive VR
8	Fragments of Babel AR	Yun Park	2024	Augmented Reality installation
9	Hereafter Institute	Gabriel Barcia-Colombo	2017	6DoF immersive VR
10	Image Technology Echoes	Lauren Moffat	2020	6DoF interactive VR
11	Kubo, Walks the city	Kwon Hayoun	2021	Interactive VR installation
12	Luminescence	Anke Schiemann	2024	Interactive mixed reality performance
13	Memory Theater VR	Agnes Hegedüs	1997	Interactive computer-based installation
14	Mixed Signals	kennedy+swan	2023	Interactive AR work series of 18 augmented watercolor paintings, 85 x 60cm
15	Motherboard	Nancy Baker Cahill	2021	AR Sculpture
16	Oneroom-Babel	Sanghee	2023	6DoF interactive VR
17	Power Plants OS	Hito Steyerl	2019	Augmented Reality Multimedia video-sculpture installation
18	Spectral Haven	ZKM	2024	6DoF VR experience
19	Survival Machines VR	Anke Schiemann	2023	6DOF Interactive VR installation
20	The Eternal Wave: Li Nova	Cao Fei	2020	360° immersive VR installation
21	Wunderkammer	Olafur Eliasson	2020	Augmented reality installation

Table 11: Physical-Distortion & Manipulative Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	Alison's Room	Paula Strunden	2022	Interactive VR installation
2	Bloom: Open Space	Brian Eno, Peter Chilvers	2019	Mixed-Reality installation
3	Body of Mine	Cameron Kostopoulos	2023	VR interactive Experience
4	Did you ask the river?	Joan Ross	2019	6DoF interactive VR
5	Life Without Matter	Rebecca Allen	2018	6DoF interactive VR installation
6	Rising	Marina Abramovic	2017	Interactive VR
7	Scarecrow VRC	Korea National University Art & Technology Lab	2020	VR immersive theater, multi-player
8	Starry Sand Beach	Hsin-Chien Huang	2021	6DoF Interactive VR experience
9	Three States of Home Gazing VR	Hsin-Chien Huang	2020	6DoF Interactive VR experience

Table 12: Physical-Transcendent & Observational Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	Always I Distrust	Cheng Ran	2020	360° immersive VR
2	Amaryllis VR: Ocean	Mariam Zakarian	2017	360° immersive VR
3	Atmos Aphaerae	Tamiko Thiel	2021	360° stereoscopic virtual reality video
4	Endodrome	Dominique Gonzalez-Foerster	2023	360° immersive VR
5	Evolver	Marshmallow Laser Feast	2022	360° immersive VR installation
6	I Came And Went As A Ghost Hand (Cycle 2)	Rachel Rossin	2015	360° immersive VR
7	In the Current of Being	Cameron Kostopoulos	2025	Interactive VR, Haptic
8	Into Yourself, Fall	Anish Kapoor	2018	VR film
9	Ixian Gate	Jess Johnson, Simon Ward	2015	6DoF immersive VR Installation
10	Metapanorama	Dominique Gonzalez-Foerster	2022	360° immersive VR
11	Morphogenesis VR	Can Buyukberber, Yagmur Uyanik	2016	360° immersive VR
12	Notes on Blindness	Arnaud Colinart	2016	Immersive VR film
13	Presence	Antoine Saint Maur	2022	Live immersive theater in the metaverse
14	R for Resonance	Ho Tzu Nyen	2019	360° immersive VR
15	Terminus	Jess Johnson, Simon Ward	2018	6DoF immersive VR Installation
16	Transdimensional Serpent	Jon Rafman	2016	6DoF immersive VR
17	What is it like to be a (virtual) bat? Phase IV	Zheng Mahler	2023	360° immersive VR
18	Zero Days VR	Yasmin Elayat	2017	Immersive VR film

Table 13: Physical-Transcendent & Observational Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	10.000 Moving Cities	Marc Lee	2015	Interactive Net- and Telepresence-Based Installation
2	ANANDALA	Kevin Mack	2021	6DoF immersive VR
3	ATUA	FAFSWAG	2022	Augmented Reality sculpture
4	Blortasia	Kevin Mack	2017	6DoF Interactive VR
5	CASSANDRA ROOMS	Anke Schiemann	2022	Interactive social web VR space
6	ITO MEIKYU	Boris Labbé	2024	6DoF VR installation
7	Man Mask	Rachel Rossin	2016	360° stereoscopic virtual reality video
8	n-Cave	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2021	Interactive VR meditation space driven by real-time data
9	Sculpture Park	Xavier Veilhan	2023	6DoF immersive VR
10	Solarceptors	Rasa Smite and Raitis Smits	2025	VR installation
11	Switchstance bay	Erik Parker	2016	6DoF immersive VR
12	The Sky is a Gap	Rachel Rossin	2017	Mixed media with VR video
13	Zen Parade	Kevin Mack	2015	6DoF immersive VR

Table 14: Physical-Transcendent & Manipulative Interaction Artwork list

No.	Title	Artist	Year	Output Medium
1	Bodyless	Hsin-Chien Huang	2020	6DoF Interactive VR installation
2	CAON	Marc Lee	2023	Augmented Reality sculpture
3	Éphémère	Char Davies	1998	Immersive VR
4	HanaHana	Mélodie Mousset	2016	6DoF interactive VR
5	INSIDE	Rebecca Allen	2016	6DoF Interactive VR
6	I'm Terribly Sorry	Rachel Maclean	2018	6DoF interactive VR
7	La Camera Insabbiata VR	Hsin-Chien Huang	2017	6DoF Interactive VR installation
8	NAMUANKI	Kevin Mack	2022	6DoF Interactive VR
9	Osmose	Char Davies	1995	Interactive VR installation
10	Rainbow	Olafur Eliasson	2017	6DoF interactive VR
11	Samsara	Hsin-Chien Huang	2021	6DoF Interactive VR
12	The EYE AND I	Hsin-Chien Huang	2023	6DoF Interactive VR
13	The Jellyfish	Mélodie Mousset, Edo Fouilloux	2019	Interactive VR, sound visualization, voice-responsive synthesis
14	The Museum of Other Realities	MOR Museum Inc.	2020	Interactive VR with multi-player
15	The Mutual Penetration of Physical and Virtual Bodies	'EPHEMERA ONE (Daria Smakhtina, Vandim Smakhtina)	2022	360° Interactive VR, multi-player
16	To the Moon	Hsin-Chien Huang	2018	6DoF Interactive VR installation

Strategic Design Framework for Surrealistic Spaces in Virtual Reality

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Abstract

Surrealism is an artistic movement that subverts the boundaries of reality through dreams, the unconscious, and chance, thereby fostering creative thinking and emotional liberation. Today, advances in digital technology, particularly the adoption of virtual reality (VR) technology, have made imaginary spaces perceived as real, thereby suggesting a potential to bring the experience of surrealism from art into the dimension of space. Nevertheless, existing attempts remain largely fragmented and experimental, lacking systematic guidelines and empirical evidence that practitioners rely upon. Therefore, the study aims to bridge the existing gap by identifying four core characteristics of surrealism, followed by four corresponding spatial design principles. The relationship between the two is formalized as 32q 1“1211“1q12w3rfdcx’Alz conceptual framework for surrealistic spatial design, accompanied by a range of empirical implementation strategies. The framework is examined for its practical applicability and potential for broader implementation by analyzing existing VR content through the lens of the framework. Through this, the present study provides a reliable foundation for surrealist spatial designers and researchers, and contributes to expanding the scope of aesthetic engagement for the public. This lays the groundwork for the creative potential of surrealism to be transformed into human-centered VR spatial experiences.

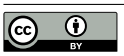
CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Surrealism, VR Space Design, Design Framework, Spatial Experience

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1 Introduction

Surrealism explores dreams, the unconscious, and imagination, offering expressions that transcend conventional logic [1]. This cultural movement has disrupted traditional forms in painting, sculpture, and literature to create unreal, dreamlike imagery. By stimulating the psyche and imagination, surrealism extends everyday life's boundaries, restoring creative thought and emotional balance. Today, with digital technologies enabling imagined worlds, surrealism is increasingly recognized as a key resource for reconfiguring artistic practices, spatial design, and psychological experience [2].

However, material constraints bind architecture to reality, limiting its integration of surrealism compared to media like painting or film [3, 4]. Consequently, surrealism in architecture mainly envisions utopian spaces through perceptual shifts rooted in fantasy, rather than transforming physical space literally [5]. Surrealistic spatial experiences have more often been realized indirectly through visual storytelling such as film. Vesely argued that architecture has not become central to surrealist thinking like painting or sculpture [6], and Frampton suggested “the surreal doesn't exist in architecture” [7].

Advances in VR are expected to meet growing demand for surreal spaces, as VR removes architectural physical constraints and enables immersive exploration of once impossible environments [8, 9]. This aligns with surrealism's artistic goals of visualizing unconsciousness, dreams, and chance, opening new possibilities for multisensory surreal experiences in spatial design. Building on these traits, emerging efforts have applied surrealism to spatial design via VR. Recent VR exhibitions of Van Gogh and Klimt's artworks let visitors immerse themselves in paintings, gaining acclaim. In gaming, VR titles like Superliminal, using perceptual illusions, and Hyperbolica, based on non-Euclidean geometry, provide novel disorienting spatial encounters.

However, these surreal VR designs remain isolated “creative experiments” lacking coherent principles and validated frameworks for practitioners. Many VR and metaverse projects still simulate real-world environments or reproduce physical norms, failing to provide systematic methods for evoking surreal spatial experiences

[8, 9]. This reveals a critical gap in empirical research on enabling and understanding surreal experiences in virtual spaces. To address this, the present study conducts a multi-stage investigation: (1) integrates traditional surrealist concepts with VR space properties; (2) extracts key surrealist characteristics from painting techniques; (3) examines surrealist film spatial expression to derive VR spatial design principles; (4) proposes empirical design strategies and a framework for surreal VR experiences; and (5) assesses practical applicability via comparison with existing VR platforms.

2 Theoretical background

2.1 Surrealism and its Spatial Applications

Surrealism, an early-20th-century movement rooted in Dadaism and psychoanalysis, aims to transcend reality by channeling the unconscious, dreams, and imagination [10, 11]. Breton's *Manifesto of Surrealism* (1924) defined it as "pure psychic automatism," advocating thought free of rational and moral constraints; he later framed it as an "ultimate attempt to resolve the fundamental problems of life" [12].

Visual artists advanced this aim through automatism, dépaysement, collage, the paranoiac-critical method, and other chance-based techniques, building a dreamlike visual language [3, 11]. Gablik grouped these methods into eight effects such as isolation, distortion, scale shifts, and paradox, while Alexandrian and Schreyer added magnified details, animated objects, and logical transpositions [3]. Collectively, these strategies dismantle rational frameworks to evoke the unreal.

Surrealism also recasts *space* as a psychological medium. Passeron [13] likened the fusion of visible and invisible realms to a "playground," encouraging designers to treat architecture as an extension of unconscious desire. Coleman [14] showed how the La Tourette Monastery, Salk Institute, and Amsterdam Orphanage abstract meaning through austere forms and sensory experience, freeing them from stylistic convention. Such works position architecture as an artistic vehicle for dream and emotion.

Thus, surrealist spatial design shifts emphasis from tangible materials to embodied sensation, turning space into a stage where imagination flows and rigid conventions dissolve [2]. By foregrounding intangible, experiential qualities, it expands human emotion beyond physical limits and challenges the reduction of architecture to a merely functional system [14].

2.2 Unique Properties of VR Spaces

VR spaces transcend physical limitations, enabling surreal environments that align closely with surrealism's emphasis on imagination and unconscious-driven spaces [15]. These virtual environments often incorporate non-Euclidean structures, providing immersive experiences comparable to physical reality [16–18]. However, careful design is essential to mitigate cognitive dissonance caused by spatial distortions. For example, VR spaces inspired by Escher's Relativity, featuring multidirectional staircases, initially disorient users but subsequently deepen immersion and self-awareness [8]. Likewise, environments with unpredictable spatial transitions can positively influence emotions and enhance optimism. Ware highlights the importance of incorporating spatial cognition mechanisms, such as depth perception and visual processing, into surreal VR design, underscoring the need to balance perceptual innovation with user comfort [19, 20].

Meanwhile, VR is designed to immerse users in unfamiliar environments disconnected from the physical world by utilizing a combination of sensory stimuli, including high-resolution graphics, 3D audio, and haptic feedback. Jerald provides a multidimensional analysis of the sense of immersion and presence experienced by users in VR environments, explaining that these sensory inputs strongly contribute to the perception of actually being present within the virtual space [21]. Similarly, Slater and Wilbur emphasize that spatial arrangement and sensory feedback play a crucial role in establishing presence [22]. Cummings and Bailenson quantitatively examine how different types of VR displays affect user immersion, demonstrating that immersive experience is not merely the result of visual elements but a complex outcome of integrated design features [23]. These findings underscore how VR's immersive qualities provide diverse spatial cues that allow users to perceive unreal spaces as real.

Dynamic user–environment interaction, especially locomotion, is pivotal for immersive or surreal VR experiences but remains limited by physical space. Presence is highest when proprioceptive feedback aligns with virtual motion, as demonstrated by comparisons of real walking, virtual walking, and flying [24]. Redirected-walking techniques allow traversal of vast virtual worlds within constrained areas and are naturally accepted by users despite their surreal nature [25]. Thus, locomotion design must integrate safety, perceptual coherence, and immersion.

Surrealistic spatial design is increasingly explored in VR environments, leveraging physically impossible architectural features. Han et al. identified surreal elements such as space-time variability, anti-physics structures, unreal materials, and cognitive asymmetry in their "Metaverse Design Catalogue," exemplified by gravity-defying structures and interactive morphing spaces [9]. Practically, surreal VR environments enhance creative processes, significantly improving idea originality and fluency compared to conventional tools [26, 27]. Additionally, immersive surreal spaces positively impact mental health, reducing anxiety, stress, and depression through awe-inspiring experiences [27]. Commercially, surreal elements like gravity-defying showrooms and interactive retail spaces extend visitor dwell time, boost conversions, and deepen brand engagement [28–30]. Further innovations, such as Kolkman's Ourtrospectre, encourage profound self-reflection by altering perceptual frameworks and challenging bodily self-awareness.

In summary, VR enables surreal spatial experiences through sensory stimuli and spatial structures unconstrained by physical laws, highlighting the need for comprehensive design strategies that address complex user interactions and cognitive responses. Despite this potential, academic exploration of surrealism's practical integration within VR spatial design remains limited, lacking systematic guidelines or empirical validation of user impacts. Therefore, this study aims to bridge the existing theoretical and practical gaps by establishing a foundational connection between surrealistic thought and spatial design within VR environments.

3 Surrealistic VR Spatial Design Framework

In this chapter, based on the expressive techniques and representative works of surrealism, we extract aesthetic characteristics that transcend reality through irrational elements. Subsequently, by examining the cinematic space design of ten seminal surrealistic films, we propose spatial design principles that define which characteristics can be considered surreal when spatially realized.

3.1 Core Characteristics of Surrealistic Expressions

Surrealist artists, inspired by Freud's psychoanalysis, aimed to express unconscious imagery through techniques emphasizing materiality and spontaneity, such as automatism, frottage, and decalcomania. Joan Miró's Catalan Peasant Head (1924–25) exemplifies automatism, abstracting facial features into simplified symbols and improvisational forms without distinct figure-ground separation. Similarly, Max Ernst's Histoire Naturelle (1925) employs frottage, transforming textures from wooden grains, woven surfaces, and seashell patterns into organic forms reminiscent of cosmic creation and primitive creatures.

Meanwhile, Salvador Dalí employed a psychological strategy he termed the "paranoiac-critical method," which superimposes illusions upon realistic depictions. In Dalí's work The Invisible Man (1933), the central figure appears at first glance as an empty silhouette, but in reality, it is a meticulously composed assemblage of multiple figures, columns, and background elements that collectively imply an invisible presence. This exemplifies the paranoiac-critical method's characteristic of reorganizing reality-based images into new orders or systems to construct surrealistic illusions, eliciting repeated visual pleasure and disorientation in the viewer [31].

The superficial inconsistencies and heterogeneities among images within a collage extend beyond mere visual clashes to generate new narrative layers and imaginative spatial structures [32]. Max Ernst described his collage work as an "alchemy of the visual image" (Alchimie de l'image visuelle), illustrating the process whereby images, removed from their original contexts, collide or fuse in uncanny ways. Within this process, no physical or anatomical distortions occur; rather, it enables holistic semantic shifts and formal transformations [33]. Such illogical assemblage and contrasts induce sensory disorientation through the juxtaposition of visual fragments, while simultaneously functioning as cognitive devices that activate unconscious associations and imaginative transference.

Based on a thorough examination of representative works and expressive techniques of surrealism, four core characteristics were identified, each performing distinct functions across the stages of generation, interpretation, structure, and experience. These characteristics are best understood as expression traits grounded in user experience within virtual reality environments rather than purely art-theoretical contexts.

The four core characteristics of surrealism from the several representative art pieces are as follows:

Chance and Spontaneity refer to the tendency of creators to minimize planning and control, exposing traces produced by unconscious impulses. This characteristic is realized through materiality-oriented techniques whose outcomes are unpredictable. Rather than consuming a finalized form, users actively engage in interpretation by discovering the continuously evolving flow of images.

Semantic Layering and Optical Illusion simultaneously provoke multilayered interpretations and visual confusion through image signs, delivering perceptual pleasure to users. Realistic details are depicted faithfully but rearranged in unfamiliar configurations, generating dual images that are both visible and invisible. This approach eschews singular meaning transmission, instead fostering interpretive shifts, confusion, and perceptual subversion that elicit visual immersion and tension.

Illogical Assemblage and Contrast is a strategy of deliberately juxtaposing disparate signs, eras, and scales, maximizing unfamiliarity by placing familiar objects within subverted contexts. users experience fragmentary narratives and non-temporal spatial orders newly created on top of logical discontinuities, embracing contradiction itself as both an object of perception and a springboard for imaginative leaps.

Sensory Immersion and Fantasticality fluidly blur the boundaries between reality and unreality by maximizing visual, tactile, and psychological stimuli through accidental textures and dreamlike images. Visual transitions such as irregular surfaces and organic forms expand a user's sense of infinite mystery and imagination, stimulating primal associative processes that induce immersive transference akin to an expansion of mental space.

The four core characteristics of Surrealism mentioned earlier are summarized in Table 1.

3.2 Surrealistic Spatial Design Principles from Cinematic Spaces

Surrealist spaces have been more often explored through temporally driven visual media like film rather than traditional painting [15]. Recently, cinematic space has also been viewed as a form of metaverse environment, leading to studies on surrealism's applicability in such contexts [9]. This section derives Surrealistic Spatial Design Principles from cinematic space and time, using the four core surrealist characteristics as analytical criteria. Ten films recognized in academic and critical discourse as representative of surrealism or surreal spatial expression were selected for analysis (for more details, see Appendix. A).

3.2.1 Principles on Chance & Spontaneity. Surreal cinematic spaces disrupt spatial logic by juxtaposing disconnected events and settings, creating narrative uncertainty and psychological tension. In *The Fall* (2006), abrupt cuts from familiar hospital interiors to expansive deserts produce spatial ruptures, visually manifesting Roy's unconscious emotional shifts and intensifying his despair. Similarly, *Mulholland Drive* (2001) subtly alters familiar spaces, such as recurring appearances of a house with changing temporal contexts, lighting, and arrangements, turning ordinary environments into uncanny, dreamlike layers. These spatial discontinuities actively involve viewers in constructing narrative meaning, inducing anxiety and curiosity, exemplifying principles of 'Chance and Spontaneity' in surreal spatial design.

Here are the four principles of surrealistic space design relevant to *chance & spontaneity:*

Table 1: The four core characteristics of Surrealism

Core Characteristics	Definition
Chance & Spontaneity	A characteristic that minimizes planning and control, exposing traces produced by unconscious impulses as they are.
Semantic Layering & Optical Illusion	A characteristic that overlaps multiple layers of interpretation and illusion within a single visual scene to create perceptual uncertainty.
Illogical Assemblage & Contrast	A characteristic that maximizes logical conflict by juxtaposing contradictory signs and objects.
Sensory Immersion & Fantasticality	A characteristic that maximizes sensory stimulation and blurs the boundary between reality and unreality through chance textures and dreamlike images.

Discontinuous Sequences weaken logical continuity between scenes to highlight unpredictability and evoke curiosity and tension in the viewer.

Contingent Event Placement delivers abrupt transitions or sudden object appearances mid-narrative to produce a strong sensory impact, emphasizing space as an evolving narrative agent rather than a static backdrop.

Multi-Layered Narratives constructs a single space to hold multiple interpretations and symbolic meanings simultaneously, prompting the viewer to continuously reinterpret and reconstruct the story.

Intentional Gaps leaves narrative gaps deliberately unfinished to invite viewer speculation and interpretation.

3.2.2 Principles on Semantic Layering & Optical Illusion. In surreal cinematic spaces, perceptual disorientation and visual illusions merge physical reality with symbolic or psychological meaning. In *Stalker* (1979), shifting settings between ruin and jungle, accompanied by changes in color, sound, and lighting, create ambivalent spaces oscillating between sanctuary and threat. *Inception* (2010) intensifies disorientation through the collapsing cityscape, disrupting gravity and spatial logic, thus blurring boundaries between dream and reality. Hitchcock's *Spellbound* (1945) employs endless corridors designed by Dalí to evoke infinite recurrence, while *Destino* (2003) continuously transforms landscapes into clock hands and facial fragments through shifting perspectives. These cinematic examples illustrate surreal spatial principles of '*Semantic Layering and Optical Illusion*'.

From the analysis of the four movies, the three principles were derived as follows:

Ambiguous Object Placement one object is designed to simultaneously have more than one meaning, which is differently recognized according to user's viewpoint, distance, and lightings, thereby allowing users to find its appropriate meaning on their own.

Illusion and Hallucination Effects stage the environment so that spaces seem to repeat without limit or appear layered upon one another, prompting users to ask, "Which direction is truly real?"

Perspective-driven Semantic Shifts configure spatial elements and objects so that their meanings transform as users move or redirect their gaze, enabling a single scene to support multiple layers of interpretation.

3.2.3 Principles on Illogical Assemblage & Contrast. Surreal cinematic spaces juxtapose disparate imagery and distorted scales to evoke emotional ambivalence and disrupt spatial-temporal coherence. *The City of Lost Children* (1995) combines fairy-tale and steampunk visuals within a dystopian setting, creating emotional tension, while Terry Gilliam's *Brazil* (1985) fuses incompatible spatial layers, mixing elegant interiors with intrusive industrial elements to highlight absurdity. Similarly, *Spellbound* (1945) and *Destino* (2003) disrupt conventional perspectives through exaggerated scale and transformation: *Spellbound* features enlarged symbolic elements like eyeballs and floating cards, and *Destino* blends realistic textures with surreal forms—melting clocks and gears formed by ants—illustrating contrasts between conscious reality and unconscious fantasy.

The spatial design principles derived from cinematic analysis of '*Illogical Assemblage and Contrasts'* in surrealist settings are as follows:

Contradictory Element Juxtapositions situate mutually incongruent motifs within a single setting to elicit a collision between familiarity and estrangement.

Scale Distortion and Fragmentation magnify or miniaturize everyday objects or architectural forms and redistribute them irrationally, thereby disrupting conventional proportional logic and narrative continuity.

Realistic Details with Unrealistic Connections depict individual objects with photorealistic fidelity while linking them through spatial joints or overarching structures that defy physical laws, creating an uncanny composite image.

Emotional and Tonal Clashes using audiovisual tonal clashes to evoke simultaneous unease and curiosity.

3.2.4 Principles on Illogical Assemblage & Contrast. Surreal cinematic spaces create intense sensory overload by manipulating visual, auditory, and spatial elements. *Paprika* (2006) juxtaposes diverse imagery, from household objects to statues, with overwhelming auditory textures, dissolving perceptual boundaries through sharp contrasts and sensory overload. Conversely, *Eraserhead* (1977) induces claustrophobic unease through monochrome visuals, subtle flickering lights, and continuous industrial sounds, entrapping viewers in sensory tension. *Destino* (2003) dynamically reshapes spatial and temporal logic via flowing transformations linking deserts, melting clocks, and fragmented faces, accentuated by abrupt shifts in illumination and texture, enhancing immersive surreal experiences.

The spatial design principles derived from cinematic analysis of *'Sensory Immersion and Fantasticality'* in surrealist settings are as follows.

Multisensory Stimulation It combines auditory cues, vibrotactile feedback, thermal changes, and airflow sensations alongside visual input, enabling users to perceive and engage with the space in an encompassing and volumetric manner.

Form Variability Walls, ceilings, and floors are configured as fluid structures that move and transform in real time, while objects continuously mutate, making the entire space behave as a dynamic organism.

Aesthetic Exaggeration Intensely saturated colours, dreamlike lighting, and atypical textures blur the boundary between light and shadow, emphasising an immaterial atmosphere detached from everyday realism.

Subjective Point-of-View Realization The environment responds instantly to user-generated stimuli such as movement and physiological signals, leading spatial properties to shift in synchrony with the user's actions and fostering a vivid illusion that the space is alive and responsive.

3.3 Empirical Strategies of Surrealistic Spatial Design

Non-linear spatial transitions in VR support Discontinuous Sequences via non-Euclidean portals that permit physically impossible "jumps," subverting spatial continuity [34, 35]. Contingent Event Placement triggers abrupt audiovisual changes in response to user states, further destabilizing coherence. Procedural random generation yields user-specific, multi-layered narrative configurations [36], while intentionally inaccessible areas and unexplained objects create gaps that intensify interpretive engagement.

Perspective-Based Illusions enable Ambiguous Object Placement: 3D models present distinct forms from different viewpoints, prompting exploratory behavior [37]. Infinite repetition and overlapping spaces implemented through multiple render targets generate Illusion & Hallucination Effects, and Perspective-Driven Semantic Shifts allow layered narratives in a single scene, letting users assemble fragmented story elements [38].

Contradictory Element Juxtaposition connects incompatible spaces along non-linear paths, combining photorealistic details with discontinuous transitions to induce defamiliarization. Extreme scale distortion reverses user–object size relations or compresses volumes, destabilizing spatial expectations and heightening dissonance [39]. Mood and tonal clashes further amplify perceptual tension.

Surreal VR spaces integrate Multisensory Stimulation, including visual, auditory, haptic, and olfactory cues, to maximize immersion. Form Variability is achieved through dynamic spatial transformations and aesthetic exaggeration techniques (e.g., exaggerated color, lighting, texture), distancing environments from everyday realism. Subjective Point-of-View Realization is realized through measured biometric data (heart rate, brain activity, gaze, movement), personalizing spatial attributes, and externalizing the user's psychological state into the VR environment. The empirical design strategies of surrealist spaces in VR corresponding to surrealist spatial design principles are summarized in the Appendix. B.

3.4 Proposal of Surrealistic VR Spatial Design Framework

This study proposes a theoretical framework for surreal spatial design in VR, considering the hierarchy and interrelations among core characteristics of surrealism, Spatial Design Principles, and Empirical design strategies (Figure 1). This framework is not a fixed standard for surreal VR spatial design, but a flexible set of guidelines that provides designers with practical strategies for selectively applying or creatively transforming surrealist expressions and techniques. In particular, this framework departs from intuitive approaches by grounding its structure in surrealist theory as well as psychological and cognitive foundations, thereby offering a clear rationale for design decisions. Designers can apply its three-tiered structure not only during the spatial design phase but also in user testing, systematically evaluating and adjusting the intensity of surreal expression, immersion, and narrative coherence. As a result, users experience a surreal narrative that is unpredictable yet internally consistent. This framework thus contributes to advancing VR as a medium of spatial imagination beyond reality. The following section analyzes its practical applicability through case studies involving current commercial VR platforms.

4 Exploration of Applicability of the Framework

This section tests the framework on four commercial narrative VR titles that showcase surreal spaces and cinematic storytelling. Each work is assessed across the framework's three tiers to show how surreal elements are built into the experience and how they shape user perception (Table 2).

Dear Angelica (2018) is a 6DoF VR narrative that uses surrealistic strategies of Chance and Spontaneity and Sensory Immersion to envelop users in painterly textures and floating text. Dynamic lighting, shifting colors, and layered lines drive principles of Space Transformation and Aesthetic Exaggeration, transitioning users fluidly from observers to active participants within imagined worlds. Non-linear Spatial Transitions and Multisensory Interaction techniques guide attention and heighten immersion.

Battlescar (2021) narrates the experiences of two teenage girls forming a punk band in 1980s New York, utilizing surrealist traits of Chance and Spontaneity and Illogical Juxtaposition. Fragmented spatial logic and abrupt scene shifts—from domestic interiors to surreal sky scenes—reflect principles like Discontinuous Sequence and Scale Distortion. Defamiliarization through exaggerated scales and collage-like urban imagery creates clashes between real and virtual realms, transforming space into an active narrative element.

A Fisherman's Tale (2019) explores surrealism through Semantic Layering, Optical Illusion, and Illogical Assemblage. Employing fractal structures and recursive nested spaces, it challenges spatial perception and self-awareness via Perspective-Driven Semantic Shifts and visual illusions. Scale distortions disrupt the hierarchy between user and environment, evoking cognitive uncertainty. Strategies like Story Layering and Perspective-Based Spatial Reinterpretation allow single spaces to take on shifting meanings.

Down the Rabbit Hole (2020), inspired by Lewis Carroll's *Alice's Adventures in Wonderland*, integrates surrealist characteristics such as Chance, Illogical Juxtaposition, Semantic Layering, and

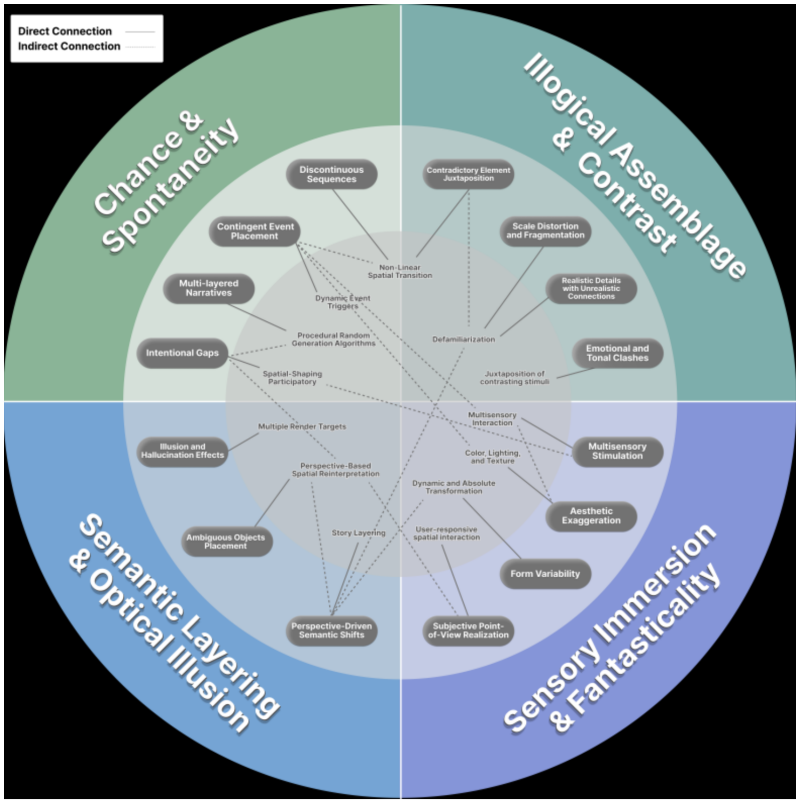


Figure 1: Surrealistic VR Spatial Design Framework

Sensory Immersion. Users traverse overlapping spaces through Falling or Mirror Transitions, leveraging Discontinuous Sequence and Perspective-Based Spatial Reinterpretation. Mirrors and shifting scales create perceptual disorientation (Extreme Scale Distortion), while vibrant colors and lighting enhance immersion, amplifying layered spatial meanings and surreal sensations.

The analysis of the four narrative VR works confirms their effective use of combined surrealistic characteristics to construct surreal atmospheres, demonstrating integrated operation across the framework's three levels despite varied narrative and interaction methods. However, practical implementation remains constrained by current technical limitations, particularly regarding advanced sensory effects (olfactory, airflow, illusions) and genre-specific interaction impacts. Future research should focus on developing genre-specific sensory guidelines and integrating broader bodily interfaces. Treating the framework as a modular toolkit rather than a fixed standard allows designers creative freedom to blend core surrealistic elements effectively. Additionally, the framework's three-layer structure provides clear criteria, such as immersion, illusion strength, and sensory satisfaction for evaluating and guiding both experimental research and practical production of reality-transcending VR spaces.

5 Conclusion

Based on surrealism in art, this study identifies four core characteristics for surrealistic VR spatial design: chance and spontaneity, semantic layering and optical illusion, illogical assemblage and contrast, and sensory immersion and fantasticality. Corresponding spatial design principles were derived to formulate a theoretical framework, establishing foundational guidelines for implementing surreal experiences in VR environments beyond traditional architectural contexts.

The design framework proposed in this study is based on theoretical analysis and case studies; thus, a limitation is that its empirical validity has not been sufficiently demonstrated. Furthermore, considerations of the practical feasibility, implementation complexity, operational efficiency, and user-centered environmental constraints, such as hardware capabilities and user fatigue, within actual VR systems have not been fully addressed, representing avenues for future inquiry.

Nevertheless, the academic contribution of this study lies in its reconceptualization of the art-historical constructs and methodologies of surrealism through the lens of VR spatial design, thereby expanding ideas about spatial experience. While previous studies have primarily emphasized strategies for augmenting realism within VR environments, this study highlights the potential of surrealistic expression to broaden imagination, creativity, and immersive engagement, thus opening new horizons in virtual spatial design. Furthermore, it is also significant in that it provides practical implications for professionals across diverse fields such as architecture, urban design, exhibitions, and gaming, who intentionally design surreal experiences.

Table 2: Analysis of narrative VR contents based on the framework

Title	Core Characteristics	Spatial Design Principles	Empirical Design Strategies
Dear Angelica	Chance & Spontaneity	Discontinuous Sequences	Non-linear Spatial Transitions
	Sensory Immersion & Fantasticality	Aesthetic Exaggeration	Color, Lighting and Texture Multisensory Interaction
Battlescar	Chance & Spontaneity	Discontinuous Sequence Contingent Event Placement	Non-linear Spatial Transition Dynamic Event Triggers
	Illogical Juxtaposition & Contrast	Scale Distortion and Fragmentation Realistic Details with Unrealistic Connections	Defamiliarization
A Fisherman's Tale	Semantic Layering & Optical Illusion	Perspective-Driven Semantic Shifts Illusion and Hallucination Effects	Perspective-Based Spatial Reinterpretation Story Layering Multiple Render Targets
	Illogical Juxtaposition & Contrast	Scale Distortion and Fragmentation	Defamiliarization
Down the Rabbit Hole	Chance & Spontaneity	Discontinuous Sequences Contingent Event Placement	Non-linear Spatial Transition
	Illogical Juxtaposition & Contrast	Scale Distortion and Fragmentation	Defamiliarization
	Semantic Layering & Optical Illusion	Perspective-Driven Semantic Shifts	Perspective-Based Spatial Reinterpretation
	Sensory Immersion & Fantasticality	Aesthetic Exaggeration	Color, Lighting. And Texture

Future research will empirically test the identified surrealistic design elements within VR, quantitatively and qualitatively evaluating perceived surrealness and user responses. This will clarify each element's contribution and effectiveness. Further systematic analysis and classification of VR spatial design elements, along with mapping them to the proposed strategies, are needed to enhance practical applicability, thereby advancing the creative and immersive potential of VR spaces.

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A Appendix: Case studies of films featuring surrealistic spatial design

A B Appendix: Empirical strategies for implementing surrealistic spatial design principles in VR

Movie Title	Year	Director	Surrealism Characteristic
The Fall	2006	Tarsem Singh	"It's certainly worth noticing, with its Gilliamesque surrealism, and its setting in Rajasthan, north-western India offers wonderful landscapes." [40]
Mulholland Drive	2001	David Lynch	"Narrative logic departs and the subconscious, the fantastical, the horrific starts to take over." [41]
Stalker	1979	Andrei Tarkovsky	"The clash of textures—light and murk, black-and-white and color, shimmering water and coarse stone—creates a frenzied visual vocabulary…" [42]
Inception	2010	Christopher Edward Nolan	"Inception is an imaginary world that offers a self-referential commentary on the act of world building… upon its own construction, adding yet another layer to the film's Russian Doll structure." [43]
Spellbound	1945	Alfred Joseph Hitchcock	"The dream sequence designed by Salvador Dali is a stunner, indulging various surrealist penchants for eyes and scissors." [44]
Destino	2003	Dominique Monféry	"Dalí called Destino the 'first surrealist cartoon,' and considered Disney a fellow cinematic surrealist." [45]
The City of Lost Children	1995	Marc Caro, Jean-Pierre Jeunet	"Set in a timeless surreal cityscape and populated with grotesque, hallucinatory characters, the film has been described as the sort of universe children might dream…" [46]
Brazil	1985	Terry Gilliam	"Depicts a world obstructed by technology and architecture… where 1940s aesthetics collide with a futuristic industrial dystopia of pipes, neon, and wires." [47]
Paprika	2006	Satoshi Kon	"Reality-bending trickery has been part of cinema… continually makes you see things in a new light." [48]
Eraserhead	1977	David Lynch	"Less a straight story than a surrealistic assemblage, brings together many of the now-familiar Lynchian visual themes and narrative figures…" [49]

Spatial Design Principles	Unique Properties of VR Space	Empirical Design Strategies
Discontinuous Sequence	Surrealist Spatial Order	Non-linear Spatial Transition)
Contingent Event Placement	Surrealist Spatial Order	Dynamic event Triggers
Multi-layered Narratives	Surrealist Spatial Order	Procedural Random Generation Algorithms
Intentional Gaps	Increasing Presence through Enhancing Immersiveness	Spatial-Shaping Participatory
Ambiguous Object Placement	Increasing Presence through Enhancing Immersiveness	Perspective-based Spatial Reinterpretation
Illusion and Hallucination Effects	Surrealist Spatial Order	Multiple Render Targets (MRT)
Perspective-Driven Semantic Shifts	Increasing Presence through Enhancing Immersiveness	Story Layering
Contradictory Element Juxtaposition	Surrealist Spatial Order	Non-linear Spatial Transition
Scale Distortion and Fragmentation	Surrealist Spatial Order	Defamiliarization
Realistic Details with Unrealistic Connections	Surrealist Spatial Order	Defamiliarization
Emotional and Tonal Clashes	Increasing Presence through Enhancing Immersiveness	Juxtaposition of Contrasting Stimuli
Multisensory Stimulation	Increasing Presence through Enhancing Immersiveness	Multisensory Interactions
Form Variability	Surrealist Spatial Order	Dynamic and Absolute Transformation
Aesthetic Exaggeration	Surrealist Spatial Order	Color, Lighting & Texture
Subjective Point-of-View Realization	Increasing Presence through Enhancing Immersiveness	User-Responsive Spatial Interaction

SOCIAL RAFT – Effects of a Multisensory VR Journey Through the Perception of Social Isolation

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Abstract

This paper presents Social Raft, an immersive Virtual Reality installation designed to foster empathy toward marginalized social groups through a layered sensory and narrative experience. The installation combines a symbolic virtual environment, a drifting wooden raft on an endless sea, with emotional storytelling based on real-life testimonies from individuals affected by discrimination, exclusion, or stigma. The experience is structured in four layers: a 360° narrative evoking emotional engagement; a virtual environment enhancing presence and immersion; an empathetic construct grounded in real voices; and a sensory layer with symbolic artifacts, original music, light, and movement. As participants navigate this environment, they encounter fragmented audio narratives tied to different vulnerable groups, reinforcing the sensation of isolation and invisibility. Interactive elements simulate futile efforts to escape marginality. This approach exemplifies how immersive media can be ethically used to promote social awareness, emotional resonance, and reflective engagement with issues of injustice and exclusion.

CCS Concepts

• ; • **Social and professional topics** → User characteristics; Race and ethnicity; User characteristics; Sexual orientation; User characteristics; Cultural characteristics; User characteristics; Age; User characteristics; People with disabilities;

Keywords

Virtual Reality, Empathy, Social Exclusion, Vulnerable Groups



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1 Introduction

Social exclusion continues to profoundly affect the lives of millions of people, even in so-called developed societies. This exclusion manifests itself in subtle or visible forms, crossing dimensions such as poverty, ethnic origin, gender, age or health status. In a world absorbed in their daily routines, many of these experiences go unnoticed. The project ”Social Raft” proposes a sensitive and immersive approach to this problem, using virtual reality to evoke empathy and social awareness.

Empathy is a fundamental element in building more inclusive, fair and supportive societies, being widely recognized as an essential competence in educational, cultural and social contexts [7], [12]. However, the promotion of empathy on a large scale continues to face significant challenges, especially when there is social, cultural or symbolic distance between individuals. In this scenario, immersive technologies - such as virtual reality (VR), augmented reality (AR) and mixed reality (XR) - have been emerging as innovative tools to enhance emotional and cognitive engagement, allowing users to ”inhabit” other realities and perspectives of sensory and symbolic form [3, 20].

This work presents and analyzes the artistic installation Social Raft, an immersive experience developed to raise public awareness of the multiple forms of exclusion experienced by socially vulnerable groups. Using a model of interactive and narrative layers, the installation proposes to create a symbolic and emotional space that facilitates the construction of empathy through the sense of presence, immersiveness and articulation between real testimonies and

sensory stimuli. The Social Raft materializes in a virtual environment where the participant is placed on a drifting vessel, surrounded by an infinite ocean, in a dynamic scenario that transforms itself in response to the stories of seven vulnerable groups.

1.1 Social exclusion and invisibility

Social exclusion cannot be understood solely in terms of poverty or lack of material resources. As Nancy Fraser [13] argues, social injustice involves two fundamental dimensions: redistribution and recognition. Exclusion thus involves the denial of full participation in the economic, cultural, and political spheres. Marginalized groups are often prevented from contributing to public debate, represented in a stigmatizing way, or, worse still, rendered invisible. Their symbolic absence from the public sphere is one of the most profound forms of exclusion: that of not being considered worthy of attention or listening. This denial, institutionalized in multiple social practices, erodes the foundations of mutual respect and social cohesion.

Axel Honneth [15] adds to this reading the concept of recognition as an essential condition for the development of identity and self-esteem. Invisibility, understood as a form of disrespect, directly interferes with the construction of the subjectivity of the excluded, denying them the status of valid interlocutors. The lack of recognition in the public sphere generates not only psychological suffering, but also the practical impossibility of exercising rights. Judith Butler [9] expands on this analysis by demonstrating how certain lives are treated as "unmournable" – that is, existences that, for the social majority, do not deserve to be mourned or recognized as a loss. This symbolic dehumanization has concrete effects: it legitimizes policies of indifference and exclusion, renders the suffering of certain groups invisible, and reinforces the naturalization of inequality.

Zygmunt Bauman [5] conceives of the excluded as "human waste" – disposable people in a global system that values only productivity and competitiveness. This metaphor points to a structural exclusion that goes beyond economic marginality: individuals considered useless become invisible in the eyes of the system. Complementarily, Pierre Bourdieu [8] introduces the concept of symbolic violence to explain how social structures of domination are internalized by the dominated themselves. By incorporating the criteria and views of dominant groups, the marginalized end up accepting their subordinate position as legitimate, which hinders any critical reaction or challenge to the established order. Domination is thus reproduced not only by force, but above all by the naturalization of social hierarchies.

In the urban context, Loïc Wacquant [23] analyzes the process of spatial marginalization as a form of social confinement. The "hyper-ghettos" he describes are not only areas of poverty, but also symbolically and politically segregated territories. In these areas, the stigma of the place contaminates its inhabitants, who face mistrust, exclusion from public services, and a lack of state investment. Urban marginality thus becomes a device of containment, where exclusion becomes visible in physical space but invisible in dominant discourses. By associating certain territories with crime or dysfunction, prejudice against their inhabitants is reinforced and their social exclusion is perpetuated.

Finally, it becomes clear that social exclusion is a complex, relational, and multidimensional phenomenon that combines economic inequality, symbolic devaluation, cultural stigmatization, and spatial segregation. Effectively combating this phenomenon requires more than alleviating poverty: it requires the active recognition of historically silenced subjects, the fight against structural forms of discrimination, and the creation of conditions for full and equal participation in public life. As Fraser, Honneth, Butler, Bourdieu, Bauman, and Wacquant show, a just society is defined not only by equitable access to resources, but also by the ability to ensure that all lives are seen, heard, and valued.

1.2 Empathy and immersive technology

Empathy is a vital human ability for building social bonds and promoting coexistence [7]. In a world marked by polarization, inequality, and complex challenges, fostering empathy is increasingly urgent, especially in education, culture, and healthcare. Immersive technologies such as virtual reality (VR), augmented reality (AR), and mixed reality (XR) offer new possibilities for enhancing empathy through emotional and cognitive engagement. This artwork explores the concept of empathy and how immersive environments can catalyze transformative, ethical, and compassionate experiences.

Empathy involves emotionally and cognitively understanding others' feelings and perspectives. Batson [4] defines it as "an emotional response congruent with the perceived condition of another". Bloom [6], however, cautions that purely emotional empathy may lead to biased decisions, advocating for cognitive empathy, rational understanding, as more effective in ethical contexts. Waal [22] emphasizes empathy as an evolutionary trait shared by other social mammals, underlining its biological basis.

Empathy is expressed through actions like listening, compassion, and solidarity, and is understood as the ability to understand and resonate with another's emotional experience [1], which has been explored as a pedagogical and social tool. However, cultivating empathy on a large scale remains challenging, particularly where there is social or cultural distance. This is where immersive technologies present meaningful opportunities. Immersive technologies simulate environments that create a sense of presence, making users feel as if they are experiencing another reality. This enhances empathy by allowing people to temporarily live in someone else's perspective.

Virtual reality offers a controlled, sensory rich and subjectively intense environment that can amplify empathy [1]. However, there are challenges: Bloom [6] warns of the risks of superficial or manipulative empathy. These technologies go beyond sensory engagement, they foster emotional immersion, enabling users to feel vulnerability, exclusion, or resilience through compelling narratives.

Three key mechanisms promote empathy through immersive experiences, as outlined by Barbot and Kaufman [2]. The first is perspective exchange, where participants virtually "step into the shoes" of others, enabling them to experience situations of discrimination or hardship firsthand. Secondly, embodied narratives use multisensory input to place users physically and emotionally

within a storyline, enhancing emotional engagement and internalization. Lastly, the destabilization of certainties occurs when users encounter realities different from their own, which challenges preconceived notions and encourage openness, critical reflection, and a deeper understanding of others lived experiences.

The feeling of presence, understood as the psychological state in which the participant feels that he is "inside" a virtual environment, is one of the central elements in the construction of empathy mediated by immersive technologies. By simulating an alternative reality in a convincing way, the sense of presence transforms digital content into lived experiences. This perception of reality intensifies the emotional and cognitive reactions, bringing the participant closer to the perspective of the other in a more authentic and engaging way. This deep involvement is essential to generate lasting empathy, especially when addressing contexts of suffering, discrimination or social exclusion.

The immersiveness provided by virtual, augmented or mixed reality creates a sensory environment that promotes identification with the characters or situations represented. By manipulating perspectives, for example, seeing the world from a child's height or the point of view of a person with reduced mobility, participants experience realities different from their own. This sensory and emotional simulation generates a significant impact on the perception of the other, shortening affective and cultural distances that often hinder empathy in everyday life.

In addition to visual and auditory perception, the embedded narrative (360ºnarrative) plays a decisive role. By integrating multiple sensory stimuli and involving the body and mind in the narrative experience, these technologies create an environment of strong emotional engagement. The experience ceases to be merely observational to become experiential, which allows the participant to internalize emotions such as fear, impotence or hopelessness. This approach intensifies the emotional impact of the message, promoting a deeper and more reflective empathy.

Another relevant aspect is the ability of these immersive experiences to shake pre-established certainties. When users encounter realities that contradict their assumptions, they are confronted with the complexity of the social world and the limits of their own vision. This "destabilization of certainties" acts as a catalyst for critical self-reflection, creating space for questioning prejudices, recognizing privileges and valuing the diversity of human experiences.

This transformative potential is reinforced by the fact that the memory of immersive experiences is often processed in a way like real events. As several studies show, the emotions experienced in virtual reality environments tend to remain in the memory of users with greater intensity, which prolongs the effects of emotional learning [21]. This feature makes immersive technologies powerful tools to stimulate not only momentary empathy, but also long-term changes in attitudes and behaviors.

It is important to recognize that the ethical use of these technologies is fundamental to ensure that the empathy promoted is not superficial, manipulative or focused on the spectacle of other people's suffering. Immersive experiences must be carefully designed to respect the dignity of the people involved in the stories represented and foster an active empathy, which goes beyond the passing emotion and leads to solidarity action, critical awareness and commitment to a more just and inclusive society.

1.3 Immersive art as social intervention

Contemporary immersive art has established itself as a powerful means of social intervention, exploring in an innovative way the potentialities of interaction, presence and empathy as catalysts for critical reflection. Emblematic works in virtual reality such as Clouds Over Sidra or Notes on Blindness reveal the immense potential of virtual reality to communicate complex and invisible human realities, providing immersive experiences that transcend traditional narrative formats [18]. These experiences are often described as memorable and transformative, precisely because they awaken deep emotions and put the participant at the center of the experience, allowing him to do more than just observe "put himself in the place of the other".

The Social Raft proposes an approach through a sensory narrative, structured around a spatial and emotional metaphor of exclusion: sailing alone in the high seas, in a fragile raft, symbolizes the isolation experienced by individuals belonging to vulnerable groups in a society increasingly absorbed in their routines. This multisensory experience, which combines image, sound and surrounding rhythm, was designed to induce authentic emotional states such as loneliness, discomfort, impotence or hopelessness, which act as triggers for self-reflection and ethical awareness. The distinctive strength of immersive environments lies in their ability to create a sense of subjective presence (the sense of "being there"), which amplifies the emotional impact and favors the internalization of the message.

Instead of presenting a closed discourse, Social Raft invites individual introspection, raising in the participants questions about belonging, marginalization and collective responsibility. In this sense, the installation is not limited to illustrating a social problem, but proposes an embodied, emotional and cognitive experience that seeks to generate critical awareness and active empathy.

Critical awareness and active empathy are two fundamental pillars for building a more just and inclusive society. While critical awareness allows us to understand the power structures, dominant narratives and exclusion mechanisms present in social dynamics, active empathy mobilizes this understanding for concrete action, this type of empathy is not limited to feeling but leads to doing.

Critical consciousness, as defined by authors such as [24] and [14], implies the ability to analyze and question social, economic and cultural structures that shape reality, challenging the naturalization of inequalities. In the context of social exclusion, this awareness allows the subject to recognize the systemic mechanisms that marginalize certain groups, overcoming simplistic or moralistic views on phenomena such as poverty, mental health or structural discrimination. On the other hand, active empathy represents the movement that leads the individual to leave himself, to recognize the other in all his dignity and to act from this connection [16]. It is at this point that immersive art, as proposed by The Social Raft, can play a transformative role. By providing intense immersive emotional experiences that put the participant in the place of the "other," the immersive environment not only sensitizes, but also calls for responsibility. The participant not only understands, but he also feels. And this feeling can generate lasting changes in the way it looks at the world, makes decisions, participates civically or positions itself against exclusion [1].

Social transformation is born when informed and emotionally committed individuals begin to act in different spheres, from small attitudes in everyday life to political or institutional interventions. Promoting critical awareness and active empathy is therefore planting seeds of change in society.

By challenging passivity, this kind of art does not offer closed answers, but opens spaces for new questions. It is precisely in this space, between discomfort and awakening, that a more solidary, equitable and truly inclusive society can be generated.

1.4 The Ethics of Representing Human Experience in Virtual Art

The creation of an artwork involves the integration of various sensory elements that engage and transport the participant into a creative and immersive space. The use of different types of stimuli, such as images, video, and sound, is common in this type of artistic installation. However, throughout the design, development, and implementation of the project, creators must remain attentive to the ethical principles associated with the use of materials derived from human intervention, particularly when working with visual and audio elements. Respect for privacy, consent, representation, and cultural sensitivity should be central to the artistic process, ensuring that the experience is both impactful and ethically sound.

The use of the human voice, quoting phrases that express personal situations, ideas, feelings, or opinions can significantly enhance the emotional impact of a narrative. However, this process requires particular care, especially when it involves vulnerable populations. Respecting confidentiality and protecting the identity of the individuals whose voices or testimonies are included is an ethical obligation of the artwork's creator. Safeguarding anonymity and ensuring that no one can be directly or indirectly identified is fundamental to maintaining ethical integrity throughout the artistic process.

Recital 75 of the GDPR notes that the risk to the rights and freedoms of natural persons (...) may result from personal data processing which could lead to physical, material or non-material damage, in particular: where the processing may give rise to discrimination (...) where personal data of vulnerable natural persons (...), This concern is in line with the wish of the prohibition of paragraph 1 of article 9, based on the principle of human dignity. In this sense, Mendes et al. [17], refer that the protection of human dignity must be at the center of data collection in vulnerable contexts.

It is important to clarify that the testimonies used in this study are dramatized by actors, but with language as faithful as possible to lived experiences, respectful and not sensationalist, based on expressions used and published in scientific literature. Thus, considering the concepts of personal data and treatment defined in article 4 of the GDPR, if no direct or indirect collection is carried out, this study does not process personal data, of natural persons, identified or identifiable, regarding Article 2, paragraph 1, of that Regulation.

Once the assumption of personal data processing is removed, there are no questions of informed consent, nor the subsequent anonymization or pseudonymization of personal data. However, ethical commitment is particularly demanding, because vulnerable groups involve a greater risk of exploitation, stigmatization or harm, even if unintentional, which is why, as Silva [19] argues, data collection in contexts of vulnerability cannot ignore the layers of oppression that structure the silence or exposure of these voices. The same is to say, that giving visibility to experience also implies protecting them, ensuring that testimony is an act of emancipation and not of new symbolic violence.

Therefore it is reiterated that the exposure of testimonies, dramatized by actors, be respectful and not sensationalist, in order to minimize possible stigmatizing effects as a result of the impact of research, based on the dignity of the human person, in the sense described by Costa [11], that the ethics in the use of testimonies is not only in the way data is collected, but above all in the way people are given back their words, with justice and respect.

2 METHODOLOGY

The adoption of the research-creation model, as proposed by Candy and Edmonds [10], is particularly suitable for the development of this work, since it legitimizes artistic practice as a valid form of knowledge production in the academic environment. This model allows an innovative methodological approach, which values the fusion between creative thinking and analytical thinking, favoring the exploration of complex problems through sensory and reflective experiences. In addition, it promotes the generation of situational knowledge, sensitive to context and rooted in lived experience, which is essential in a project that aims to address, in an immersive and empathetic way, the impacts of social exclusion. The exploratory and integrative nature of this method contributes significantly to the construction of an artistic narrative capable of mobilizing emotions, provoking critical reflection and encouraging social transformation.

Being the present work the construction of a digital media artwork, it was adopted the research-creation model (practice-based research) developed by Linda Candy and Ernest Edmonds [10], which represents a methodological framework that recognizes creative practice as a legitimate form of academic knowledge production. The research-creation model is based on five fundamental components (Figure 1):

1. Research-creation is initiated by the process of inquiry with epistemic value through a documented and validated approach, in which creative practice is simultaneously the object of study and how knowledge emerges from reflection on practice. Creative work is part of the contribution to knowledge.
2. The creative processes were documented in a systematic way, so that the results can be transmitted and valued by peers.
3. The method allows the research project to explore the duality of the results obtained, either by producing a creative work (artistic product) or through a critical/reflective narrative (scientific article), which explains the process of generating knowledge.
4. The creators/researchers adopted a critical and reflexive attitude throughout the whole process, questioning, justifying and reviewing the creative decisions taken throughout the entire process.
5. The contextualization of creative work is inserted in a disciplinary and epistemological context of social intervention,

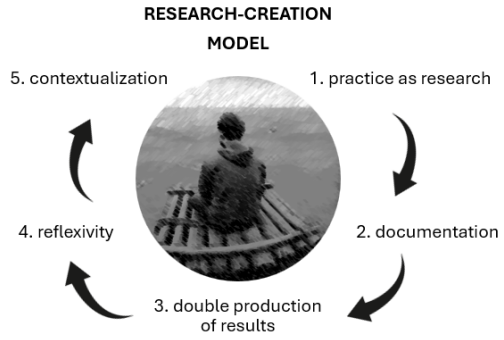


Figure 1: Research-Creation Model [10]

dedicated to promoting functionality, social inclusion and quality of life for people in situations of social exclusion.

The methodology adopted follows the research-creation model, combining artistic practice with theoretical foundation and interdisciplinary collaboration [10]. Interviews were conducted with representatives of vulnerable groups (with informed consent), whose content inspired five composite characters with dramatized testimonies. The environment was designed in Unity with binaural audio, using minimalist sound and visual design.

The construction of the immersive installation Social Raft followed a model of interdependent layers, designed to create a sensory and emotionally engaging experience, capable of evoking empathy in the face of social exclusion. This model, composed of four levels, 360ºnarrative, virtual environment, empathic construct and sensory stimuli, was conceived based on principles of experiential design, research-creation and immersive orientation to social reflection (Figure 2). Each layer has been carefully developed to contribute, in a unique and synergistic way, to the construction of a transformative artistic experience.

The first layer corresponds to the 360ºnarrative, which immerses the participant in a metaphorical scenario of drift and isolation. This non-linear narrative is marked by symbolic visual elements (water, raft, horizon), evoking emotions of uncertainty, loneliness, hopelessness and resistance. By avoiding a closed or conclusive plot, the work is proposed as an open space for emotional interpretation, allowing each user to project their own experiences and readings, which is essential in building a felt and not imposed empathy.

The second layer corresponds to the interactive virtual environment, where the user is surrounded by a three-dimensional space that simulates the precariousness and instability of an open sea raft. The feeling of presence, that is, the perception of being ”inside” the situation, is amplified by a spatial composition that favors sensory and emotional immersion, using the oscillation of the platform, directional sound and visual depth. This level reinforces the affective involvement, allowing the participant to feel, in the body and in the senses, the condition of vulnerability that characterizes many exclusion situations.

At the core of the project is the empathic construct, anchored in real testimonies collected from people in situations of vulnerability, people with disabilities, immigrants, refugees, people who felt racism, LGBTQIA+ community, people with mental illness, elderly, and people in a state of poverty and social exclusion. These testimonies were adapted in an ethical way and dramatized by neutral voices, respecting the confidentiality and dignity of the participants. This layer ensures the ethical and human rooting of experience, giving voice to authentic experiences and allowing the empathy aroused by immersion to become a critical and ethical understanding of the real world.

The sensory layer integrates symbolic artifacts representing each vulnerable group, original music tailored to each phase of the experience, dynamic lighting and color effects, ambient sounds, and the oscillatory movement of the raft, all of which complete the aesthetic and emotional experience. These stimuli were designed with a strong symbolic and emotional value, acting as sensory triggers to accentuate feelings of imbalance, acceptance or disorientation. The music alternates between tense and harmonious tones, mirroring the emotional states present in the testimonies. Light floats between fog and darkness, suggesting transitions between discrimination and social invisibility.

The combination of these four layers aims to build a multisensory, ethically grounded and emotionally impactful experience that invites the public to reflect on the phenomenon of social exclusion from a position of presence, shared vulnerability and active listening. The raft, as a metaphor, thus becomes a space of emotional crossing and inner transformation, where art and technology meet to promote critical awareness, active empathy and potential social transformation.

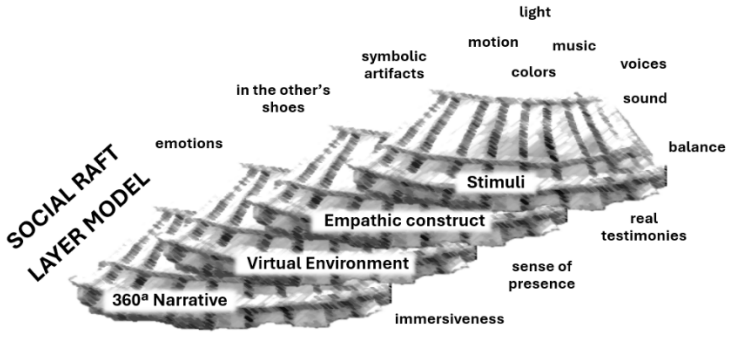


Figure 2: Social Raft interdependent layers model

3 DESCRIPTION OF THE INSTALLATION

Social Raft is an immersive installation designed as an artistic and sensory experience aimed at promoting empathy and critical reflection on phenomena of social exclusion. Integrating virtual reality (VR) technologies and a multimodal aesthetic approach, the work offers a symbolic representation of the experiences of socially vulnerable groups, inviting visitors to indirectly experience situations of marginalization, invisibility, and isolation.

3.1 Virtual Environment

The main immersive space is built around the metaphor of the raft - an unstable floating platform, which moves slightly with the wave of the sea, evoking uncertainty and helplessness. The setting is devoid of territorial references, with an infinite and empty horizon, which reinforces the sense of isolation. Visual and sound elements like the sky and the sea are dynamic and respond to the emotional contents of the narratives, oscillating between the oppressive gray, the absolute darkness or atmospheres of latent tension. Distant urban sounds, such as laughter, horns or fragments of news, appear as unreal echoes of an inaccessible daily life, symbolizing the exclusion of the subject from the social sphere.

3.2 Fragmented Narratives and Environmental Symbolism

The installation is structured around seven narrative segments, each representing a vulnerable group: people with disabilities, immigrants and refugees, victims of racism, LGBTQIA+ community, people with mental illness, elderly and individuals in situations of poverty or social exclusion. The environmental transformations function as emotional markers associated with each group:

- People with disabilities - thick fog that reduces visibility and reinforces the feeling of disorientation.
- Immigrants / Refugees - intense storm, evoking forced displacement and danger.
- Racism - persistent rain as a metaphor for constant discrimination.
- LGBTQIA+ - grey sky with the discreet presence of a rainbow, sign of resistance and identity.
- Mental illness - fast-moving clouds with sporadic sunshine, representing emotional instability.
- Old age - prolonged sunset, referring to finitude and social oblivion.
- Poverty / social exclusion - nighttime darkness, symbol of invisibility and abandonment.

The voices that share real testimonies appear intermittently, mixed with ambient sound, in the form of whispers or cries. This aesthetic option aims to materialize the idea that these stories are present in the social space but often remain inaudible.

3.3 Symbolic Interaction and Distancing Strategies

The interaction with the environment is limited, underlining the impotence felt by the subjects represented. The user may try to row, but the raft remains almost motionless, a metaphor of constant effort without social progress or recognition. When looking at the water, there are diffuse reflections of people walking in a city. These figures are always on their backs, moving, and never interact with the participant, symbolizing indifference and structural exclusion.

3.4 Sensory and Affective Evocation

The installation uses visual, sound and kinetic stimuli to provoke emotional states of loneliness, frustration and exclusion. The combination of light, color, sound and movement creates a dense atmosphere, intended to destabilize the visitor and induce a form of experiential empathy, not by direct suffering, but by confrontation with distance, non-belonging and social silence.

3.5 Space for Post-Experience Reflection

The installation ends in a physical space designed to consolidate the experience. This includes real audio-visual testimonies, statistical and scientific data on social exclusion and an interactive digital wall. This mural allows visitors to record messages, reflections or personal commitments, functioning as an extension of the installation and a stimulus for ethical and civic action. Experience does not offer a narrative ”solution”. The raft remains at sea, but the participant leaves with the voices echoing, in an empathetic extension strategy.

4 PRELIMINARY RESULTS AND DISCUSSION

Experimental pilot sessions were held, the reports collected indicate increased awareness about issues of exclusion and an intense emotional connection with the testimonies. Expressions like ”I had never thought about what it was like to be on the other side” or ”I felt really helpless” came up often. It is planned to apply empathy scales in the next iterations.

The ”Social Raft” demonstrates that it is possible to build artistic experiences based on real testimonies, without falling into emotional exploitation or stereotypes. The use of metaphors and abstraction allows the universalization of experiences without decontextualizing them. On the other hand, it is recognized that empathy does not replace political or structural action but can be a catalyst step.

5 CONCLUSIONS

The Social Raft represents an artistic and technological contribution to combat social indifference. Through virtual reality, an emotional approach to marginalized realities is promoted, favoring active listening and a deeper understanding. The project continues to develop, with planned expansion for educational, museum and social contexts.

In a world marked by systemic inequalities and the growing invisibility of vulnerable groups, the awakening of critical awareness is an essential step to break with indifference. It is a process of denaturalization: to understand what is often seen as ”normal” or ”inevitable”, such as the loneliness of homeless people, discrimination against ethnic minorities or the marginalization of people with disabilities, the result of political, cultural and social decisions that can (and should) be questioned.

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Na senda das dimensões da média-arte digital nas narrativas biográficas em Macau: uma perspetiva à luz da diversidade cultural

On the trail of digital media art dimensions in biographical narratives in Macau: a perspective in light of cultural diversity

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Abstract

The concept of narrative identity as a psychological construct illustrates the role of biographical narrative in shaping and reformulating one's identity. Narrative serves as a fundamental element for acquiring knowledge and constructing identity. The exercise of narration involves co-constructing and responding to others within a dialogical relationship, which enhances awareness as well as individual and collective identity. Personal (auto)biographical narratives, when they assume a digital and potentially interactive nature, can function as communal tools that strengthen ethnic-cultural and socio-cultural identification. In this article, the authors reflect on their approach to studying audiovisual narratives. They concentrate on (auto)biographical narratives published or shared on social networks and examine their dimensions of digital media art along with their interventionist socio-cultural nature.

Résumé

O conceito de identidade narrativa como uma construção psicológica ilustra o papel da narrativa biográfica na formação e reformulação da identidade de uma pessoa. A narrativa é um elemento fundamental para a aquisição de conhecimentos e a construção da identidade. O exercício da narração envolve a co-construção e a resposta aos outros numa relação dialógica, o que aumenta a consciência e a identidade individual e coletiva. As narrativas (auto)biográficas pessoais, quando assumem uma natureza digital e potencialmente interativa, podem funcionar como ferramentas comunitárias que reforçam a identificação etnicocultural e sociocultural. Neste artigo, os autores refletem sobre a sua abordagem ao estudo das narrativas (auto)biográficas audiovisuais. Concentram-se nas narrativas publicadas ou partilhadas nas redes sociais e examinam as suas dimensões à luz da média-arte digital, bem como o seu cariz sociocultural intervencionista.

CCS Concepts

• **Human-centered computing**; • **Applied computing** → Arts and humanities; Media arts;

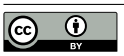
Keywords

Biographical Narratives, Cultural Diversity, Digital Media Art, Cultural Sustainability, Macau, Transmedia Storytelling

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1 Introdução

A compreensão da identidade cultural na contemporaneidade exige abordagens que integrem múltiplas vozes, memórias e experiências, especialmente em contextos de intensa diversidade e contacto intercultural, como é o caso de Macau. As narrativas biográficas (eventualmente autobiográficas), particularmente em formato audiovisual, transmédia e interativo, emergem como dispositivos privilegiados para aceder a essas múltiplas camadas de sentido, permitindo a construção e reconstrução de pertenças individuais e coletivas. Neste quadro, a narrativa assume uma dupla função: como ferramenta epistemológica e como instrumento de intervenção cultural e social [1].



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Com o avanço das tecnologias digitais e a crescente presença das redes sociais como espaços de enunciação e mediação simbólica, torna-se pertinente explorar o papel das narrativas audiovisuais como artefactos de média-arte digital com potencial de ação cultural. A articulação entre práticas artísticas, metodologias de investigação qualitativa, híbridas e transdisciplinares, assim como estratégias de comunicação digital, permite desenvolver dispositivos inovadores para a preservação e valorização da diversidade cultural, promovendo a coesão e o diálogo entre comunidades onde as narrativas biográficas podem assumir um importante papel.

Este artigo propõe uma reflexão crítica sobre as potencialidades das narrativas biográficas audiovisuais quando partilhadas nas redes digitais como instrumentos de reforço da identidade etnicocultural e sociocultural no espaço lusófono, com particular enfoque em Macau. A partir dos projetos Conta.Me e Radio.Me, desenvolvidos na Universidade de São José (Macau), em articulação com instituições do Brasil e de Portugal, analisa-se a integração das dimensões da média-arte digital nestas narrativas, bem como os seus contributos para a sustentabilidade cultural e para a construção de uma memória coletiva inclusiva e policêntrica.

Partindo da conceção de identidade narrativa enquanto construção dinâmica e dialógica, abordamos neste trabalho os cruzamentos entre arte, tecnologia, memória e identidade, ancorados numa metodologia inter/transdisciplinar. Propõe-se, assim, uma abordagem crítica e inovadora sobre o potencial das narrativas biográficas digitais enquanto formas de mediação cultural, de valorização da diversidade e de construção de comunidades de sentido no contexto da lusofonia contemporânea.

2 Da identidade narrativa à identificação etnico cultural e sociocultural – o papel das narrativas audiovisuais enquanto ferramentas comunitárias e de intervenção sociocultural

2.1 Dinâmicas Identitárias na Comunidade Lusófona

A definição de cultura e identidade tem-se revelado uma tarefa complexa e multiforme, resistindo a enquadramentos uniformes, os efeitos da globalização e da consequente homogeneização cultural contribuíram para a crise dos paradigmas clássicos de identidade. Autores como Moisés de Lemos Martins defendem que uma globalização intercultural e transcultural pode contrariar a vertente cosmopolita da globalização, promovendo a valorização da diferença e da diversidade, como acontece no caso da lusofonia [8]. A memória coletiva ganha particular relevância, devendo ser salvaguardada de forma equitativa.

A identidade cultural, pode ser entendida como a forma como o sujeito interpreta o mundo e nele se insere, em íntima articulação com o seu enquadramento cultural. Neste sentido, a reflexão sobre a identidade cultural é moldada por questões como a localização geográfica, o género, a etnicidade, a história, a nacionalidade, o idioma, a orientação religiosa ou sexual, entre outras dimensões que se entrelaçam num processo fragmentário [2]. A UNESCO, na Declaração Universal sobre a Diversidade Cultural [3], defende que a diversidade cultural é uma das origens do desenvolvimento, tanto em termos de crescimento económico, mas também como meio de acesso a uma existência intelectual, afetiva, moral e espiritual satisfatória.

O universo cultural lusófono pode ser interpretado como uma constelação que integra padrões comportamentais e sociais, onde coexistem a língua portuguesa e as suas variantes. A linguística contemporânea reconhece que os processos de construção identitária se ancoram na língua e por meio dela se manifestam. Deste modo, os conceitos de identidade, cultura e língua são interdependentes [4]. Nesta linha de raciocínio, Macedo et al. interpretam a lusofonia como vivência e ideologia partilhada por todos os que pensam, sentem e comunicam em português [5]. Venâncio propõe uma definição mais inclusiva, ao descrever a lusofonia como o espaço partilhado por falantes do português — enquanto língua materna, oficial ou de herança — incluindo aqueles que, mesmo não sendo nativos, experienciam culturalmente a língua [6]. Nesta ótica, o português adquire um estatuto simbólico de pertença, mais do que uma definição geográfica tangível.

Moisés de Lemos Martins adverte que, embora os descobrimentos portugueses tenham favorecido uma certa abertura ao outro, essa dinâmica foi comprometida pelo colonialismo, que obliterou a diferença, tornando-se assim crucial não esquecer as diferenças entre histórias coloniais e processos de colonização que impuseram sobre um povo a narrativa pós-colonial de um outro, diluindo assim a identidade desse povo [7].

A inter-relação entre língua, património e narrativa no espaço lusófono constitui um campo fértil de investigação, onde o português funciona como catalisador de múltiplas identidades culturais. Para além do seu papel comunicativo, a língua incorpora práticas, memórias e manifestações artísticas que revelam a diversidade intrínseca ao mundo lusófono.

Neste contexto, o português desempenha uma função estruturante na transmissão e preservação do património imaterial, sendo fulcral para a construção de um sentido partilhado de pertença. A lusofonia ultrapassa fronteiras territoriais, configurando-se como uma comunidade geocultural transcontinental onde a língua atua como elo entre diversas culturas e temporalidades históricas [8].

Neste contexto, as narrativas — orais, escritas ou audiovisuais — assumem um papel essencial na transmissão de valores e saberes culturais, permitindo a continuidade das memórias e a formação de identidades. No caso da lusofonia, essas narrativas revelam a multiplicidade de vivências e a riqueza cultural dos países que partilham o idioma. A análise da produção musical lusófona, por exemplo, revela um diálogo simbólico e afetivo entre universos culturais distintos, espelhando a interconexão das identidades lusófonas [4].

O património cultural partilhado neste contexto deve ser compreendido como uma construção em movimento, alimentada por fluxos de ideias, pessoas e memórias, desenhando um espaço policêntrico de interculturalidade efetiva. A lusofonia não se reduz, portanto, a uma noção unitária ou homogénea, sendo antes marcada pela sua diversidade constitutiva [2].

2.2 Narrativa Biográfica e Sustentabilidade Cultural no Espaço Lusófono

A narrativa biográfica constitui-se como uma abordagem metodológica que ultrapassa os limites disciplinares tradicionais, possibilitando aos seus autores assumirem um papel ativo e crítico

na construção e interpretação das suas trajetórias de vida. Em oposição à mera reprodução de biografias lineares, estas narrativas surgem como dispositivos epistemológicos enraizados em práticas interculturais e experiências vividas, articulando, de forma indissociável, o narrar, refletir, partilhar, transformar, sentir e imaginar [9].

Elsa Lechner destaca o potencial emancipatório das histórias de vida e dos relatos experienciados [10]. Estes processos não só promovem uma tomada de consciência dos sujeitos, como também desafiam estereótipos, permitindo-lhes reconstruir criticamente as suas memórias e posicionamentos sociais. Deste modo, a investigação biográfica adquire uma dimensão política, afirmando-se como ferramenta de análise das condições humanas e de promoção de transformação social.

Enquanto construções discursivas, as narrativas biográficas condensam múltiplos significados oriundos da diversidade de experiências. A sua elaboração desenvolve-se numa dupla dimensão: por um lado, o sujeito narrador organiza o seu percurso em função do destinatário; por outro, manifesta-se como ser social, projetando a sua perceção do mundo no tecido comunicacional. Este processo envolve também a reformulação de saberes comunitários — compreendidos como património cultural — em função de novos sentidos que orientam práticas sociais, afirmando-se como instrumento contínuo de reivindicação e reconhecimento.

No campo da investigação, a narrativa biográfica insere-se na metodologia qualitativa, sustentada num empirismo crítico que desloca o centro da produção do conhecimento para os sujeitos e contextos investigados. Esta postura metodológica evita os enviesamentos do olhar científico tradicional e aproxima-se do que Santos denomina "epistemologias do sul" fundamentadas numa "ecologia dos saberes", que valoriza a pluralidade epistémica e promove o diálogo entre diferentes matrizes de conhecimento [11]. Esta abordagem propicia a construção de comunidades solidárias, enraizadas na memória e orientadas para a emancipação [12].

A construção de conhecimento a partir de múltiplas narrativas possibilita ao investigador aceder à realidade tal como é experienciada pelos sujeitos, permitindo validar ou reconfigurar as hipóteses iniciais. A biografia, enquanto ferramenta epistemológica, articula conhecimento, prática e reflexão, promovendo mudanças nos planos individual e coletivo. Tal abordagem permite o resgate crítico das histórias pessoais e sociais dos indivíduos, analisando as estruturas culturais, sociais e políticas que os condicionam. Neste sentido, torna-se uma via para compreender as dinâmicas humanas em contextos interculturais e fomentar processos orientados para a autonomia e o reconhecimento.

Nos estudos da memória, a recuperação da experiência dos falantes de português em Macau, por exemplo, não visa validar a veracidade dos relatos, mas sim explorar os sentidos atribuídos aos acontecimentos. Ecléa Bosi, na obra Memória e Sociedade: Lembranças de Velhos, afirma que os testemunhos baseados na memória são sempre recriações subjetivas, moldadas pelas vivências subsequentes do narrador [13]. Para Bosi, essa ressignificação não compromete a validade do relato, pois permite acentuar dimensões morais, culturais e éticas que o narrador considera relevantes.

Edvaldo Pereira Lima, no livro Páginas Ampliadas, aprofunda este entendimento ao demonstrar como os discursos biográficos permitem compor um mosaico representativo de fenómenos históricos e culturais [14]. As narrativas de vida, sobretudo em formato autobiográfico, oferecem perspetivas singulares e enriquecedoras sobre o passado, iluminando a articulação entre memórias individuais e coletivas.

Neste enquadramento, as narrativas biográficas desempenham um papel crucial na salvaguarda das identidades culturais, contribuindo para a continuidade simbólica das comunidades. Ao documentarem histórias pessoais, estas narrativas captam e preservam práticas e saberes que integram o património imaterial, assegurando a sua transmissão entre gerações. Como argumenta Jan Assmann, a memória cultural é essencial para a manutenção de identidades coletivas, sendo estas narrativas veículos eficazes para esse propósito [15].

As narrativas biográficas em formato audiovisual intensificam esse potencial, ao combinarem recursos visuais e sonoros capazes de transmitir nuances expressivas — como gestos, entoações e códigos culturais — que frequentemente escapam à linguagem escrita. Estes registos audiovisuais assumem-se como arquivos vivos, facilitando a circulação intergeracional de conhecimentos e fortalecendo o legado cultural.

A ampla disseminação de narrativas audiovisuais através de plataformas digitais e redes sociais contribui também para uma maior democratização do acesso à memória coletiva. Jenkins destaca que a convergência digital amplia a circulação de conteúdos culturais, fomentando o diálogo intercultural e reforçando o sentimento de pertença em comunidades diversas [16].

Contudo, como alertam Pereira et al., os produtores contemporâneos de narrativas audiovisuais enfrentam desafios distintos dos seus predecessores [1]. O público atual procura interação, autenticidade e experiências significativas, o que exige uma abordagem comunicacional mais participativa [17].

Este formato narrativo não apenas evidencia a singularidade das experiências humanas, como também sublinha os elementos universais que atravessam as culturas. Appadurai salienta o papel transformador dos media audiovisuais na visibilidade das culturas periféricas, permitindo-lhes reconfigurar as suas identidades em cenários globalizados [18].

No domínio educacional, o uso de narrativas biográficas audiovisuais contribui para o reconhecimento e valorização das culturas locais, promovendo a diversidade nos currículos escolares. Documentários e vídeos baseados em histórias de vida constituem ferramentas pedagógicas eficazes para sensibilizar os alunos acerca da importância da memória e da identidade cultural, alinhando-se com os princípios da educação para a sustentabilidade defendidos pela UNESCO [19].

Para além do contexto educativo, estas narrativas são também instrumentos de ativação social. Ao visibilizarem comunidades e práticas em risco de desaparecimento, promovem a consciencialização e incentivam medidas de proteção cultural. Assim, as narrativas biográficas audiovisuais assumem-se como dispositivos poderosos na construção de uma memória inclusiva, promotora de diversidade, coesão e continuidade cultural.



Figure 1: Estrutura lógica do projeto Conta.Me (e Radio.Me). Fonte: autores

3 Os projetos "Conta.me" e "radio.me" em macau: análise das narrativas biográficas do projeto

3.1 Apresentação do projeto *Conta.me*

O projeto "Conta.Me: A narrativa biográfica como instrumento de afirmação social e da diversidade cultural no contexto do desenvolvimento humano sustentável de Macau" foi desenvolvido pela Universidade de São José, entre 2023-2024, com cofinanciamento da Fundação Macau, sendo continuado em 2024-25 através do projeto "Radio.Me: Narrativa Autobiográfica na comunicação ferramenta de coesão cultural transdisciplinar de Macau para o Mundo Lusófono" (2024-25).

Conta.Me analisou o impacto das narrativas biográficas para o desenvolvimento humano sustentável em Macau (Figura 1), estabelecendo Macau como referência epistemológica multicultural, criando um repositório vivo e dinâmico de memórias e experiências partilhadas. Valoriza as memórias dos períodos da administração portuguesa, transição política e contemporaneidade, revelando as complexidades dos processos de adaptação cultural, resistência e integração. Este projeto não documentou apenas histórias de vida, mas também visou fortalecer o tecido social através da compreensão mútua entre as diversas comunidades que compõem o mosaico cultural de Macau, contribuindo assim para um modelo de desenvolvimento humano sustentável baseado no respeito à diversidade.

Neste âmbito, foi realizada uma recolha sistemática de narrativas biográficas, provenientes de espólios já existentes, bem como de entrevistas a residentes de Macau, representando a diversidade cultural da região. O foco principal recaiu sobre indivíduos com memórias vivas dos períodos da administração portuguesa, da transição ou plenamente integrados na contemporaneidade multicultural macaense e falantes de português. Estas narrativas audiovisuais foram posteriormente tratadas e disseminadas através de diversos canais mediáticos. O projeto criou um arquivo digital acessível ao público, permitindo que as vozes dos participantes sejam ouvidas e valorizadas. Estas narrativas audiovisuais são disponibilizadas no site oficial de Conta.Me promovendo o diálogo intercultural e intergeracional, de forma a fortalecer o sentido de identidade e pertença entre os membros da comunidade. O site Conta.Me é também um recurso educativo e de investigação, oferecendo materiais valiosos para estudiosos e interessados na cultura e história de Macau.

O projeto Conta.Me abriu caminho para uma nova linha de investigação multidisciplinar e transdisciplinar sobre narrativa biográfica transmédia, integrando as várias dimensões do desenvolvimento humano sustentável e ampliando este modelo para os contextos da lusofonia e da China.

Deste projeto resultaram: a virtualização das narrativas biográficas; a criação de um espaço museológico virtual Conta.Me; o lançamento de uma rádio web académica com polos fundadores em Macau e em São Paulo, Brasil; a conceção de uma instalação de vídeo-arte; o lançamento das bases para o estabelecimento de uma comunidade científica, artística e cultural nesta área, em torno de um evento anual - o simpósio Tell.Me (Conta.Me).

3.2 Apresentação do projeto Radio.Me

O projeto Radio.Me tem como objetivo analisar o impacto da comunicação radiofónica académica baseada em narrativas autobiográficas enquanto ferramenta de coesão cultural transdisciplinar, de Macau para o mundo lusófono, à luz da Carta da Transdisciplinaridade, da Agenda 2030 das Nações Unidas e da Declaração Universal da UNESCO sobre a Diversidade Cultural.

O corpus inicial da investigação é constituído por um conjunto de entrevistas académicas realizadas nos últimos anos em programas de rádio como "Diversidade em Ciência", da Rádio USP, da Universidade de São Paulo, Brasil, e pela sua redistribuição através de uma Estação Académica de Rádio Web na rede lusófona, com polos iniciais em Macau, São Paulo (Brasil) e Braga (Portugal). Estas narrativas radiofónicas serão posteriormente avaliadas de forma crítica.

Com Radio.Me pretende-se:

- Virtualizar as narrativas autobiográficas através de técnicas de *digital storytelling*, com vista à sua disseminação digital completa em formato áudio.
- Contribuir para a criação de uma estação de rádio web académica, com polos fundadores em Macau (Universidade

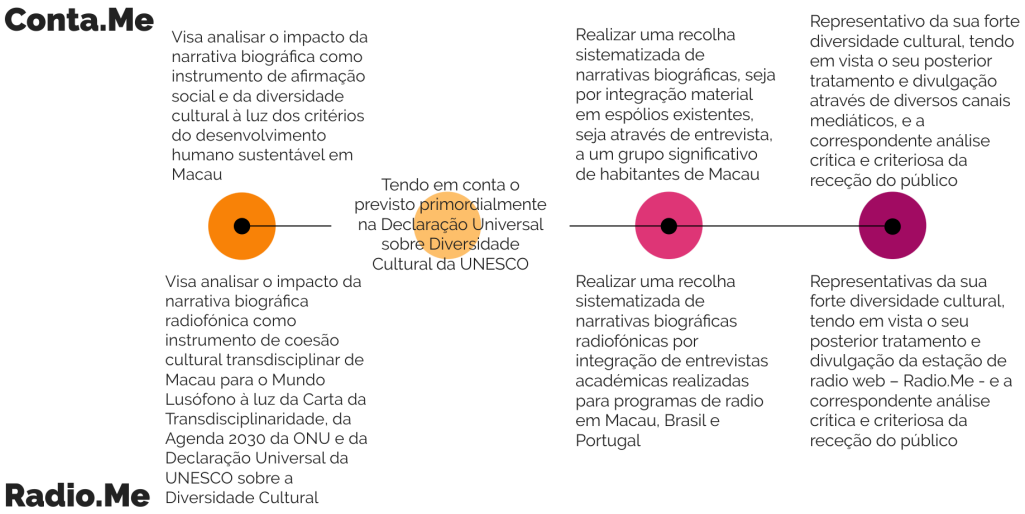


Figure 2: Apresentação do Projeto Conta.Me e Radio.Me. Fonte: autores

de São José), São Paulo, Brasil (Universidade de São Paulo), e Braga, Portugal (Universidade Católica Portuguesa), a qual integrará as narrativas autobiográficas como um dos seus eixos programáticos. Esta rádio estará aberta à colaboração e à expansão em rede com rádios académicas e locais dos Países e Territórios de Língua Portuguesa.

- Contribuir para a constituição de uma comunidade científica, artística e cultural em torno da temática da narrativa (auto)biográfica digital e do *storytelling*, nos países e territórios de língua portuguesa.

3.3 Apresentação do projeto Radio.Me

A investigação no domínio das narrativas biográficas audiovisuais, especialmente em contextos marcados pela diversidade cultural, requer metodologias interdisciplinares que combinem abordagens qualitativas, fenomenológicas, artísticas e comunicacionais. Neste âmbito, assume particular relevância o recurso à entrevista biográfica como técnica central para aceder às memórias e experiências dos sujeitos, em articulação com os conceitos de memória fenomenológica propostos por Henri Bergson [20] e com a teoria geral dos sistemas de Edvaldo Pereira Lima [21].

A metodologia adotada integra uma perspetiva mista, combinando dados qualitativos — como entrevistas em profundidade e análise narrativa — com dados quantitativos obtidos através de inquéritos aplicados aos públicos participantes, tanto em eventos presenciais como nas plataformas digitais associadas à rádio web académica. Esta abordagem permite uma triangulação dos dados, assegurando uma leitura mais abrangente da receção, impacto e significância das narrativas audiovisuais.

Na componente de criação, recorre-se à investigação baseada na prática artística, que se afirma como uma via legítima de produção de conhecimento. Este modelo metodológico, tal como delineado por Fernandes-Marcos, baseia-se num ciclo criativo de experimentação, reflexão e sistematização, no qual o processo artístico se transforma simultaneamente em objeto e meio de investigação [22].

A construção das narrativas audiovisuais obedece, assim, a um rigor metodológico sustentado em referenciais teóricos sólidos, que incluem os contributos de McAdams no campo da psicologia narrativa [23], de Joe Lambert no desenvolvimento das técnicas de *digital storytelling* [24], e de Brailas na articulação entre narrativas digitais e ecologias do conhecimento [25]. Estes autores oferecem modelos que permitem estruturar as narrativas de modo a integrar aspetos identitários, emotivos, culturais e contextuais, valorizando simultaneamente a autoria e a escuta ativa.

Do ponto de vista técnico, as narrativas são produzidas em formato multimédia, com especial atenção ao registo sonoro, edição de áudio e montagem audiovisual, incorporando elementos simbólicos e expressivos que potenciam a experiência sensorial do público. A linguagem audiovisual é concebida como um dispositivo de mediação entre o sujeito narrador e a comunidade, servindo não apenas para comunicar um conteúdo, mas também para criar uma ambiência de escuta empática e de envolvimento afetivo.

O processo de recolha das narrativas decorre a partir de repositórios já existentes — como os arquivos do programa "Diversidade em Ciência" da Rádio USP — bem como da realização de novas entrevistas no âmbito de projetos como o Conta.Me com polos em Macau, São Paulo e Braga. Esta articulação entre material pré-existente e produção original permite desenvolver uma cartografia representativa da diversidade identitária lusófona.

A componente de receção é igualmente considerada fundamental no desenho metodológico. Através de questionários, grupos focais e entrevistas, recolhem-se dados sobre a forma como estas narrativas são percebidas e apropriadas pelo público, permitindo aferir o seu



Figure 3: Vista do cenário de entrevista do projeto Conta.Me. Fonte: autores

impacto na construção de sentidos partilhados, no fortalecimento da identidade cultural e na valorização do património imaterial.

A disseminação das narrativas biográficas através de uma rádio web académica — com polos fundadores na Universidade de São José (Macau), Universidade de São Paulo (Brasil) e Universidade Católica Portuguesa (Braga) — inscreve-se numa lógica de comunicação em rede, aberta e colaborativa. Esta plataforma constitui simultaneamente um meio de arquivo, difusão e cocriação de conteúdos culturais, promovendo um ecossistema de partilha de saberes e de valorização das vozes múltiplas que integram a comunidade lusófona.

O uso de tecnologias digitais não é neutro nem meramente instrumental; trata-se de uma escolha epistemológica que visa ampliar o alcance e a acessibilidade das narrativas, potenciando a sua ressonância social e cultural. O caráter multissensorial e imersivo das produções audiovisuais permite representar com maior profundidade as nuances das experiências humanas, incluindo aspetos muitas vezes invisibilizados em formatos convencionais.

Esta metodologia integrativa — que articula teoria, prática, participação e reflexão — contribui não só para a produção de conhecimento científico, mas também para a criação de dispositivos culturais sustentáveis, capazes de fomentar a coesão, a inclusão e o reconhecimento mútuo no espaço lusófono, tomando Macau com um dos cenários experimentais.

3.4 Critérios de análise crítica para as narrativas biográficas

As entrevistas realizadas no âmbito destes projetos são analisadas segundo seis critérios, que englobam: o contexto sociocultural; o desenvolvimento pessoal e as relações interpessoais; as contribuições e realizações; os desafios, superações e legado; aspetos da diversidade cultural e aspetos de ligação à lusofonia.

Os critérios usados para a análise crítica das entrevistas pretendem avaliar a intersecção entre narrativas biográficas e dinâmicas culturais contemporâneas, sendo orientados por abordagens teóricas de memória coletiva, diversidade cultural e identidade lusófona.

O critério "Contexto sociocultural" destaca a importância de situar as narrativas individuais no seu ambiente social e cultural. A memória coletiva é inseparável do contexto em que os indivíduos vivem, sendo moldada por eventos históricos, práticas sociais e dinâmicas culturais. Analisar este contexto permite compreender como Macau, enquanto espaço de interseção cultural, influencia as identidades e os discursos dos entrevistados.

"O desenvolvimento pessoal e relações interpessoais" é importante para a compreensão de como os indivíduos moldam suas identidades ao longo do tempo. Este critério explora como as experiências familiares, de amizade e de comunidade se entrelaçam nas histórias, enriquecendo a compreensão da identidade macaense.

O critério "Contribuições, realizações e legado", aborda a dimensão ativa das narrativas biográficas. O impacto das ações individuais na cultura e na sociedade ultrapassa a simples documentação, consolidando memórias que inspiram mudanças e fortalecem o património coletivo. Este critério avalia como os entrevistados deixam marcas significativas nas suas comunidades.

Já o critério "Desafios, Superações e Legado" fornece uma perspetiva crítica sobre as estruturas sociais e culturais. As narrativas de superação são instrumentos emancipatórios, permitindo que os entrevistados resignifiquem suas trajetórias e inspirem processos de transformação social. Este critério foca-se na capacidade dos indivíduos de superar barreiras e contribuir para o legado cultural.

Os critérios "Aspetos da diversidade cultural" e "Aspetos de ligação à lusofonia" são importantes para compreender a singularidade de Macau enquanto espaço lusófono multicultural. A língua portuguesa e as práticas culturais partilhadas criam pontes de diálogo entre comunidades diversas. Este critério explora como os entrevistados percebem e integram esta pluralidade nas suas narrativas, refletindo a complexidade identitária da região.

No projeto Conta.Me, foi adotada a técnica da entrevista semidirigida, onde os participantes, a partir de uma pergunta inicial, desenvolveram as suas narrativas. O entrevistador priorizou a escuta, permitindo que o entrevistado construísse suas memórias. Dessa forma, o entrevistado assumia o papel de narrador, em vez de apenas responder a perguntas, tendo a liberdade de explorar os temas que considerava relevantes sobre sua própria história pessoal e experiências específicas. Isso possibilitou uma exploração mais profunda e autêntica das vivências individuais, enriquecendo a compreensão das trajetórias pessoais e coletivas. Além disso, essa abordagem

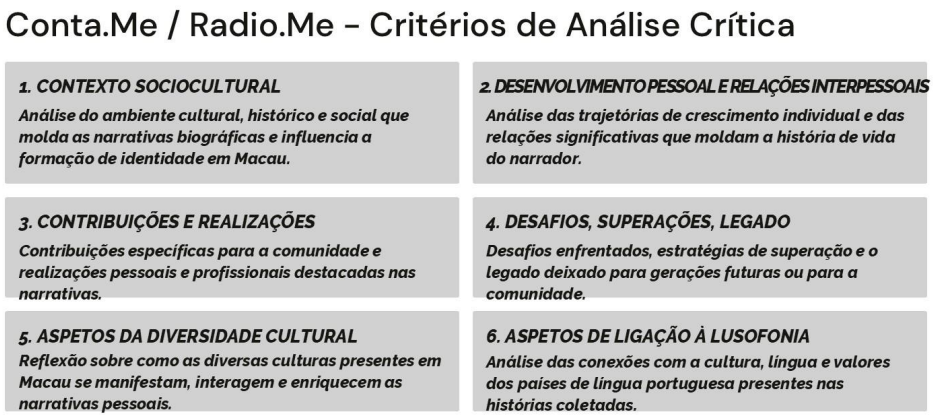


Figure 4: Tabela dos Critérios de Análise Crítica das Narrativas Biográficas. Fonte: autores

facilitou a emergência de temas inesperados e significativos, proporcionando uma visão mais ampla e detalhada das histórias de vida.

4 Reverberando acerca das dimensões da média-arte digital nas narrativas biográficas realizadas em macau

Os projetos Conta.Me e Radio.Me integram elementos de elevada criatividade, ampliando as dimensões da média-arte digital (Figura 5). À medida que nos adentramos no território da média-arte digital, notamos que esta se afirma não apenas como meio expressivo, mas como um dispositivo epistemológico capaz de reconfigurar a própria maneira como concebemos e transmitimos narrativas biográficas. As quatro dimensões centrais, interatividade, virtualidade, transmedialidade e imersão, não operam isoladamente, mas entrelaçam-se para produzir um campo sensível onde o sujeito biografado deixa de ser uma figura distante ou cristalizada no tempo. Em vez disso, torna-se um corpo em movimento, redimensionado por uma estética processual que desafia os limites do documento e da ficção.

Ao integrar práticas de média-arte, os projetos oferecem não só novas formas de salvaguarda da memória, mas também dispositivos de experimentação estética, nos quais o passado e o presente dialogam. O ambiente digital, ao permitir a reinterpretação dos arquivos biográficos através de tecnologias interativas, amplia as possibilidades de apropriação subjetiva destas histórias e incentiva a participação ativa de públicos diversos.

Dessa forma, a construção, fruição e preservação das narrativas biográficas transcendem o simples registro documental, apresentando-se como experiências sensoriais, colaborativas e abertas a múltiplos olhares. O valor educativo dessas práticas manifesta-se tanto na promoção de competências digitais quanto no estímulo ao pensamento crítico, à empatia e à inovação social. A mediação artística, ao cruzar as fronteiras da oralidade, do visual e do envolvimento corpóreo, faz emergir novas ecologias de sentido, nas quais a identidade macaense se revela dinâmica, plural e em constante reinvenção.

Entre as quatro dimensões articuladas no contexto da média-arte digital, destaca-se a interatividade, que reposiciona o público de mero observador para agente interveniente na construção narrativa. Nos ambientes digitais em vista nos projetos Conta.Me e Radio.Me, a possibilidade de participar ativamente, seja selecionando percursos, inserindo comentários, ou cocriando conteúdos — transforma a experiência da biografia num processo dialógico e plural. A interatividade contribui para descentralizar o protagonismo, permitindo que múltiplas vozes, relatos e interpretações convivam e se entrecruzem. Essa abertura não só democratiza o acesso à memória, como também sublinha a importância da escuta ativa e da colaboração nas práticas de resgate biográfico. A sensorialidade potenciada por estas plataformas digitais oferece ainda novas camadas de mediação, combinando imagem, som, texto e movimento, e ampliando os modos de receção e fruição das narrativas. A experiência estética, longe de se limitar ao registo verbal ou visual, passa a convocar afetos, memórias partilhadas e sensações corporais, tornando o gesto de narrar e ouvir biografias numa vivência expandida e participativa.

A virtualidade introduz a ideia de presença ausente, onde a vida narrada assume contornos simbólicos. O sujeito biografado pode ser representado através de reconstruções 3D através de artefactos artísticos, avatares ou paisagens sonoras que funcionam tanto informando quanto sugerindo. Esta dimensão interage com a memória coletiva, permitindo uma abordagem da representação em que vozes historicamente marginalizadas são incluídas (Figura 6).

A transmedialidade permite que a biografia se espalhe por diferentes suportes e linguagens — texto, vídeo, instalação, jogo, performance — respeitando a diversidade das formas de existência e expressão. Valoriza o fragmento, o desvio e a heterogeneidade.

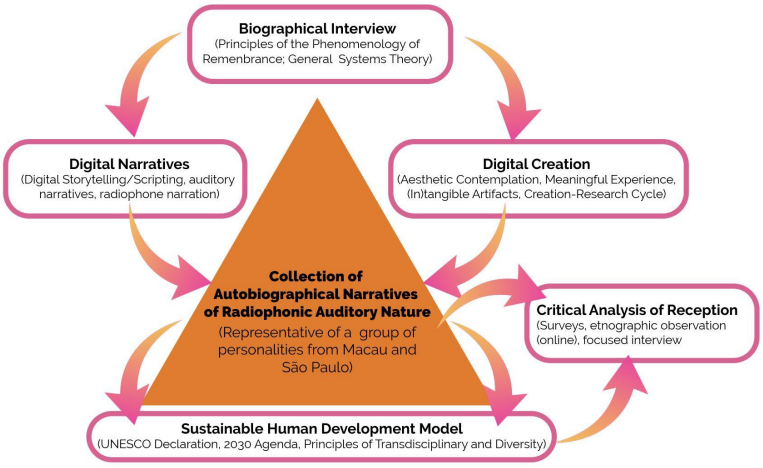


Figure 5: Estrutura lógica da criação, salvaguarda e fruição de narrativas biográficas no âmbito dos projetos Conta.Me e Radio.Me. Fonte: autores

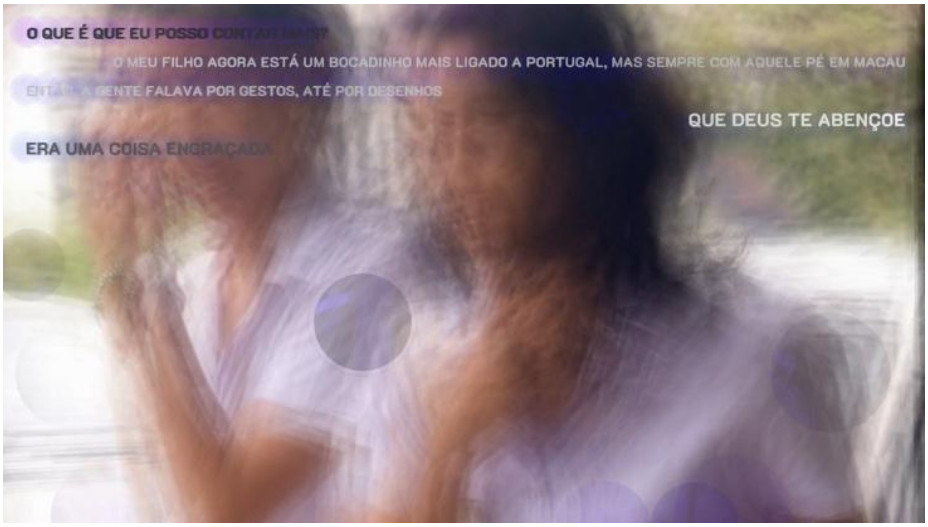


Figure 6: Imagem do artefacto BioFlux de Pedro Alves da Veiga (2024) realizada com base nas narrativas biográficas do projeto Conta.Me. Fonte: autores

Esta fluidez é particularmente relevante em contextos interculturais como os de Macau ou Brasil, onde as camadas da identidade individual se cruzam com legados coloniais, saberes orais, línguas coexistentes e sistemas de crença diversos. A narrativa biográfica digital, nesses cenários, torna-se uma prática de tradução e negociação simbólica.

A imersão dissolve a barreira entre obra e espectador. Ambientes sensoriais e realidades mistas incorporam o corpo na narrativa, criando uma experiência vivencial. Narrar-se ou narrar o outro não é apenas descrever, mas fazer sentir. A vida se torna uma dramaturgia onde afetos, espaços e tempos se combinam em um gesto de escuta e partilha. Nesta dimensão abre-se caminho à criação de instalações artísticas que explorem as várias gradações de imersão em torno de artefactos instanciados como narrativas (auto)biográficas.

A média-arte digital inaugura um novo regime de visibilidade ao interagir com narrativas biográficas. Ela amplia os modos de narrar o vivido, inscrevendo essas vidas em ecologias estéticas que conectam experiências individuais com desafios coletivos, e expandem o horizonte político da memória no século XXI. O artefacto, objeto final do ciclo de criação em média-arte digital, constitui-se como a própria narrativa biográfica, que assume assim também e adicionalmente, uma dimensão estética e artística, de natureza interventiva.

5 Conclusões Finais

As narrativas biográficas audiovisuais configuram-se como instrumentos poderosos para a valorização da diversidade cultural, a promoção do diálogo intercultural e a preservação da memória coletiva, especialmente em contextos marcados por histórias coloniais complexas e ecossistemas culturais em transformação, como o de Macau. Os projetos Conta.Me e Radio.Me demonstram que, ao serem recolhidas, tratadas e disseminadas com rigor metodológico e sensibilidade estética, estas narrativas permitem resgatar vozes muitas vezes invisibilizadas, constituindo um legado cultural dinâmico e partilhado.

A integração das dimensões da média-arte digital nos processos narrativos — nomeadamente através de técnicas de *digital storytelling*, instalações audiovisuais e plataformas de rádio web académica — revela-se uma estratégia eficaz para ampliar o alcance, a acessibilidade e a ressonância destas histórias de vida. Estas práticas, ancoradas numa metodologia transdisciplinar que combina investigação qualitativa, prática artística e comunicação digital, tornam possível uma abordagem inovadora à identidade narrativa, à cidadania cultural e à sustentabilidade das memórias no espaço lusófono.

Além de contribuir para a construção de um repositório transnacional de narrativas que reforça os laços entre comunidades de língua portuguesa, os projetos analisados neste artigo propõem uma reconfiguração epistemológica dos modos de fazer investigação e produção cultural. Ao colocarem os narradores no centro do processo, promovem não apenas a escuta ativa, mas também a agência, a representatividade e o reconhecimento social.

Em suma, este trabalho evidencia que as narrativas biográficas audiovisuais, enquanto artefactos de média-arte digital, constituem uma via relevante para a afirmação de identidades múltiplas, a educação para a diversidade e a construção de um espaço lusófono plural, policêntrico e mais justo. A continuidade destes projetos e a sua expansão para outros territórios culturais representam um passo significativo na consolidação de práticas colaborativas, sustentáveis e inclusivas, que respondem de forma criativa e crítica aos desafios contemporâneos da interculturalidade e da memória.

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Revitalising Macau Old Protestant Cemetery with Engaging Interactive Design for Cultural Preservation

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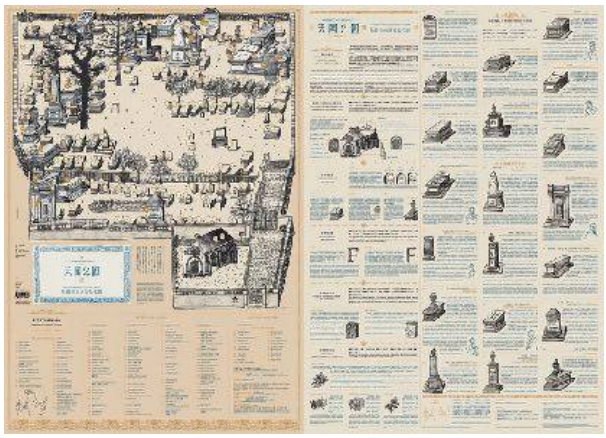


Figure 1: Drawing Map of Macau Old Protestant Cemetery. Image by Root 我城社區規劃合作社, 2017

Abstract

The study aims to contribute to current efforts to conserve Macau's Cultural Heritage (Macau Old Protestant Cemetery) via digital methods, improve user experiences, and foster creative interactions with Macau's cultural sites by investigating the usage of mobile applications and immersive technologies such as augmented reality (AR) and visual graphics for mobile applications.

Keywords

Mobile Application Design, Augmented Reality, Visual Graphics, Cultural Preservation, Macau Old Protestant Cemetery

1 Introduction

1.1 Background

"The Historic Centre of Macau" was inscribed on the UNESCO World Heritage List in 2005, featuring over 20 monuments and 30 distinct sights; it showcases the city's rich blend of Chinese and Portuguese cultural influences. To enhance accessibility and preservation, Macau's government has developed mobile apps (https://www.wh.mo/whmacau/) and virtual reality tours (https://vr.icm.gov.mo/) of these heritage sites since 2005 and 2021 [1.]. Recognizing the widespread adoption and convenience of mobile applications, which offer personalized and interactive experiences, there is an opportunity to further enhance the exploration of Macau's cultural heritage through a dedicated mobile app, potentially incorporating advanced reality technologies like AR and VR.

1.2 Purpose and Motivation

The book "Cemeteries in Macau" records a lot of different types of cemeteries in the Macau Peninsula, Taipa, and Coloane. Macau Old Protestant Cemetery is a significant historical site on the UNESCO World Heritage List. It holds the remains of pivotal figures like Dr Robert Morrison (the first Protestant missionary), George Chinnery (a famous English printer), and Anders Ljungstedt (a Swedish merchant and historian), making it a crucial window into the development of Protestantism and early foreign relations in Macau [2.].

Despite its historical importance, exploring and promoting the site further is necessary, particularly considering evolving travel trends. The increasing popularity of self-guided exploration and virtual experiences, especially post-pandemic, suggests a growing demand for deeper, more personalized cultural engagement. Macau is a city with a rich cultural legacy, ideal for self-exploration. A drawing map (Figure 1) of the old protestant cemetery was created by the Root art organization, and the authors are motivated by the desire to provide a more comprehensive and accessible understanding of Macau Old Protestant Cemetery, catering to the modern traveler's desire for unique and enriching cultural experiences.

1.3 Research Objectives

Use interactive experiences to raise awareness and understanding of the historic value of Macau Old Protestant Cemetery. Use modern technology, particularly mobile applications, to offer an immersive platform for visitors to interact with and understand the cemetery's history. Spread information about the cemetery's establishment and historical significance to a larger audience.

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1.4 Research Question

How might interactive mobile applications with (AR experiences) improve awareness and enjoyment of Macau's cultural legacy, particularly emphasizing Macau's Old Protestant Cemetery?

2 Literature review

2.1 Interactive Technologies for Cultural Heritage

Interactive Technologies have been used in mobile applications for cultural heritages; users can interact with digital objects and environments to create a sense of presence and engagement [3.]. Marker-based AR is widely used with visual cues like QR codes to identify the digital information on screens [4.], and 360-degree virtual tours use panoramic images from some fixed points to present the space [5.]. Introducing technologies such as multimedia guides makes the museum experience more engaging for visitors [6.]. The authors attempt to offer a mobile application as the platform for an AR and virtual tour experience and spread the historical information to audiences.

2.2 Visual Graphics & Storytelling

Visual storytelling is vital in engaging audiences and keeping their attention longer. Many museums and exhibitions use interactive digital storytelling to enhance the visiting experience [7.]. AR brings the story elements into the real world, while VR places users directly into story environments [8.]. The authors plan to spread the stories of the burials at the cemetery in AR for users to learn about the historical value of the cemetery and enhance their interaction with the heritage site.

2.3 Cultural Preservation and Mobile Application

In 2003, UNESCO adopted a Charter on preserving digital heritage. The Charter mentioned," The purpose of preserving the digital heritage is to ensure that it remains accessible to the public." [9.] Since then, art galleries and museums have begun to transfer their art into digital copies and store them. The loss of cultures seems undeniable, but interconnectivity and digital technologies may play a vital role in protecting cultural diversity. Tourists use mobile applications for information about cultural sites and landmarks, historical and ethnographic museums, and various interesting events. The mobile applications developed for tourism aim to enhance the user experience by integrating multiple technologies, especially for places and heritage sites with limited access, great historical value, and diverse information to share [10.].

2.4 History of Macau and Cemeteries in Macau

Macau is a historical and cultural city on a land of only 29 square kilometers. "The Historic Center of Macau" represents the architectural legacies of the city's cultural heritage. Many cities worldwide are famous for their relatively single cultural uniqueness, but the intersection and integration of multiple cultures characterize Macau. Since its opening in the mid-16th century, Macau has been an essential bridge between the East and the West, and the religions represented in the cemeteries are likewise highly different. There



Figure 2: Graphical Map of Cemeteries in Macau. Image by Lau, 2024

are Buddhism, Catholicism, Christianity, Islam, and Zoroastrianism. Because Macau's population is primarily Chinese and Portuguese, most inhabitants practice Buddhism and Catholicism. The Macau Old Protestant Cemetery was built in 1821. Before the cemetery was built, the Catholic Church in Macau was in a privileged position and did not allow Protestants to be buried within the city walls. At the same time, the Chinese people also did not allow foreigners to be buried in the customs area. Therefore, merchants from the United Kingdom, the United States, and Scandinavian countries had to be buried secretly between the city walls and the customs area [11.]. The total number of cemeteries in Macau is listed below and illustrated (Figure 2): Cemeteries in Peninsula of Macao: 6, Cemeteries in Taipa Island: 5, Cemeteries in Coloane Island: 6, Total: 17.

3 Methodology

The study methodology includes case studies of mobile apps and VR tour websites in Macau. Also, the authors surveyed the background knowledge of Macau cemeteries and users' preferences. The project will use a design thinking approach to develop a mobile application prototype with interactive technologies like Augmented Reality (AR) and a 360 virtual tour on the website. Usability testing was conducted to evaluate the effectiveness of the prototype in achieving the research objectives.

3.1 Case Studies

WH Macau (Figure 3)

- WH Macau is a mobile app created by Macau's cultural heritage.
- It provides information about Macau's heritage sites.

It offers heritage routes, news, activities, and photo galleries.



Figure 3: Mobile Application WH Macau. Image from the App Store, 2024

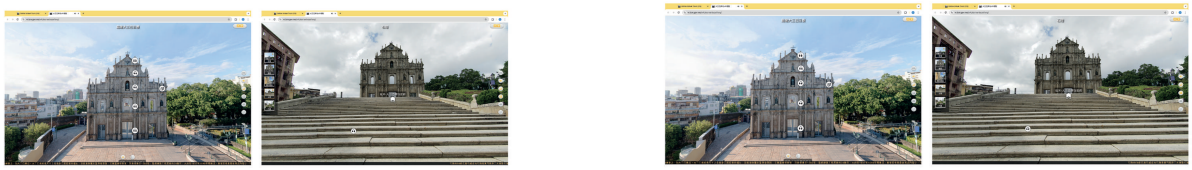


Figure 4: Virtual tour scene for Ruins of St. Paul virtual tour. Authors Instituto Cultural, 2014

The Instituto Cultural launched the "Online Virtual Tours (VR) Website," which created the tours of the heritage sites in 4 languages with floor plans, and users can access different site areas with 360-degree photos and listen to the audio guiding of the regions (Figure 4).

In summary, the case studies above have shown the availability of applying digital methods to Macau's heritage, but the authors considered the complexity of the user experience and the attractiveness of the heritage. A more user-friendly interface and fun interaction with the sites are needed as a new try for the prototype.

3.2 Design of the Prototype

The prototype is a mobile application for Macau Old Protestant Cemetery, including interactive technology functionalities such as an AR experience and 360 virtual tours. The AR experience is about four famous figures from the cemetery. To interact with the AR experience, a storytelling visual timeline board is provided with QR codes; the 360 virtual tour is with 16 pictures taken from different site locations, and the tour was created in an online platform that can be linked to the mobile application.

3.2.1 Timeline Design. To sort out all the different materials and select the valuable contents for the leaflet, the authors concentrate the historical information into two parts: Famous Figures and Historical Events as a visual timeline (Figure 5).

3.2.2 AR Experience Creation. As it has been highlighted that the historical figures are the main features of Macau Old Protestant Cemetery, four figures with their significant contribution have been settled in the ideation of the AR experience using Adobe Aero (Figure 6). (https://youtube.com/shorts/rrYoR43SwHY?feature$=$share, https://youtube.com/shorts/zYlzfmw_CUQ?feature$=$share, https://youtube.com/shorts/iGiDf2-JaQA?feature$=$share, https://youtube.com/shorts/xquTT1UsqOg?feature$=$share).

3.2.3 360°Experience Tour. A virtual tour of Macau Old Protestant Cemetery is created due to the perfect preservation of the site; users can interact with the space on a virtual tour online platform Kuula (Figure 7). (https://kuula.co/share/collection/7KPJd?logo$=$1&info$=$1&fs$=$1&vr$=$0&sd$=$1&thumbs$=$1).

3.2.4 Mobile Application Prototype. The mobile application prototype created by Adobe XD contains all the functionalities; the user can scan the QR code on the visual timeline board to access the AR experience, and the 360-degree tour is linked directly to the website (Figure 8). (https://xd.adobe.com/view/a42e34c7-9ea4-400b-bc9a-52ad71a6f53d-f17d/?mv$=$other&mv2$=$ahome&promoid$=$XKMMH7MW&xProduct$=$&xProductLocation$=$).

3.3 Usability Testing

In the usability testing of the prototype, the authors gathered 20 participants who were not familiar with Macau Protestant Cemetery, aged from 25 to 50, and skilled with mobile technologies. Question 1 is about how they feel about the product in terms of usability, quality, instructiveness, and durability; Question 2 asks how much fun and excitement they have with the interactive event; Question 5 is to see how likely they will recommend the prototype to their friends and colleagues. The responses show that most of the participants expressed appreciation for the innovation and instruction of the prototype and think that the product features are very educational and provide a new perspective on learning Macau's history,

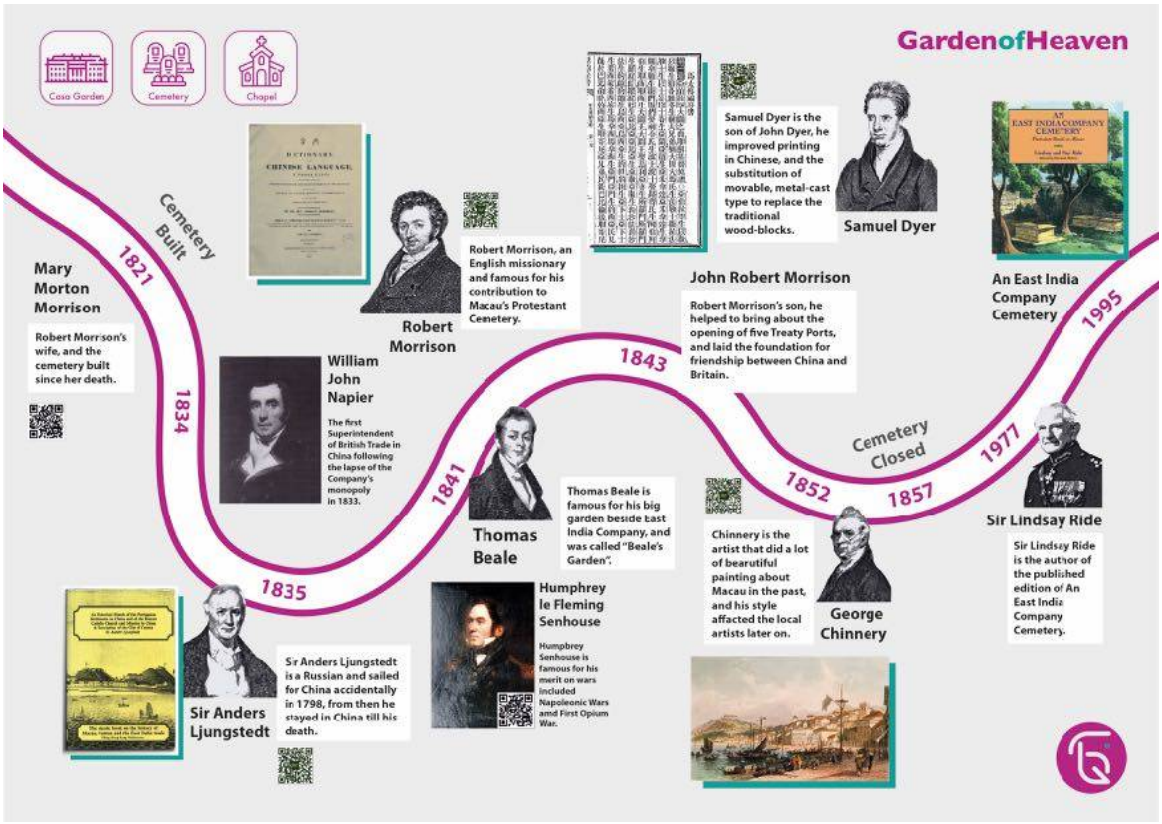


Figure 5: The layout design for the visual timeline. Image by Lau, 2024

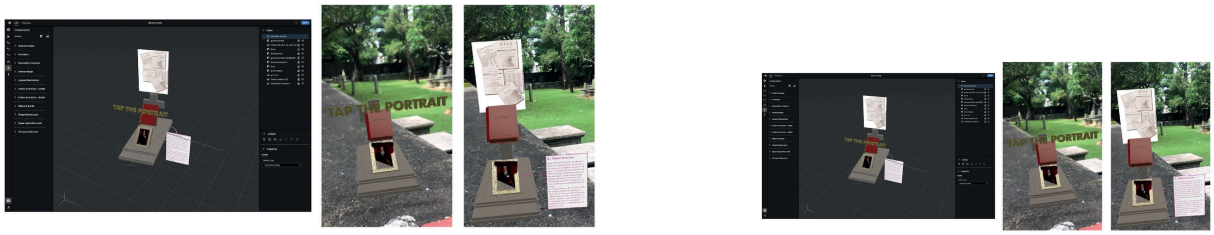


Figure 6: AR Experience Creation and Outcome. Image by Lau, 2024

especially for the Macau Old Protestant Cemetery. Meanwhile, some of them may be concerned about the sustainability of the app as it just focuses on the cemetery.

4 Conclusion

This study successfully explored integrating AR technology into a mobile application to enhance cultural preservation at Macau Old Protestant Cemetery. Through literature review, historical research, case studies, and usability testing, the authors demonstrated the potential of interactive technology to engage users with unfamiliar heritage sites in Macau. However, the authors acknowledge limitations. Firstly, the methodology must be tailored to the unique characteristics of each heritage site. Secondly, technological constraints necessitated multiple tools, highlighting the need for a fully integrated mobile application. Furthermore, we strategically limited the information presented to avoid overwhelming users.

The paper serves as a stepping stone towards a future where technology effectively bridges the gap between historical preservation and public engagement in Macau, and the authors encourage further research into the application of interactive experiences for cultural preservation.



Figure 7: 360°Experience Tours Shots. Image by Lau, 2024

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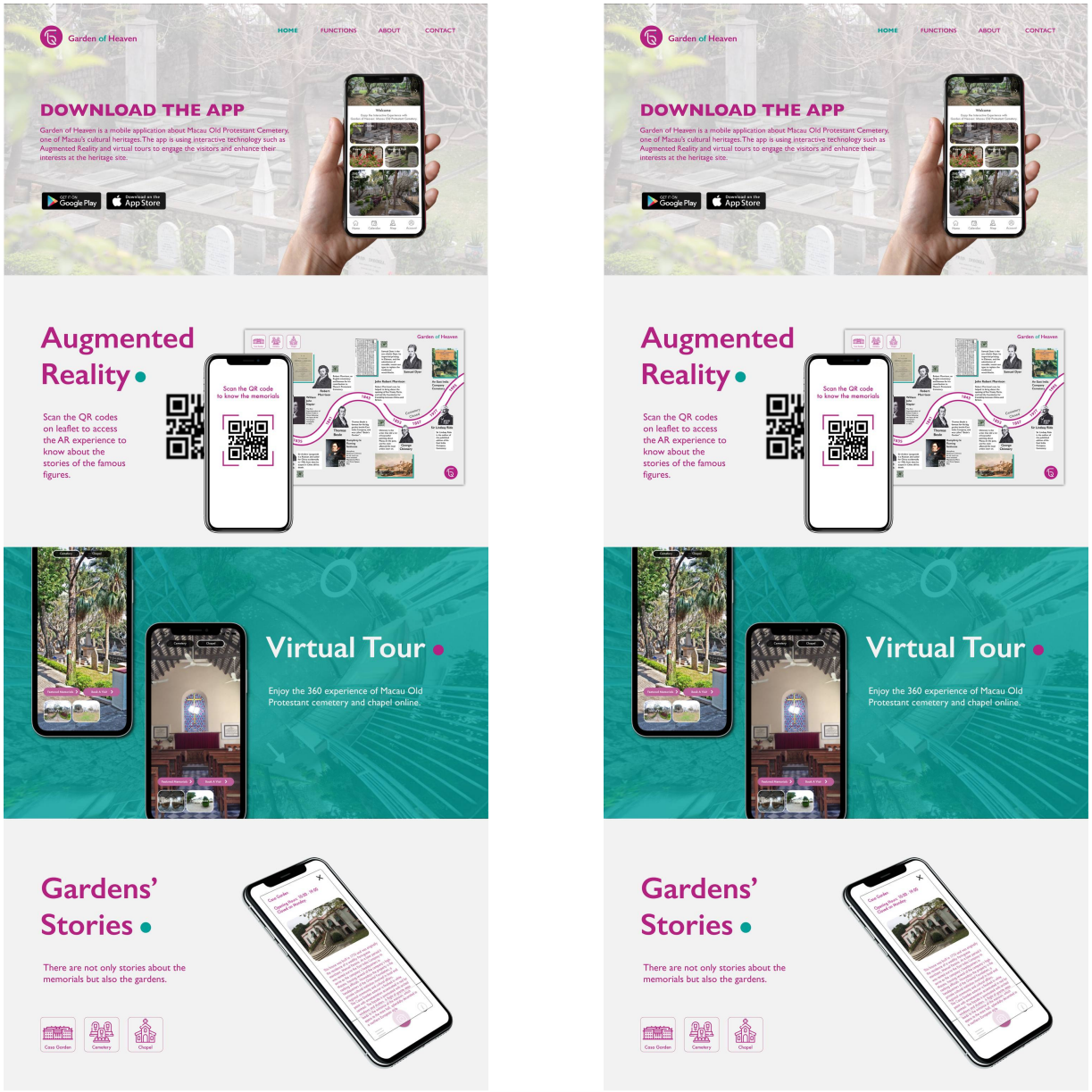


Figure 8: Mobile Application UI/UX Design. Image by Lau, 2024

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Saint Joseph the Worker Church: A Case Study in AI-Enhanced 3D Digitisation and Virtual Reality

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ABSTRACT

This research paper presents a virtual reality visualisation of the interior of the Chapel at Saint Joseph the Worker Church, the youngest Catholic church in Macao, established in 1999. Located in the Iao Hon district near the Gongbei border gate, the church symbolises openness and welcome to the people of China. This study aims to create an interactive user experience to digitally preserve the chapel's architecture, paintings, wood crafts, and statues, aligning with the church's missionary direction towards the Far East. Utilising advanced technologies such as Blender for 3D modelling and AI-driven tools for generating 3D content, this project captures the essence of the chapel's interior with high-resolution photography and precise digital reconstruction. The virtual environment is designed to be accessible via VR headsets and other devices, offering an immersive experience that enhances cultural preservation and evangelisation efforts. This paper also discusses the potential for future developments, including real-time lighting and smooth avatar navigation within the virtual reality space, to further enrich the interactive experience and broaden its reach.

Keywords

Virtual Reality, Cultural Preservation, 3D Visualisation, Digital Archiving, Artificial Intelligence

1 Introduction

Saint Joseph the Worker Church, the youngest Catholic church in Macao, was established in 1999 and locates in the Iao Hon district, closed to Gongbei boarder gate. Most of the residents in this area are workers and new immigrants from Mainland China. The appearance of the church is like two arms opened towards China, symbolising the welcome to the Chinese people to visit and get to know Christ. Bishop Lam Ka-tseung once said that "the land opposite the church leads directly to the seaside and overlooks the Mainland China like a runway". The church was built to symbolise its flying to China and the entire coastal area of the Far East, implying that the missionary direction of the Macao Diocese to the Far East. More information about the church—its history, surroundings, photos, and more—can be found at: https://sjose.catholic.org.mo/ [1].

This purpose of this research is to build a digital visualisation of the interior of the Chapel in the Saint Joseph the Worker Church, to be experience throughout Virtual Reality devices. Celebrating its 25th anniversary last year, this proposal aims to create a VR interactive user experience to digitally preserve its architecture, paintings, wood crafts, and statues.

2 Immersive and Virtual Experiences in Macao

There have not been too many immersive experiences using Virtual Reality in Macao. There are virtual tours captured in panoramic photography like cultural buildings and historical sites from the Government [2, 3,

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4], library tour in University of Macau[1] and Macau Millennium College [5]. The researchers have been working on digitising history and heritage elements around Macao [6, 7] and virtual exhibitions [8]. With other experts and researchers, since Pandemic COVID-19, aiming to broaden connection and coverage of the research outcome internationally.

The Macao Cultural Affairs Bureau launched a virtual recreation project of the church at St. Paul's College [9], a historic site established in 1594 by the Jesuits and significant as the first university in Asia during the Ming Dynasty. Despite enduring multiple fires, the façade remains a cultural icon in Macao. The virtual tour, initiated in December 2022, offers an immersive experience through a temporary installation equipped with VR technology, allowing visitors to explore the church's history and architecture. The initial version featured a guided VR tour with limited interactivity and a mini game focused on conservation tasks, though it faced challenges such as language barriers and audiovisual technical limitations. An upgraded version introduced in March 2023 enhanced the experience with improved visuals, additional language options, and new features like a "crab dance" and a parade of iconic statues. External features, including a WeChat mini-programme and augmented reality experiences, further enriched the visit. However, the upgrade also highlighted issues like rushed exploration due to time constraints and inconsistent information delivery across different languages and platforms. Overall, while the immersive experience at the Ruins of Saint Paul offers a unique blend of education and entertainment, there remains room for improvement in terms of interactivity and information coherence [10].

Other local business like the Bright Dawn Studio, is also keen on creating 3D models and miniatures of local cultural elements like, St. Paul's Ruins, Pui Ching Middle School, Holy House of Mercy, St. Dominic's Church, etc. These models are, mostly, exterior[2].

3 Virtual Environment Recreation

Open-source 3D modelling application, Blender 4.4.3[3] was operated on MacOS. In collaboration with the Parish Priest, the detailed architecture plans, both bird view and elevation, were used as the reference of the construction of the 3D model. These architectural plans were imported directly to the orthographic views within the viewport which provides realistic ratio to the 3D modeller without the need to measure several locations that are unreachable. Reference photos of important details (Figure 1) and notes were taken to ensure the authenticity of the models.



Figure 1: Interior of the Chapel (Photograph by the Authors)

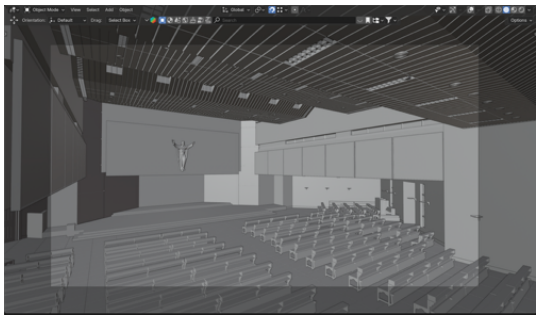


Figure 2: 3D model of the interior of the Chapel

[1] https://vr.library.um.edu.mo
[2] https://www.instagram.com/the_bright_dawn_studio/
[3] https://www.blender.org



Figure 3: Mystery of Salvation and Stations of Way of Cross in the Chapel (Photographs by the authors)



Figure 4: Workflow from photos to AI (3DAiStudio) to 3D models (Photographs by the authors)

The researchers first created the basic architecture of the chapel as the foundation, putting recurring items, e.g. wall lamps, stained glass windows, painting frames of the Mystery of Salvation, benches, etc. (Figure 2) Then, windows, doors were modelled along with wood crafted stations of the Way of Cross.

Both the painting set, and the Stations were captured in professional photographic settings. Due to the dim lighting and shadows on-site, The Sony A7R III is a high-resolution full-frame camera optimised for still life reproduction. It was paired with the Tamron 150-500mm F/5-6.7 Di III VC VXD zoom lens - a telephoto optic with exceptional resolving power ideal for capturing distant wall-mounted sculptures and oil paintings while emphasising subject details.

The Fujifilm GFX 50S II, a medium format camera renowned for its outstanding dynamic range and colour accuracy, delivers faithful reproduction of artwork textures, tonal gradations, and spatial ambiance within the venue. It was equipped with:

- The GF 35-70mm f/4.5-5.6 WR zoom lens: a compact yet powerful optic producing high-resolution images across diverse compositions, perfectly suited for both close-up documentation and environmental framing.

- The Laowa 19mm f/2.8 Zero-D: one of the smallest lenses in its class. Despite its minimalist construction, this lens captures an incredible 110° angle of view with virtually zero distortion.

For stability during long exposures and bracketed shots, the system was mounted on a Gitzo GK-2545T carbon fiber tripod providing exceptional vibration dampening.

Precise compositional control was achieved using the Leofoto G4 Geared Head, enabling fine three-axis adjustments even within confined spaces. This setup was critical in maintaining alignment across multiple exposures for later HDR blending.

Given the low-light conditions, exposure bracketing was employed to capture a broad dynamic range. In post-processing, Lightroom was operated for HDR merging and precise colour correction, aiming to faithfully reproduce the original tones and textures of the paintings. White balance and sharpness were adjusted meticulously to ensure the resulting images could serve both archival and academic purposes.



Figure 5: VR tour of the chapel on Kuula (Photograph by the authors)

These high-resolution paintings captured were directly UV mapped to the 3D model with a semi-smooth texture base. While the Stations of Way of Cross were sent to an online 3D generative artificial intelligence named 3DAiStudio[4] to achieve basic 3D sculptures (Figure 4).

After these above-mentioned elements are in place, photorealistic panoramic renderings are captured for the VR experience setup.

4 Virtual Tour Apparatus

The virtual reality (Figure 5) is streamed on Kuula.co[5] which Meta Quest Pro is recommended for the experience. Users can also navigate around the tour with a smartphone, tablet, or laptop for semi- immersive experience. Users can navigate the VR by interacting with the arrow hotspots on the floor and take a detailed look at the artefacts with those camera icons on the top rights of statues, sculptures and paintings.

This virtual tour does not only allow self-navigation within the space, but it also accommodates unlimited individual and group access. Offering quasi-realistic immersive experience with only higher resolution to images and details. This detailed information about artefacts – paintings, architects, sculptures, etc. is a potential for Edutainment and Gamification.

5 Conclusion and Future Work

The 3D virtual environment was built not only to digitally and interactively archive the interior elements of the chapel. It as well assisted in consideration of reallocating the organ piano. The organ piano was originally positioned in the front right of the chapel next to the altar and it was proposed to move to the back of

[4] https://www.3daistudio.com/

[5] https://kuula.co/share/collection/7D7tk?logo=0&info=1&fs=1&vr=1&sd=1&thumbs=1

the hall along with the opportunity to upgrade and update the entire sound system. Nevertheless, it is too heavy to move without a concrete idea that the adjustment would be in favour of the organist, the choir conductor, the choir and the officiating priest. Thus, this 3D simulation came in picture. All 3D models in the scene were built in real scale, and thus, allow us to have a realistic rendering simulation. This can save both time and expenses for attempting the reallocation in case the outcome was not disable which helps facilitating the administrative aspect of the parish.

To make this a truly interactive experience, we target to import the 3D model into a game developing engine, Unreal Engine for achieving real time light and smooth avatar navigation to the virtual reality. It will also be promoted to the Parish new official website and its social media accounts like Facebook, Instagram, and WhatsApp community to achieve large social coverage. We will also promote this interactive user experience to the Parish for an installation for people to experience with the Meta Quest Pro. Nevertheless, it would be ideal if this experience can reach to communities abroad as it aims to evangelise.

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The Platypuses of Art

Unclassifiable Practices and a Media Archive in Chile

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ABSTRACT

This article offers a critical and historical review of media arts in Chile, addressing their emergence, development, and the challenges of their inscription within the artistic field. From a situated genealogical perspective, it analyzes practices that intertwine art, science, and technology, highlighting both their growing institutional visibility and the difficulties surrounding their categorization and recognition within national art historiography. Using the figure of the "platypus" as a metaphor for the unclassifiable, the article proposes a reflection on the tensions between practice and theory, the persistence of exclusionary disciplinary models, and the need to expand interpretative frameworks to understand these cross-border experiences. It considers both pioneering and current cases and draws on theoretical references from science and technology studies, decolonial thought, technoscientific feminisms, and posthumanism. Overall, it underscores the urgency of constructing critical narratives that account for these practices as an integral—though historically marginalized—part of contemporary artistic production in Chile.

Keywords

Media Arts, Art and Technology, Art History in Chile, Transdisciplinarity, Platypus

1 Introduction

ACM's In recent decades, the development of media arts has shaped a dynamic and expansive field where aesthetic, technological, and scientific explorations converge. This expansion—observable both in the growth of institutional initiatives and in the diversity of formats, languages, and materialities—has generated a series of critical and conceptual challenges that question traditional categories of art. In Chile, the proliferation of festivals, laboratories, collaborative platforms, and collectives has helped to consolidate an active media ecosystem, although still scarcely documented from a historical and analytical perspective.

This work proposes a panoramic and situated review of the media arts field in Chile, attending both to its genealogy and the conceptual tensions that have accompanied its development. Central questions include: How has this field historically taken shape, and what narratives have been left out of the official histories of art? What discursive, political, or material strategies have artists working at the intersection of art, science, and technology deployed? How do these often marginal or unclassifiable practices challenge prevailing notions of authorship, medium, craft, and experimentation in contemporary art?

The methodology combines a critical bibliographic review of national and international texts, analysis of emblematic case studies, in-depth interviews with artists and curators, and the construction of an open digital archive: www.arteymedios.org. This repository seeks to gather, systematize, and circulate dispersed or hard-to-access information about works, artists, and initiatives that articulate art, science, and technology in Chile, with particular attention to experimental, collaborative, and decentralized experiences.

Through the metaphor of the platypus, this work offers a critical reflection on the unclassifiable condition of media arts, highlighting their cross-border potential and their capacity to reconfigure the links between aesthetics, technique, and knowledge, as well as to imagine alternative futures from a technopolitical and situated perspective.

2 What is Visible and What is Absent: Experimental Practices and Pending Narratives

Currently, artistic practices that use resources, references, and methodologies from various intersections

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with the sciences (biological, mathematical, physical) and technologies (analog and digital) have gained increasing momentum. This observation can be confirmed by the proliferation of specific events in this area and the considerable growth in their audiences. In Chile, initiatives such as the Bienal de Artes Mediales, the Tsonami Festival of Sound Art, the Toda la Teoría del Universo Festival, and the Lumen Art and New Media Encounter have become significant landmarks in the cultural calendar.

This growth has gone hand in hand with new critical approaches emerging from philosophy, anthropology, history, and the social sciences. These perspectives have nourished both artistic creation and thought around it, including actor-network theory [4, 5], new materialisms [2, 6], decolonial thought [10, 9], and posthumanism [1, 8].

Despite the significant rise of these practices, they have not been sufficiently addressed in a systematic way from the standpoint of art history and theory. In Chile, there are no books that have studied the relationship between art, science, and technology from a historical and analytical perspective focused on its specificity. This is not surprising, as there have also been few historical-theoretical attempts to describe national contemporary artistic production more broadly. While a large number of monographic essays or exhibition catalogues can be traced, until quite recently there were no texts addressing the topic in a panoramic way. To date, *Copiar el Edén* [19] and *Chile Arte Extremo: nuevas tendencias en el cambio de siglo* [20] are among the few attempts to describe this specific period of prolific production, though it displays vast conceptual, aesthetic, and formal differences. In the field of media arts, there is only the book *Apuntes para una historia del video en Chile* [16], which devotes just a brief section to video art, privileging instead the use of this medium in other independent genres such as journalistic documentary, and covering only a limited period: from the 1970s to the 1990s. Another relevant publication is *Sonidos Visibles: Antecedentes y desarrollo del Arte Sonoro en Chile* [17], which also seeks to provide a broad and general perspective on sound experimentation, referring only to a few works involving technology from the 1970s to the present. A text that also merits attention is *En el principio: arte, archivos y tecnologías durante la dictadura en Chile* [21], which addresses some moments in the early development of media arts in Chile, though from a critical stance regarding the dispersion of their archives. A more recent contribution is the book *Visiones Laterales. Cine y Video experimental en Chile 1957–2017* [15], which analyzes audiovisual artistic production from the mid-twentieth century to 2017. Even so, there are no published texts that address other areas of experimentation involving intersections with science and technology on a broader level. To date, the most exhaustive effort to describe and highlight the specificity of these practices has been the thesis *Arte de los Medios y transformaciones sociales en Chile durante la transición política* [13], but its temporal scope excludes the exponential growth of digital technologies related to big data, the application of artificial intelligence, and the mass use of mobile devices. This scarcity of narrative about contemporary production is likely due to the difficulties involved in defining this specific field.

3 On the Designation of the Field

"Media Art," "Medial Arts," "Art and New Media," "Electronic Art," "Digital Art," "Cyberart," "Transmedia Art" are some of the terms used to group or describe the diversity of practices that began to emerge with increasing visibility in the second half of the 20th century. These practices are characterized by the experimental and creative use of electronic and digital technologies, and later expanded their reach by incorporating approaches and languages from the biological, physical, chemical, and social sciences. This diversity of manifestations shares an experimental vocation and can hardly be reduced to a single style or program. That is, each of the different trends observable in this subfield of contemporary art develops distinct processes and presents varied formal, discursive, and material characteristics [11]. The names by which we know them may seem synonymous, but they are not equivalent. Some focus on their supports (electronic, digital, biological, organic, cybernetic, mechanical); others on their devices (computer art, net art, robotics, cinema, video); still others on their operational modes (interactive art, generative art, data visualization, mapping), or more generally are defined by the supposed novelty they entail. In this sense, the term "new media," popular since the 1990s and originally used to describe the impact of computing and video on our lives, may be the most problematic and questionable, as paradoxically the "new" refers to devices that become prematurely obsolete [14]. The technological devices that surround us

age and are discarded at an unprecedented speed, not because of their structure or functionality, but most often because of the mandate imposed by the market, which uses the concept of "innovation" as both a brand and an end in itself.

The nomenclatures used to designate this unstable and ever-shifting field of production always seem insufficient and pose a persistent challenge. Sociology, history, and art theory almost always seem to arrive too late in the face of the disciplinary overflow brought on by the new formal and technical possibilities offered by emerging languages, technological supports, and scientific challenges for artists. As digital art curator and theorist Christiane Paul notes, "technologies develop much faster than the rhetorics that describe them in their social, economic, and aesthetic dimension" [7]. This apparent gap between praxis and theory poses a major challenge for the disciplines that seek to narrate, systematize, analyze, and reflect upon artistic practices. But this problem is also evident in the more conventional and hegemonic fields of art. Even today, it remains uncomfortable to find a widely accepted definition for the term "art" itself, and the picture becomes even more complex with the use of compound terms that seek to delineate areas, categories, languages, and artistic genres. According to the standard art history books, for a long time the dominant expression was "fine arts," whose inscription in the 18th century attempted to establish a separation from utilitarian crafts—also called "servile" or applied arts [18]. However, the rapid transformations in representational forms throughout the 19th century—resulting from political, economic, social, and also technical changes—would lead to the collapse of the "fine arts" designation, which was replaced, not without controversy, by the contemporary label "visual arts". This label, again, proves insufficient, as it excludes practices such as sound art or those centered on tactile, olfactory, or kinesthetic perceptions, or whose aim lies in the production of knowledge.

4 Art's Platypuses: Unclassifiable Creatures at the Intersection of Science and Aesthetics

Artists who work with technological devices and draw from scientific inquiry often provoke confusion. They are frequently mistaken for engineers, activists, or inventors [22]. Their work seems to escape the traditional categories of the art field—as though they were specimens absent from a naturalist's catalogue. When Europeans first encountered a platypus in 1798, they believed it to be an elaborate hoax by a taxidermist. They searched for seams, suspecting that this strange creature from Tasmania was nothing more than a Frankenstein-like monster made from parts of other animals. Indeed, the platypus is a curious animal, with a "rare" constitution: it has a duck-like bill, a beaver-like tail, and an otter-like body. It is semi-aquatic, bioluminescent, a mammal that lays eggs; it is timid, playful, and venomous, and it possesses more than 40,000 electroreceptors that allow it to detect the electric field of its prey. In other words, it is an animal that eludes any known classification, any taxonomic order. Media artists may provoke a similar perplexity among audiences and critics. For a long time, the history and theory of art taught us to believe that science, aesthetics, and technology were distant realms. As a result, a wide range of artifacts, projects, and inventions were left out of the narrative constructed by art history to define a narrow and exclusive idea of what counts as art.

The construction of automata—documented since antiquity or in the writings of Giovanni Fontana in the 15th century; Athanasius Kircher's magic lantern in the 17th century; Leonardo da Vinci's inverted waterfalls; or the many optical machines that preceded the invention of the daguerreotype and cinematograph—were proposals either omitted or marginalized by art history and aesthetics. In a similar fashion, artistic representations from non-European regions were excluded, dismissed as "craft" rather than "fine art." These omissions and dismissals persisted well into the twentieth century. Nearly a hundred years ago, Marcel Duchamp himself—vanguard artist *par excellence*, known for his readymades—also created a series of strange devices (less acknowledged by the canon that celebrates him) that incorporated motors and generated optical illusions through the spinning of images: Rotative Plaques Verre (1920) and Rotary Demisphere (1925). In 1935, Duchamp extended this optical-aesthetic project by entering a competition for amateur inventors, presenting cardboard discs printed with lithographed drawings meant to be spun on a phonograph. His novel proposal went completely unnoticed by the public, as his invention was an "unidentified object," useless—or, as described by his friend Gabrielle Buffet-Picabia, lacking a "civil status" and therefore "impossible to classify for

scholars of aesthetics and urgent reason" [3]. Indeed, this lack of disciplinary inscription has long accompanied cross-border projects linking art, science, and technology.

Years later, in the 1960s, philosopher Gilbert Simondon would again use a legal metaphor to refer to technological objects: "Culture is unbalanced because it recognizes certain objects, such as the aesthetic object, and grants them citizenship in the world of meanings, while rejecting other objects, particularly technical ones" [12].

These cross-border arts have had to assume their marginal or eccentric condition. Although much time has passed since the 1960s—when, in the context of the emergence of computers and video, connections began to form between the scientific, technological, and artistic worlds through initiatives like E.A.T. Experiments in Art and Technology (1966), promoted by Bell Industries in the United States, or when Argentine artist Marta Minujín presented her piece *Simultaneidad en Simultaneidad* at the Instituto Torcuato di Tella in Buenos Aires, using the media of the time (television, telephone, radio, satellite)—techno-artistic experimentation continues to be met with suspicion or misunderstanding.

5 Media Arts in Chile

In our country, there have been many artists since the 20th century who could well have been identified as platypuses. In 1960, Juan Carlos Martinoya and Nahum Joel built the *Abstractoscopio cromático*, a kind of robot that, combining electronics, cybernetics, and crystallography, was able to project a wide range of visual compositions. Matilde Pérez incorporated electric motors into her kinetic sculptures and built the *Túnel Cinético* (1970), which allowed viewers to pass through it among effects produced by mirrors, lights, and geometric figures. In the same decade, Alejandro Siña worked with electromechanical elements; he studied at the Center for Advanced Visual Studies (CAVS) at MIT in the United States and experimented not only with the use of neon but also with its fabrication. In 1978, José Vicente Asuar invented the COMDASUAR, a hybrid-technology computer that enabled the performance of music. In the United States, Enrique Castro-Cid combined mathematics and planimetry (originally developed for aircraft design) to represent theories of physics, and inspired by cybernetics, he built strange anthropomorphic robots using discarded industrial parts, air compressors, electromagnets, and film projectors. In the 1970s, Gonzalo Mezza ventured into video art, installation, and the use of Polaroids and photocopiers; for his part, Juan Downey is not only considered one of the pioneers of video art but also stood out for his explorations in computer science, cybernetics, telematics, and "invisible energy" (radiation, seismic vibrations, radio and radar waves), seeking to establish connections between society, history, environment, and identity [13].

In the following decades, all these artists—unclassifiable in their time and whose work was often overlooked or dismissed by academia—found in the label 'media arts' a space of convergence. Initiatives such as the Bienal de Artes Mediales (dating back to 1993); the Matilde Pérez competition; the Primavera Hacker meeting; the Anilla MAC space; the regional gatherings LUMEN (Punta Arenas), Norte Medial (Antofagasta), Toda La Teoría del Universo (Concepción), and Tsonami (Valparaíso), have created platforms for exchange, training, and visibility for artists working across these disciplinary intersections.

While it may seem excessive to assign qualifiers to contemporary artistic practices, the adjective "medial," as used in Latin America—especially in Chile—has proven useful. The field of media arts has demonstrated remarkable dynamism, not only in terms of crossing disciplines, but also in contributing to critical, philosophical, political, and even socio-economic reflection on our time. It has allowed us to question the technoscientific predeterminations fostered by the digitalization of our lives and has invited us to imagine other im/possible futures.

6 Some Contemporary Platypuses

Among the contemporary artists whose work paradigmatically embodies the platypus-like condition of media arts are Constanza Piña, Natacha Cabellos Ricart, Nicole L'Huillier, and Daniel Cruz. Far from belonging to a single disciplinary field, their work moves between technological experimentation, aesthetic sensitivity, and critical thought. However, alongside these forms of hybridity between art, science, and technology, another equally unclassifiable current has emerged in recent years: that of those who reactivate ancestral knowledge through a medial lens, engaging with Indigenous cosmologies, ritual techniques, and native technologies.

This current—which we might call ancestral platypuses—broadens the medial spectrum by incorporating a cosmopolitical, affective, and spiritual dimension into technoscience.

Constanza Piña, also known as Corazón de Robota, is a clear example of this crossing between electronic art, feminist genealogy, and ancestral knowledge. Her project Khipu (2014–), conceived as a long-term research endeavor, revives the ancient Andean system of cords and knots as a form of coding and oracle. Using wool and copper threads as sonic and tactile antennas, Piña creates installations that allow us to "hear the voices of the void," exploring other possible genealogies for computing and memory technologies from a decolonial, situated, and feminist perspective. The act of spinning, amplifying, and resonating with the past from a collaborative laboratory embodies the figure of the platypus as an assemblage of dissonant knowledges.

Natacha Cabellos Ricart, for her part, shifts the focus toward technopoetic ecology. In works such as *Laboratorio de afectos para una planta migrante* (2019), a robotic hand caresses an aloe plant while sensors translate the contact into data visualizations. Her practice dismantles binary oppositions between nature and artifice, plant and machine, making visible the affective dimension of the non-human. From a posthuman and ecofeminist aesthetic, her work proposes forms of symbiotic coexistence between organic bodies and sensitive technologies.

In the case of Nicole L'Huillier, the intersection of sound art, science fiction, and technological spirituality takes the form of a kind of cosmic witchcraft. Works such as *Telemetron*, *Soledad*, and *Paracantora* are sonic and performative devices that connect data, residues, frequencies, and memories. In collaboration with other artists—as in *Resonaciones* (2022)—she has worked on reactivating Moche whistling vessels alongside Francisca Gili and healer Karen Urcia, proposing a medial mode of listening grounded in the Andean reciprocity of ayni. Here, technique is not merely machine: it is ceremony, vibrant memory, and cohabitation with the non-human.

Daniel Cruz, meanwhile, approaches the medial condition through a critical archaeology of contemporary control infrastructures. In *Espesores Tisulares*, he explores how information and surveillance systems shape our bodies and desires. Cruz acts as a techno-spy tracking the invisible flows of algorithmic power, staging the hidden matter of global digitalization: cables, data, dust, bodies, memory.

To these profiles we can add the emerging category of the ancestral platypus, a figure that finds resonance in the work of Francisca Gili. In the project Cantarino, Gili does not use technology as an instrumental medium, but rather as a form of sensory and cosmopolitical reactivation. Working with pre-Hispanic whistling vessels from the Moche culture, she does not conceive of them as archaeological remnants but as "ceramic beings," sonorous entities capable of affecting the present. Through sensors, synthesis systems, and immersive performances, Gili listens to and translates these silenced voices, integrating shamanic practices, contemporary technologies, and Andean epistemologies. Her work situates itself within what Yuk Hui has called *cosmotechnics*, what Silvia Rivera Cusicanqui names *ch'ixi* [10], or what Elvira Espejo proposes as *crianza mutua*: ways of thinking about technique beyond modern binary logic, as a vital network interweaving bodies, memory, affect, and territory.

In sum, the platypuses of media art in Chile not only destabilize disciplinary categories but also allow us to imagine other possible maps for art, where technique might be a fabric, a sound, a ritual choreography, or a gesture of care. In times of automation and planned obsolescence, perhaps the most radical act is not to invent the new, but to reactivate that which never truly left.

7 Conclusions

The platypuses of media art in Chile represent not merely an aesthetic anomaly but a powerful critical reservoir in response to the regimes of classification, archiving, and legitimation in contemporary art. Their practices do not fit within traditional taxonomies precisely because they emerge from border-crossing territories: between art and science, between invention and ritual, between technology and memory. But also between the visible and that which has been historically omitted.

Far from being mere eccentricities, these practices respond to deep and situated genealogies—often embodied in ancestral knowledge, vernacular technologies, or non-Western cosmologies—that challenge the linearity of technical progress imposed by hegemonic models. In this regard, concepts such as *cosmotechnics* by Yuk Hui (2020), *ch'ixi* by Silvia Rivera Cusicanqui (2015), or *crianza mutua* by Elvira Espejo (2019) operate not only as theoretical frameworks but as

ways of making, inhabiting, and resisting through media art.

In the face of a field still unevenly narrated, initiatives like PAM / Plataforma Arte y Medios have proven essential. Created nearly a decade ago, PAM has aimed to collect, document, and circulate a fragmented history: works, artists, devices, writings, and processes that would otherwise have remained outside official narratives. Rather than a closed archive, PAM functions as a living, open, and ever-evolving space that embraces disciplinary overflow as a methodology and media memory as a political act.

Like the platypus, these practices escape the natural order of things—not because they are monstrous, but because they reveal that what is considered 'natural'—even in art—has been an exclusionary construction that we can now dismantle, wire by wire. Perhaps the most challenging—and promising—aspect of media arts in Chile is not what they represent, but what they disrupt.

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SOMA: Interactive Dynamic Calligraphy and Poetic Sceneries

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Figure 1: SOMA: a dynamic visual composition generated as a poetic landscape, created through participant interaction via pose and voice input.

Abstract

This paper introduces SOMA, an AI-driven interactive system that bridges embodied interaction, traditional Chinese art forms (calligraphy and landscape painting), and real-time media art creation. SOMA transforms users' body movements into dynamic calligraphy and generates poetic landscapes based on spoken phrases, enabling a cross-cultural and personalized artistic experience. The system employs a Variational Autoencoder (VAE) to map motion data to calligraphic strokes and utilizes voice input to create generative landscape paintings inspired by Chinese aesthetics. Through experiments with users from diverse cultural backgrounds, SOMA demonstrates its potential to democratize the appreciation of traditional art forms and foster collaboration between humans and AI. This paper discusses the system's technical implementation, artistic contributions, and implications for cross-cultural media art.

CCS Concepts

• **Applied computing** → **Media arts**; • **Human-centered computing** → *Human computer interaction (HCI)*; • **Computing methodologies** → *Machine learning*.

Keywords

Calligraphy, Embodied interactive art, Language, digital landscape, machine learning

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1 Introduction

Art has always served as a bridge across cultures, enabling people to connect, communicate, and understand diverse perspectives [19, 22].

The intersection of human-computer interaction (HCI) and media art has further opened up new possibilities for creative expression, offering innovative ways to reinterpret traditional art forms in contemporary contexts [12, 16]. Among these, traditional Chinese art forms, such as calligraphy and landscape painting (Shan Shui), stand out for their profound cultural and philosophical significance [10, 23]. These art forms, with their emphasis on the fluidity of brush strokes, balance of composition, and poetic abstraction, embody the essence of Chinese aesthetics [15].

However, traditional Chinese art forms pose significant challenges for cross-cultural engagement and appreciation [28]. Their elegance and philosophical depth often require extensive cultural and historical knowledge to fully understand, creating barriers for global audiences unfamiliar with their context. Moreover, the static nature of these art forms limits their accessibility in a world increasingly shaped by interactive and immersive experiences. This raises the question: How can we make traditional Chinese art forms more accessible and engaging for diverse audiences while preserving their cultural essence?

The fusion of art and technology has shown promise in addressing such challenges. From Harold Cohen's AARON [9], an autonomous drawing program in the 1970s, to recent advancements in deep learning (DL), the integration of artificial intelligence (AI) into artistic processes has significantly transformed how we create and experience art [7, 29]. AI-powered systems enable innovative translations across semiotic spaces, such as converting speech into images or gestures into visual compositions, and redefine audience participation in artistic experiences [24]. Meanwhile, embodied interaction—which allows participants to engage with art through physical movements and personal experiences—has emerged as a powerful medium for bridging cultural and artistic gaps [32, 35]. Generative AI models, such as Variational Autoencoders (VAEs) and text-to-image synthesis frameworks, further enable the creation of dynamic, real-time artistic outputs that adapt to user inputs, fostering new forms of creative expression.

Despite advancements in technology, there remains a lack of research methodologies that effectively integrate embodied interaction, real-time AI generation, and traditional Chinese art to explore personalized, cross-cultural, and intuitive artistic experiences. Current approaches often struggle to balance the authenticity of traditional aesthetics with the interactivity of modern technology, leaving significant opportunities unexplored in the intersection of these domains. Moreover, limited attention has been given to how techniques such as pose-to-glyph mapping or voice-to-landscape translation might reinterpret traditional Chinese art in ways that resonate with contemporary audiences.

To address these challenges, this paper proposes a novel method for reimagining traditional Chinese art forms through embodied interaction and real-time media generation. This method explores how pose-to-glyph projection and voice-driven generative landscapes can be employed to enhance the expressive potential of traditional aesthetics while fostering a deeper connection between cultural heritage and modern technology. To validate this approach, we developed a system, SOMA(as shown in figure 1), as an implementation of the proposed method. SOMA, inspired by the Greek word meaning "body," transforms users' body movements into dynamic calligraphy and their vocal inputs into poetic landscapes, creating a personalized and immersive artistic experience .

The implementation of SOMA serves as a proof of concept to evaluate the feasibility and potential of our method. By bridging cultural heritage with cutting-edge technology, this research contributes to the democratization of traditional art and fosters cross-cultural engagement and creative collaboration between humans and AI. Furthermore, the proposed method leverages scalable and adaptable techniques to provide insights for future artistic and cultural applications. Our work includes the following contributions:

- **A method for integrating embodied interaction and real-time AI generation to reinterpret traditional Chinese art forms.** This approach highlights the role of human gestures and voice as dynamic inputs, transforming traditional aesthetics into participatory and evolving experiences.
- **A Decoupled Few-Shot Pose-to-Calligraphy Synthesis Method.** Novel training paradigm separating style learning (via unpaired VAE) from pose conditioning, enabling few-shot generation while preserving artistic fidelity.
- **Mechanisms for Generative AI-Mediated Abstraction and Cultural Translation.** The development and validation of SOMA,a system designed to demonstrate the feasibility and potential of the proposed approach.This work reveals computational technology's potential to reinterpret cultural heritage while enhancing its contemporary accessibility and communicative power.

2 Related Work

With the transformative potential of emerging technologies in audience engagement, creative expression, and cultural preservation, the intersection of art and technology has become a significant area of research. This section reviews related works across three key domains: embodied interaction in media art, machine learning in artistic creation, and the integration of technology in calligraphy. By exploring these fields, we aim to uncover the possibilities and challenges of combining traditional art forms with contemporary computational techniques, providing a comprehensive foundation for this study.

2.1 Embodied Interaction in Media Art

Embodied interaction has been widely explored in media art, emphasizing user engagement through physical movement. Lights! Dance! Freeze! by Papatheodorou employs pose indexing and machine learning-based body tracking to allow participants to interact with a vast database of musical film sequences [26]. By mirroring participants' real-time movements and linking them with choreographic poses from iconic musicals, the system transforms passive media consumption into an immersive and participatory experience.

Similarly, Wendell and Guan's Embodied Movement and Generative Media Performance integrates motion capture into a performative context [34]. Set within an 8' cubic projection volume, the performer's movements trigger generative media projections that narrate the history of Asian American immigration. This work combines embodied interaction with cultural storytelling, using the

dancer's body as a medium for exploring historical and generative narratives.

These examples reflect the growing potential of embodied interaction in media art to bridge the physical and digital realms. By integrating motion tracking and generative media, such works not only enhance audience engagement but also open new pathways for storytelling, cultural exploration, and creative expression.

2.2 Machine Learning in Artistic Creation

AI technologies, particularly generative models like Variational Autoencoders (VAEs) and Generative Adversarial Networks (GANs), have significantly transformed artistic creation. These models enable the synthesis of complex visual and auditory outputs, fostering new forms of creativity in painting, music composition, and poetry. Despite these advancements, integrating AI systems with real-time user inputs remains a challenge, especially in contexts that involve cross-cultural expression.

One notable example is Dream Painter (2021), an interactive robotic art installation by Varvara and Mar [4]. This work connects robotics and interface design with generative AI, allowing participants to navigate the latent space of a model in real-time through voice input. The robotic system generates sketches that lie between abstract and figurative forms, inviting both the participant and the audience to interpret the artwork. This open-ended interaction exemplifies how AI can enhance creativity by engaging users as co-creators in the artistic process.

Recent research by Christian Sivertsen et al. highlights ambiguity in AI art as a key source of interpretative richness [30]. Sivertsen et al. (2024) analyzed nine AI artworks and identified a novel concept: ambiguity of process. Unlike traditional ambiguity, which focuses on the artifact itself, ambiguity of process emerges through the machine learning (ML) pipeline, including dataset curation, model training, and application. For instance, works like ImageNet Roulette by Crawford and Paglen challenge the assumptions embedded in pre-existing datasets by exposing problematic or biased labels, provoking critical reflection on AI's perceived objectivity [25]. Similarly, Mario Klingemann's Butcher's Son leverages visual artifacts generated through unconventional model training to create painterly, ethereal portraits [17]. These examples demonstrate how ambiguity, deliberately introduced at different stages of the ML process, can deepen audience engagement and open new pathways for artistic expression.

2.3 Expanding the Horizons of Calligraphy

Calligraphy, as both a visual art form and a medium of cultural expression, has been a subject of reinterpretation through artistic and technological means. Two distinct approaches—traditional reconstruction and AI-driven synthesis—demonstrate how calligraphy continues to evolve in modern contexts.

One seminal work in this area is Xu Bing's Tian Shu (A Book from the Sky) [2], created between 1987 and 1991. This monumental installation comprises hand-carved woodblock prints of over 4,000 fabricated Chinese characters, meticulously modeled after Ming dynasty Song typefaces. The installation features hundreds of bound volumes, scrolls, and enlarged book pages arranged in an immersive environment. While these "pseudo-characters" resemble real Chinese characters, they hold no semantic meaning, rendering the texts unreadable.

Xu Bing's intention was to challenge the viewer's assumptions about language, culture, and knowledge systems. He once remarked that these pseudo-characters "make intellectuals uncomfortable," compelling audiences to question the established structures of meaning. The juxtaposition of intricate craftsmanship with illegibility highlights the tension between visual familiarity and semantic inaccessibility, forcing viewers to confront their own compulsion to decipher meaning. Since its debut in 1988, Tian Shu has sparked widespread discussion and been included in numerous art historical texts as a critical work of postmodern deconstruction.

In contrast, recent developments in artificial intelligence have introduced computational methods to reconstruct and extend calligraphy's expressive potential. Projects like MaLiang employ generative models, such as GANs, to synthesize emotionally nuanced calligraphy based on textual sentiment [21]. Unlike Xu Bing's deliberate obfuscation of meaning, AI systems like MaLiang aim to enhance expressiveness and accessibility, generating stylistically diverse and emotionally resonant calligraphy artworks.

Cursive Calligraphy in 3D and Bio-Ink by Lin, Zhou, and Zhang (2024) leverages emerging technologies to reinterpret the traditional concept of qi (vital energy) in calligraphy [20]. This project integrates bio-data, such as EEG (electroencephalogram) and EMG (electromyography), with motion capture and 3D particle systems to create dynamic, immersive calligraphy artworks. The authors introduce the concept of bio-ink, a visualization technique where the calligrapher's physical and emotional states directly influence the flow, brightness, and size of particles. This approach expands calligraphy beyond the limitations of two-dimensional space, offering a metaphorical and tangible representation of the calligrapher's inner world.

These three works showcase complementary approaches to calligraphy's evolution in contemporary contexts. Xu Bing's Tian Shu challenges the constructed nature of language by creating pseudo-characters, provoking philosophical reflection on linguistic systems. MaLiang bridges tradition and technology, employing AI to generate emotionally resonant and stylistically diverse calligraphy. Meanwhile, Cursive Calligraphy in 3D and Bio-Ink integrates bio-data and 3D visualization to provide an immersive, interactive representation of the calligrapher's inner world. Together, these works exemplify how tradition and innovation converge, offering new perspectives on how calligraphy can evolve as both an artistic and technological practice.

3 Method

Our goal is to translate live human body configurations, captured by a monocular camera, into stylistically faithful calligraphy glyphs. Because collecting large pose–glyph corpora is prohibitively labour-intensive, we decouple style learning from pose conditioning. The complete pipeline (Fig. 3) therefore comprises three stages:

(1) **Large-scale data preparation** using an *unpaired* calligraphy corpus and a much smaller pose–glyph set;
(2) **Unconditional VAE training** on the calligraphy corpus to capture the full stylistic manifold *once and for all*;



Samples from the CCD dataset Samples from our Pose-glyph dataset

Figure 2: Dataset. Left: Representative glyphs from the 1.6 M-image Chinese Calligraphy Dataset (CCD), illustrating the stylistic breadth across six historical scripts on which our unconditional VAE is trained. Right: Construction and examples of our ∼ 500-pair *pose–glyph* set. A raw RGB frame is first captured (top-left inset), OpenPose extracts a stick-figure skeleton that is binarised, centred, and resized to 256×256 (labelled "pose"), and the performer's handwritten character scanned at 600 dpi provides the matching calligraphy image ("cali"). The grid shows additional pose–glyph pairs spanning varied limb configurations and characters, serving as supervision for the pose-to-latent projector.

(3) **Pose-to-latent projection** that learns to navigate the frozen VAE space from only ≈ 500 labelled pairs.

This modular strategy amortises the expensive style model across millions of readily available glyphs, while limiting the human-in-the-loop effort to a few hundred curated poses.

3.1 Data Curation

Calligraphy corpus. We build on the public *Chinese Calligraphy Dataset* (CCD)[1], which provides roughly 1.6 M glyph images covering six canonical scripts—clerical, regular, running, grass, seal, and clerical-variant. Each glyph is already deskewed, binarised, and rasterised as a 140×140 black-on-white bitmap; we simply bilinearly up-sample to 256×256 before feeding the VAE. The absence of stroke-level labels is irrelevant here—*unsupervised* learning of style is precisely what allows us to exploit this massive resource without additional annotation cost.

Pose–glyph pairs. Because collecting millions of paired samples is infeasible, we instead curate a focused set of ≈ 500 pose–glyph pairs $\{(\mathbf{s}_i, \mathbf{g}_i)\}$. For each target character, one or two volunteers align their limbs to evoke its dominant stroke pattern; a single 1080p RGB frame is captured against a plain backdrop. The same volunteer then writes the character in black ink on white paper, and the sheet is scanned at 600 dpi, yielding a style-consistent glyph. This minimal but high-quality set is sufficient once the heavy stylistic burden has been shifted onto the unconditional VAE(As shown in Fig. 2).

[1]https://github.com/zhuojg/chinese-calligraphy-dataset

Pose preprocessing. Each frame is processed with OpenPose [5, 6, 33] to extract an 18-keypoint skeleton, which we rasterise into a 10-pixel-wide white stick figure on black. We crop the tight bounding box of foreground pixels, pad to a square, and resize to 256×256, producing a binary image $\mathbf{s} \in [0,1]^{256\times256}$ that serves as input to the projector. This representation is cheap to obtain and, thanks to the VAE, *does not* need to reflect stroke-level detail.

3.2 Variational Auto-Encoder Preliminaries

Variational Auto-Encoders (VAEs) [17, 27] learn a differentiable mapping between a Gaussian latent space and a high-dimensional data manifold. They define

$$p_\theta(\mathbf{x}, \mathbf{z}) = p_\theta(\mathbf{x} \mid \mathbf{z})\, p(\mathbf{z}), \qquad p(\mathbf{z}) = \mathcal{N}(0, I),$$

with decoder $p_\theta(\mathbf{x} \mid \mathbf{z})$ and an approximate posterior $q_\phi(\mathbf{z} \mid \mathbf{x}) = \mathcal{N}(\boldsymbol{\mu}_\phi(\mathbf{x}), \operatorname{diag} \boldsymbol{\sigma}^2_\phi(\mathbf{x}))$ implemented by an encoder. Training maximises the evidence lower bound

$$\mathcal{L}_{\text{ELBO}} = \mathbb{E}_{q_\phi(\mathbf{z}|\mathbf{x})}\big[\log p_\theta(\mathbf{x} \mid \mathbf{z})\big] - \mathrm{KL}\big(q_\phi(\mathbf{z} \mid \mathbf{x}) \,\|\, p(\mathbf{z})\big). \quad (1)$$

In our setting the decoder learns to *render* any 128-D latent code as a 256×256 glyph, while the encoder maps a glyph back into latent space. Once trained on the large unlabeled CCD, we **freeze** the decoder: this prevents the tiny paired set from collapsing stylistic diversity and lets later modules "speak the decoder's language" without re-learning style.

3.3 Unconditional Calligraphy Generation

We implement (E, D) as a 5-layer Conv–BN–LeakyReLU encoder that reduces resolution from 256 to 4, and a mirrored decoder; the latent dimension is d=128. The loss

$$\mathcal{L}_{\text{VAE}} = \|\mathbf{x} - D(E(\mathbf{x}))\|_1 + \beta\, \mathrm{KL}\big(q(\mathbf{z} \mid \mathbf{x}) \,\|\, \mathcal{N}(0, I)\big), \quad (2)$$

$\beta = 0.005$ balances fidelity and latent smoothness. Online affine and elastic augmentations ensure that the learned manifold is well connected, which later simplifies pose navigation. Training for 100 epochs on the full CCD (batch 256, Adam, 10^{-4} LR with cosine decay) amortises style learning across millions of glyphs—an investment we need make *only once*.

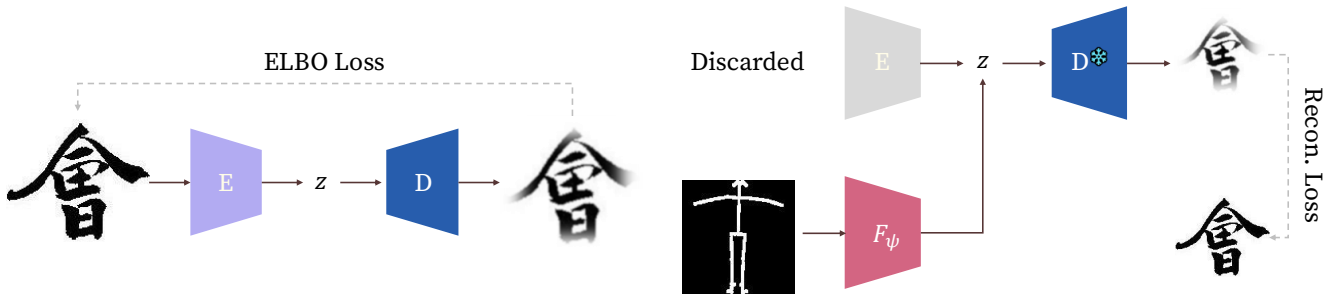
3.4 Pose-Conditioned Calligraphy Generation

Pose-to-latent projector. Given that the decoder is frozen, we need only learn a lightweight mapper $F_\psi : \mathbb{R}^{256\times256} \to \mathbb{R}^{128}$ from preprocessed skeletons to latent codes. A four-block Conv–BN–ReLU network followed by global average pooling and a linear layer suffices. We optimise

$$\mathcal{L}_{\text{pose}} = \|\mathbf{g} - D\big(F_\psi(\mathbf{s})\big)\|_1 + 0.1\, \|F_\psi(\mathbf{s}) - E(\mathbf{g})\|_2^2, \quad (3)$$

for 8 k iterations (batch 32, Adam, 10^{-4} LR). Because D is fixed, this small network converges in minutes and *cannot* over-fit style—the decoder enforces it automatically.

Inference. A live video stream is skeletonised, rasterised, and passed through F_ψ; the resulting latent code is decoded by D to produce the glyph. The entire system runs at > 40 fps on one RTX 3090, enabling interactive "pose-as-ink" performance art.



(a) First Stage Unconditional VAE Training (b) Second Stage Pose-Conditioned Model

Figure 3: Pose-to-Calligraphy pipeline. (a) Stage 1: an unconditional VAE is trained on 1.6 M unlabeled glyph images. The encoder E compresses a glyph into a 128-D latent code, and the decoder D reconstructs the glyph; dotted arrows indicate the reconstruction loss used during VAE training. (b) Stage 2: after training, the decoder D^* is frozen. A binary stick-figure skeleton extracted from a camera frame is fed to the pose projector F_ψ, which predicts a latent vector. During learning, the generated glyph is supervised by (i) an image-space loss against the paired ground-truth glyph and (ii) a latent-space alignment term obtained by re-encoding the glyph with E. At inference time only F_ψ and D are active, turning live human poses into stylistically coherent calligraphy in real time.

Discussion. Training the stylistic decoder on an abundant *unpaired* corpus while keeping pose conditioning in a separate, lightweight module offers several synergistic benefits. First, it is highly *data-efficient*: millions of historical glyphs can be exploited without the prohibitive effort of recording equally many pose–glyph pairs. Second, freezing the decoder after unconditional training provides an intrinsic *regulariser*: every projected code is forced to reside on the well-behaved calligraphic manifold, so the small paired set cannot collapse stylistic diversity. Third, the projector's tiny footprint enables *rapid iteration*; it retrains in minutes, allowing quick experimentation with alternative pose normalisation schemes, loss weights, or even entirely new conditioning signals such as audio or depth. Finally, the modular split future-proofs the system: one can swap in a higher-resolution decoder, adopt a diffusion prior, or upgrade the pose extractor—*without* re-collecting paired data or altering the training recipe.

4 Experiments and Results

4.1 Unconditional Generation

Setup. We randomly split the 1.6 M-image CCD into 95 % training and 5 % held-out test sets. The VAE is trained exactly as described in Sec. 3; all quantitative scores are reported on the test split. For qualitative inspection we render: (i) the original glyph, (ii) its reconstruction after a pass through encoder E and decoder D, and (iii) a glyph decoded from a random $\mathcal{N}(0, I)$ latent (Fig. 4).

Metrics. On the held-out test split we measure a mean absolute error of MAE=0.0740 and a structural similarity of SSIM=0.7490 between the original glyphs and their reconstructions. These values confirm that the 128-D latent codes preserve both stroke layout and a significant portion of high-frequency brush texture. We omit FID here because it is dominated by inter-script style variance and is less informative for single-image reconstructions.



Figure 4: Each column shows one character; rows are (top) original CCD glyph, (middle) reconstruction obtained by passing the glyph through the encoder–decoder, and (bottom) a glyph synthesised by decoding a random Gaussian latent vector. The middle row illustrates that the VAE preserves overall stroke layout and style despite compressing each image to a 128-D code, while the bottom row demonstrates its ability to generate plausible—though occasionally imperfect—new calligraphy samples without any pose conditioning.The third row (bottom) is randomly generated by AI.

Training. We train the VAE for 100 Epochs (approximately 90K steps). The KL term drops precipitously during the first few hundred iterations and then flattens around 7, confirming that the small weighting factor β quickly constrains the posterior without dominating learning. A low, stable KL is desirable here: it regularises the latent codes toward the unit Gaussian while still leaving most capacity for reconstruction quality. After an initial sharp descent, the reconstruction loss continues a slow but steady decline across the remaining 80 k steps. This long tail indicates that the network keeps discovering finer brush-stroke details and subtle intra-script variations even after the global structure is learned.

Analysis. Reconstructions remain visually faithful despite aggressive compression, underscoring the decoder's capacity to model

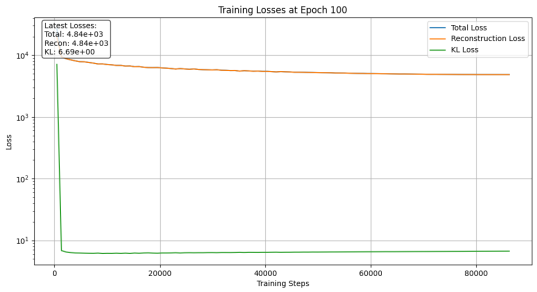


Figure 5: Log–linear plot of total loss (blue), reconstruction loss (orange), and KL divergence (green) over 90 k optimisation steps (100 epochs on CCD). The legend (top left) shows the final values at the end of training.

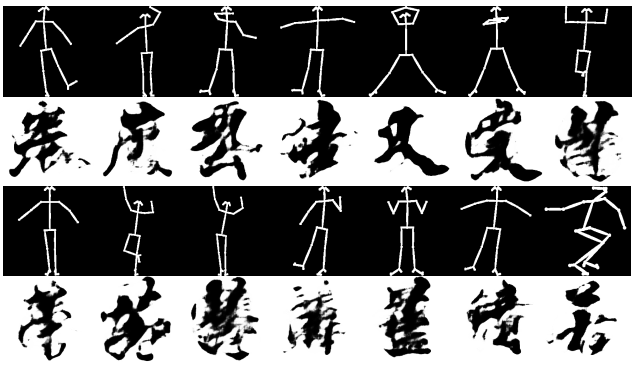


Figure 6: Pose-conditioned synthesis: glyphs generated by feeding the skeleton through the pose projector F_ψ and the frozen decoder D^*. The examples cover static, symmetric postures as well as highly articulated, asymmetric ones. In all cases the model produces calligraphy that echoes the global silhouette of the pose while preserving brush texture learned from the unconditional VAE. The generated characters exhibit traces of multiple classical calligraphic traditions, most notably embodying distinctive features of the Wei Bei style – characterized by its angular strokes, deliberate irregularity, and stone-carved aesthetic. This manifests particularly through sharp turnings in brushwork, asymmetrical balance in compositional structure, and the rugged visual rhythm reminiscent of Northern Dynasties stele engravings.

the CCD manifold. By contrast, samples drawn *directly from the isotropic Gaussian prior* exhibit broken strokes or ink splatter (bottom row, Fig. 4). This quality gap is expected for three reasons:

(a) **Prior–posterior mismatch.** The aggregated posterior only approximates $\mathcal{N}(0, I)$; random codes can land in regions the decoder has rarely visited.
(b) **KL trade-off.** The KL term pushes codes toward the origin for smooth interpolation but limits their capacity to retain fine script-specific detail. Reconstructions decode from $q_\phi(\mathbf{z} \mid \mathbf{x})$, which still carries image-dependent information; prior samples receive none.
(c) **Single-stage generation.** A vanilla VAE must capture both geometry and texture in one shot, unlike diffusion [14] or hierarchical models [31] sthat refine details over multiple steps. Random latents therefore reproduce coarse layout but may lose brush refinement.

4.2 Pose-Conditioned Generation

Experimental protocol. The pose projector F_ψ is trained on the $\sim$500 curated pose–glyph pairs for 8 k optimisation steps (batch 32, Adam, 10^{-4} LR) while the VAE decoder D^* remains frozen. During training we augment skeleton images with random horizontal flips and slight affine jitter to encourage robustness to camera viewpoint changes.

Qualitative evaluation. Figure 6 shows a diverse set of test-time poses alongside the glyphs produced by our system. The model reliably maps upright, spread, and one-arm-raised configurations to distinct global stroke layouts: narrow stances yield compact glyphs, whereas wide arm spans lead to horizontally elongated brushwork. Because the underlying style prior comes from the unconditional VAE, the generated ink retains realistic feathering and stroke taper even though the projector has never seen these exact poses.

Observations and limitations.

- **Stylistic consistency.** All outputs share a coherent cursive flavour inherited from the VAE, demonstrating that pose conditioning does not break the learned style manifold.
- **Pose sensitivity.** Small changes in limb angle produce smooth variations in glyph morphology, suggesting that the latent space learned by F_ψ is locally continuous.
- **Failure cases.** Extreme or out-of-distribution poses occasionally map to overly sparse glyphs whose strokes fragment (rightmost columns). We attribute this to latent codes falling near the edge of the VAE prior, a problem that could be mitigated with a larger or more varied paired set.

Runtime. Because F_ψ contains fewer than 0.3 M parameters and D^* is a single forward pass, the full pipeline runs at real-time on desktop graphic cards, enabling live "pose-to-ink" performance art without specialised hardware.

5 Art Design and Implementation

5.1 Artistic Concepts

SOMA is an interactive art installation that transforms participants' bodily movements and spoken language into dynamic, generative visual forms, including abstract calligraphy and poetic landscapes. Unlike traditional static artworks, SOMA prioritizes the fluidity of artistic creation, where artificial intelligence continuously interprets human gestures and voices in real time. The resulting outputs are visually captivating, blending cultural symbolism with modern computational aesthetics. This work reimagines traditional Chinese art forms such as calligraphy and Shan Shui (mountain-water) painting, constructing a poetic interplay between the human body, language, and AI.

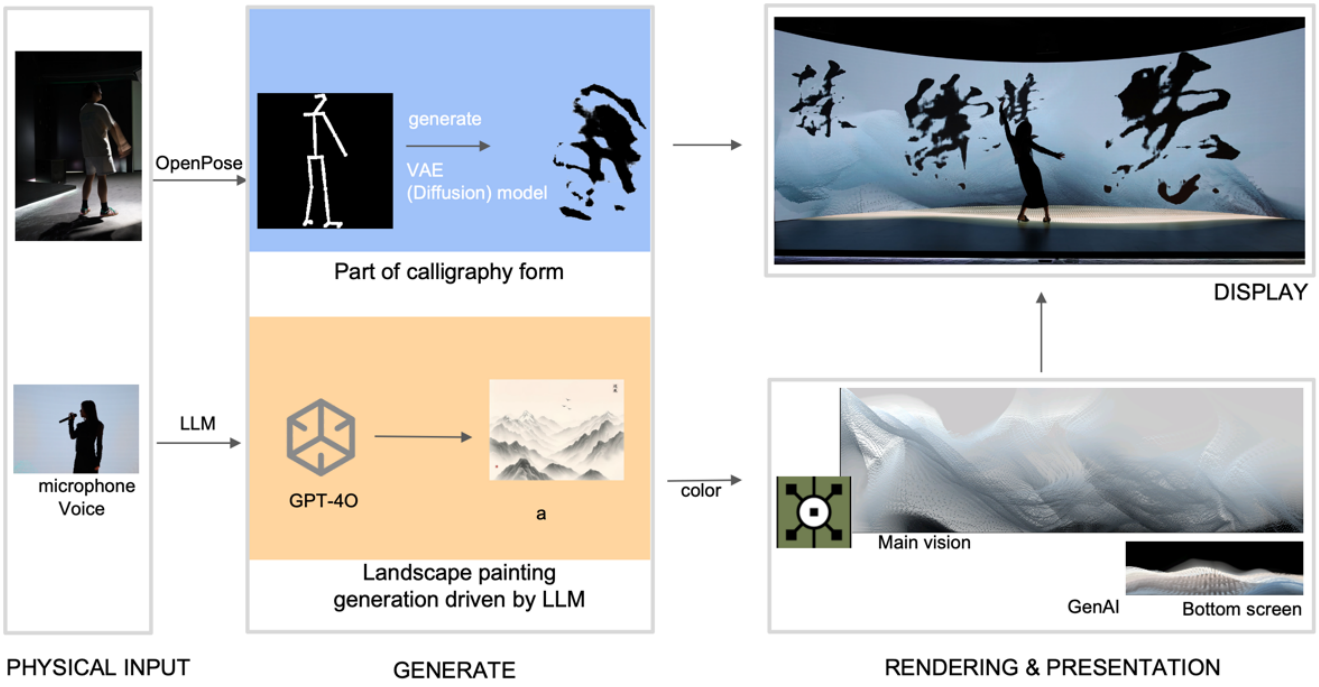


Figure 7: SOMA workflow

The system decodes participants' gestures through OpenPose, an advanced pose estimation algorithm that captures the spatial trajectories and temporal dynamics of bodily movements. These motion data are then mapped to a generative AI model based on a Variational Autoencoder (VAE), which creates abstract calligraphic strokes. These strokes convey a sense of familiarity yet resist readability, creating a dynamic tension between recognizability and abstraction. Simultaneously, participants' spoken language is processed by a large language model (LLM) to generate corresponding visual imagery. These images are rendered into elements of Shan Shui landscapes, seamlessly blending traditional aesthetics with computational innovation. By integrating AI into this process, SOMA underscores the democratizing potential of mechanical reproduction, as described by Walter Benjamin, enabling ancient cultural symbols to be reimagined and shared across diverse audiences [1].

Furthermore, the LLM supports multiple languages, allowing the transformation of diverse linguistic inputs into cross-cultural visual expressions. This mechanism evokes a continuation of the "Tower of Babel" narrative, where disparate languages are unified through visual and artistic interpretation.[13] SOMA redefines "language" by transcending traditional notions of text and speech, incorporating bodily movement as an expressive medium. The resulting artworks are ephemeral and transient, existing only in the moment of interaction and embodying the dynamic relationship between human intent and machine interpretation. Through this process, SOMA breathes new life into classical artistic forms, blending the rhythm and flow of human gestures with the serenity and depth of traditional Chinese art.

5.2 Implementation

SOMA integrates multiple technologies to create an interactive and dynamic visual experience driven by physical movements and vocal inputs(As shown in Fig. 7). OpenPose is used to capture the user's body movements, detecting and mapping their skeletal structure in real time. Simultaneously, a microphone collects vocal inputs, enabling the system to interpret the user's speech or vocal expressions. These inputs are processed by a large language model (LLM), which analyzes the voice data to generate descriptive outputs. Meanwhile, skeletal data (denoted as "b") is fed into a Variational Autoencoder (VAE) based on a diffusion model to produce abstract, calligraphic visual representations inspired by the user's movements.

The outputs from the LLM and VAE are then combined. The LLM generates an image, which is used as an input for TouchDesigner (TD). This input directly influences the color and style of the generated visuals. Through TouchDesigner (TD) rendering, the system creates a digital poetic landscape inspired by traditional Chinese ink painting.Meanwhile, the Noise component was applied to extract and manipulate the color data generated by GPT-4o, infusing the visual outputs with dynamic, textured gradients that mimic the fluidity and tonal richness of ink washes.

This TouchDesigner system processes vocal input through a two-stage pipeline. In the first stage, GPT-4O generates images from participant speech, which are normalized through a Fit TOP. Color

data extracted from these images passes through a Null TOP to drive procedural geometry in a Geometry COMP. The output from this stage is rendered as "render1" but lacks artistic detail. To enhance visual expression, the second stage employs a Feedback TOP to create trailing effects through frame blending, combined with Noise and Transform TOPs that introduce organic distortion and diffusion. These processed layers are composited and mapped onto a cylindrical display, transforming voice input into dynamically evolving visual art with improved textural complexity.

The primary display showcases the main artistic visuals, while the bottom screen incorporates generative AI (GenAI) to produce complementary, pre-designed visual effects. By merging body movements, voice interaction, and generative AI, the system offers a seamless and immersive environment where traditional calligraphy is reinterpreted through modern computational techniques.

5.2.1 Ethics and Data Governance. This study adheres to the principles of data minimization, transparency, and revocability. By default, the system processes and stores only anonymized skeletal keypoints and text transcripts; raw audio and video are not retained. If short-term buffering of raw streams is required for verification, data are encrypted locally and scheduled for timely deletion. All participants provided informed consent and may request deletion of their data and generated imagery at any time. Multilingual adaptation and accessibility interfaces are provided to support participants with diverse bodily abilities and language backgrounds.

5.2.2 Accessibility Considerations. SOMA runs in real time on consumer-grade hardware and offers degraded rendering modes and alternative input pathways to accommodate varied resource conditions and bodily abilities. The system supports multiple languages and text-based alternatives to speech input, and provides motion amplification and parameterized abstraction controls to ensure that participants with different abilities and cultural backgrounds can achieve aesthetically compelling and controllable experiences.

5.3 Interactive Participation



Figure 8: The digital landscape of mountains and waters generated by the system based on oral input from different cultural backgrounds

We invited participants to provide linguistic inputs in various languages, such as Chinese, Italian, and French. When processed by GPT-4o, the generated images tend to lean toward realistic and representational styles. To address this challenge and align the outputs with the poetic abstraction of traditional Shan Shui (mountain-water) painting (As shown in Fig. 8), we utilized TouchDesigner to reinterpret these images. By adjusting the camera perspective and employing Box and Noise components, we transformed the input data into planar, particle-based digital landscapes that emulate the aesthetic of traditional ink paintings. This technique effectively bridges the gap between realism and abstraction, ensuring that the system's artistic outputs resonate with the intended style.

Figure 9 demonstrates how linguistic inputs transform into abstracted landscapes while merging with movement-driven calligraphy. When describing "The peach tree in its prime" (top), the participant's sweeping arm motions generated cursive glyphs that integrated with blossoming particle formations, creating rhythmic unity between body and nature. Similarly, the phrase "The night rain has tinged the sky and water with emerald" (bottom) materialized as layered ink washes where voice-triggered gradients merged with rain-like calligraphic strokes. These outputs visually manifest the participant's assertion of their body becoming a brush—where gesture defines form and language sets tone.

One participant remarked, "In this system, I can imagine my body as a brush." This poetic metaphor encapsulates the essence of interactive participation in SOMA. The body, through its gestures and movements, becomes an active tool for creation, dynamically shaping the generative calligraphy and landscapes. By inviting the audience to interact with the system through their own physical and linguistic expressions, SOMA transforms the creative process into a deeply personal and immersive experience. Participants not only engage with the artwork but also become co-creators, merging human intention with artificial intelligence to produce unique, ephemeral visual compositions.

6 Discussion

In the realm of interactive AI art, the designer occupies a pivotal role in orchestrating and shaping the audience's experience [3, 18]. Compared to traditional art forms, generative AI art is distinguished by its inherent unpredictability and dynamic nature. This unpredictability not only introduces boundless creative possibilities into the artwork but also diversifies and personalizes the audience's interactive experience. However, this dynamic quality also presents challenges for artists, who must carefully navigate the balance between the autonomy of algorithm-generated outputs and the participatory role of the audience. Ensuring aesthetic coherence and maintaining cultural integrity within a technology-driven creative process remain critical tasks for practitioners in this space.

As a prominent representative of Chinese traditional art, calligraphy has historically oscillated between the "purity of line-based abstraction" and the "readability of textual content" [8, 11]. Traditionally, it has served as both a visual art form and a linguistic medium. However, in the context of contemporary art, its role has gradually shifted from being primarily a carrier of language to a form of visual abstraction that emphasizes aesthetic expression. The integration of generative AI further extends the expressive boundaries of calligraphy, transcending the constraints of two-dimensional surfaces. Dynamic generation techniques amplify the



Figure 9: This figure shows two cases. Top Image: Shows the landscape generated from a participant's input text: *"The peach tree in its prime."* This visual scene is merged with calligraphy dynamically generated by her movements.Bottom Image: Shows the landscape generated from the participant's input text: *"The night rain has tinged the sky and water with emerald."*

expressive potential of calligraphic strokes, focusing less on textual legibility and more on the rhythm, force, and spatial flow of lines, thereby underscoring its potential as an abstract art form.

A key challenge in SOMA lies in managing the spatial relationship between the generated calligraphy and the digital landscape backgrounds. Currently, achieving a harmonious composition relies heavily on manual adjustments by designers. This dependence on manual intervention not only limits scalability but also hinders automation, particularly when dealing with diverse or highly complex inputs. Future efforts could address this limitation by developing an automatic spatial adaptation and layout system that dynamically aligns calligraphy with landscape elements. Such a system could leverage machine learning models trained on traditional Chinese art compositions or employ rule-based algorithms to balance visual weight, symmetry, and spatial harmony in real time, ensuring aesthetic coherence across varying contexts.

Furthermore, as iconic art forms deeply rooted in Chinese culture, calligraphy and shanshui (landscape painting) face the ongoing challenge of enhancing their cross-cultural communicative power in a globalized world. Computational media offer innovative pathways to tackle this challenge. By integrating generative AI with interactive technologies, artists can create immersive artistic experiences that enable audiences from diverse cultural backgrounds to appreciate the formal beauty of traditional art while actively participating in its creation. For instance, this study combines motion capture and voice input to dynamically generate calligraphic and shanshui elements. By blending advanced technologies with cultural expression, this approach not only expands the expressive boundaries of traditional art but also enhances its accessibility and communicative power in cross-cultural contexts.

7 Limitations and Future work

SOMA has several technical and methodological limits. Compositional balance between pose-driven calligraphy and shanshui backgrounds still depends on designer-led scaling, placement, and layering, reducing scalability for heterogeneous or extreme inputs. The pose–glyph mapper is trained on about 500 pairs, leaving gaps for long-tail poses and self-occlusions. VAE issues—prior–posterior mismatch, KL trade-offs, single-stage decoding—can produce stroke breaks, plasticky textures, and occasional semantic drift. The system is sensitive to out-of-distribution gestures and noisy speech; cross-modal asynchrony and multi-pass rendering add latency, rhythm drift, and artifacts. Freezing the decoder stabilizes style but constrains expression to the training envelope. Evaluation remains limited to small, context-specific audiences, and preservation/reperformance is hindered by the lack of a standardized score (versioned parameters, interaction logs) and reliance on evolving toolchains.

Building on the present system, our future work will bridge technical innovation with deeper artistic and social engagement. We envision advancing the system along four integrated trajectories.

1. Adaptive Spatial Composition and Real-Time Curation. We will develop an automatic spatial adaptation engine that harmonizes calligraphy and landscape through rule-based composition and learned aesthetic priors.

2. Expressive Enrichment through Dataset Diversification and Model Enhancement. To broaden the system's gestural and stylistic vocabulary, we will expand the pose–glyph dataset through artist collaborations and participatory workshops. We will explore diffusion-based or hierarchical decoders with style adapters to improve output quality and mitigate artifacts, while maintaining real-time interactivity. These enhancements will capture nuanced variations in how different bodies and languages shape calligraphic expression and landscape tone.

3. Robust Multimodal Interaction and Audience Co-Authorship. We will strengthen multimodal robustness via adaptive abstraction controls, out-of-distribution detection, and tighter audio–visual synchronization. Concurrently, we will introduce lightweight audience-facing controls—enabling participants to influence the clarity or ambiguity of outcomes—thereby making the tension between readability and abstraction a deliberate part of the experience.

4. Cross-Cultural Evaluation and Ethical Stewardship. A program of cross-cultural audience studies will examine interpretations of legibility, abstraction, and the "body-as-brush" metaphor. Insights will inform the design of contextual interpretive aids such as poetic captions and visual scores. Finally, we will establish a reperformance and preservation protocol to ensure the work can be faithfully and

responsibly restaged, archived, or withdrawn across cultural and institutional settings.

8 Conclusion

In conclusion, this study demonstrates the potential of AI in reimagining traditional Chinese art forms through interactive systems. By transforming body movements and voice inputs into dynamic calligraphy and poetic landscapes, SOMA bridges traditional aesthetics with modern computational techniques. This research highlights the shift from static artistic appreciation to personalized, real-time art creation, showcasing the adaptability of traditional art in contemporary contexts. Additionally, it emphasizes the role of embodied interaction and AI in fostering cross-cultural engagement and accessibility.Ultimately, this study contributes to a deeper understanding of how technology can preserve, reinterpret, and innovate cultural heritage in meaningful and impactful ways.

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Controlling Chair: Experiencing User Autonomy versus Automation through an Interactive Artifact

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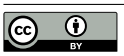
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Figure 1: *Controlling Chair* is equipped with textile sensors that can recognise when people sitting on it, lean forward or back, while a linear actuator tilts the sitting surface upwards or downwards. Sometimes this movement follows user input, but sometimes the movement happens automatically, creating tension between the sitter and the technological system.

Abstract

With increasingly more present and complex applications of automation, its relationship to the user has become a subject of more study and discussion. Although there are many benefits of automation, there are also several challenges in designing automation that successfully fulfills its tasks and is well accepted among users. Although the tension between technology automation and user autonomy is highly discussed in professional circles, it is rarely presented in an understandable way to laypeople. To convey this topic, we created an experience that allows people to feel the difference between automation and user autonomy firsthand. Current research promotes finding a balance between automation and autonomy, and we used these keywords to guide the experience with our artifact. People and the system were both required to find balance in between their interactions, as well as literally in the tilt of the sitting position on the interactive *Controlling Chair*. During a one-day exhibition, we assessed the experience with people who interacted with the chair and observed how it helped them better understand the topic and reflect on its relevance to their own lives.



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CCS Concepts

• **Human-centered computing** → **Interaction devices**.

Keywords

Interaction Design, Interactive artifact, Embodied experience, User autonomy, Automation

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1 Introduction

In developing applications with automated technological systems, developers and designers (and other relevant stakeholders) need to decide what kind of interaction the system should have with the user [28]. Should the technological system decide everything autonomously and ignore the human, should it act automatically, but keep the human informed, or only act autonomously if the human approves, or only offer certain actions without carrying them out, or any other level in between [29]?

Several automated systems can already be observed in our daily lives. Automatic doors are omnipresent, car airbags open automatically after a crash, and lights turn on and off automatically based on people's presence in the room. With the rise of AI technologies, applications with automation will become even more present and complex. However, with increased complexity, lay people's understanding of how such automated systems work decreases, and discussing the relationship between automation and people will become even more important [17, 18, 28, 30]. Current discussions on the topic are largely confined to academic publications, ethics committees, and corporate decision-making bodies, with limited engagement from the public, however, lay people are the ones who feel the effects of automation the most in their lives [13].

Art plays a crucial role in science communication by bridging the gap between expert knowledge and public understanding. It can provoke reflection and make abstract or technical content more tangible and emotionally resonant [6]. Through narrative, aesthetic, and sensory engagement, artistic approaches can make scientific topics more accessible to non-specialist audiences [20]. These strategies are particularly valuable when the public stands to be significantly affected by scientific developments, yet lacks the means or invitation to participate in the discourse [20].

With our work, we aim to communicate some of the scientific discourse on the topic in a more easy-to-understand artistic manner [16, 20] and allow people to reflect for themselves how much automation they want in their lives and how much autonomy they want to keep through their explicit interactions. The scientific community promotes finding the correct *balance* between the two [17, 18, 30], and this word became the metaphor for our interactive experience. *Controlling Chair* encourages people to find a balance between being in control and giving up control due to automation, through adjusting the tilt of the sitting position, cf. Figure 1.

Our main contribution is to raise awareness and provoke debate among lay people by communicating a complex issue of automation and user autonomy in technological systems easily and understandably, through an interactive experience with *Controlling Chair*.

2 Background

We begin this section by clarifying what we mean by *user autonomy* and *automation*. We then outline key ideas from HCI research on the relationship between the two, which serve as the foundation for what our artifact is intended to convey. Finally, we turn to the field of art, where we explore different strategies for communicating scientific ideas through artistic artifacts.

2.1 Terminology

Autonomy is the *"capacity to make informed, uncoerced decisions"* [31]. Autonomy can exist in technological systems that learn and evolve, and can change their function based on input data [1], however, in this paper, we will rather focus on *user* autonomy. Friedman uses the term user autonomy to describe *"individuals who are self-determining, who are able to decide, plan, and act in ways that they believe will help them to achieve their goals and promote their values"* [7].

Automation, on the other hand, stands for the *"use of machines and computers that can operate without needing human control"* [3]. Automated technological systems are designed to follow a set of largely pre-determined steps in a repeating pattern to achieve a limited set of outcomes [1]. In this paper, we will use the term automation to describe the technological system that executes its tasks automatically while informing the user of the action, but without allowing for intervention [29].

Autonomy and automation are both values, which refer to what *"a person or group of people consider important in life"* [8]. The potential conflict arises when designers and developers of technology find different things important than the users of technology. This relationship and potential conflicts were the focus of our artifact and will provide the contextual frame for the rest of the paper.

2.2 Grounding in HCI

Automation offers several benefits, not only by reducing human labour, but also by taking over control of tasks people often find tedious or repetitive. People generally dislike mundane chores [30], and automated systems such as washing machines, robotic vacuum cleaners, and smart pet feeders help offload these duties. These technologies are praised for their efficiency, accuracy, time savings, and cost-effectiveness [4], however, designing automation that works well in everyday life remains a significant challenge [17].

One major issue is that automated systems often operate in the background, offering little to no visible cues about how they function. This lack of signifiers can leave users confused about what the system is doing or why it behaves a certain way [19]. Without a clear understanding of a system's reasoning, users may either overrely on automation or lose trust in it altogether [4]. Ju and Leifer [19] illustrate this with the example of automatic doors, arguing that even simple systems should clearly communicate their purpose, affordances, and intentions. They advocate for automation that behaves more like people by providing signals, context, and cues, instead of relying on guesses and assumptions. While transparency might seem like an ethical design goal, Sadeghian and Hassenzahl [27] point out that too much explanation can overwhelm users, suggesting that control depends not only on access to system details but also on meaningful comprehension.

The concept of control in automation involves two dimensions: either the user is in control of performing the task directly, or controlling the workings of the automated system, stepping in when necessary [30]. In well-designed systems, users must be able to override automation and regain manual control when appropriate [19, 28, 29]. Diefenbach et al. [4] propose customisation as one possible design solution, allowing users to set their preferred level of control. This point is critical, since people who feel they have lost control with automated systems may experience reactance, the unpleasant feeling experienced during a lack of freedom [4].

Several researchers emphasise that while automation offers convenience, it may also reduce opportunities for meaningful experiences. Autonomy, particularly in personally significant activities, can be an important source of well-being [4, 27, 30]. For example, Wiberg et al. [30] explain this with coffee making and reflect on the benefits of an automated coffee machine when one is in a hurry and just wants to get caffeine into their body, however, when one has time and a high appreciation for coffee, the process of making it manually can be a sensual and pleasurable experience.

Another challenge to user acceptance of automation is the issue of vulnerability, especially concerning privacy and data collection. Many automated systems rely on gathering large amounts of personal data to function effectively [17, 28]. This makes it difficult, if not impossible, for users to control or safeguard their identity or intentions [11].

The relationship between users and automation is always one of negotiation. As Sheridan's levels of automation framework shows, systems can range from giving full control to the human, to acting entirely on their own, with many in-between levels, such as merely informing the user or requiring confirmation before action [29]. Across the literature [4, 17–19, 30], there is widespread agreement that striking the right balance between user autonomy and automation is essential, yet there is no objective answer to which level is best for which situation, or in other words, where exactly the right balance between user autonomy and automation lies.

2.3 Grounding in art

The agency of objects has been explored in several artistic artifacts. Simone Rebaudengo created a series of toasters that could not be owned, but had their own agency to complain when not being used enough, and tried to leave and find a better user [26]. Another work comes from Jan Zuiderveld, who transformed everyday appliances into platforms for interactive, almost philosophical exchange between people and technology [33]. The coffee vending machine, for example, demands that people prove themselves worthy of its efforts before starting to make the beverage. Giving agency to objects is anthropomorphism, but in the context of automation, it creates an interesting second level of perceiving technology as either looking out for us or working against us [11, 17].

Equally interesting to observe are the techniques people use to preserve their human agency, with projects exploring various ways of tricking technology. Tomo Kihara created two interactive installations, where people try to trick AI. *How to (not) get hit by a self-driving car* is a street-based game that challenges people to explore (and avoid, if they wish) detection by an AI-powered camera as they are crossing the street [15]. Although self-driving cars need to detect pedestrians, such technologies will also inevitably work as tracking systems in public spaces. Another example, the *Deviation game*, encourages people to work together in a drawing challenge against AI to protect their creativity [14]. In both examples, people are trying to preserve their own agency over technology.

Similar to tricking, some projects also explore how to preserve our privacy in times of automation. The most notable example comes from Bjørn Karmann and Tore Knudsen. *Project Alias* is a teachable parasite that can be put on top of smart home voice assistants [12]. It is designed to block the mainstream voice assistant from constantly listening, and only unblock it as a response to its own wake-up word, which was trained through a local and secure network. Meanwhile, *Consensus Gentium* does not offer many solutions, but a critique by providing us with an interactive experience that brings us into the dystopian world of surveillance [24].

Research done in the field of HCI provided a sound overview of the relationship and potential value conflict between user autonomy and automation in technological systems, which we took as a basis for the science we wanted to communicate with our project, while the art field offered several interesting approaches on how to bring such complex topics closer to the general public. We join this landscape of examples with an interactive experience embedded in a chair that allows people to feel the balance between user autonomy and automation firsthand.

3 Methodology

By including interactivity, we aimed to create a deeper understanding of and engagement with the technological systems represented in our artifact [10, 21]. We, therefore, started our design process by defining the interaction first. We used the Odd Interactions methodology [23], which also proposes starting the design process by first developing the interaction and then creating the artifact to support and embody that interaction. In exploring the interaction possibilities, we primarily focused on odd body parts and mapped out several full-body interaction possibilities for our project. Among them all, we were the most inspired by seating-interactions such as leaning, jumping, or squeezing, which are rarely used for explicit user input. This became the starting point for our artifact.

We used the Critical Design methodology [5, 22] to develop the artifact as a provocation [22] to raise awareness and encourage debate. Being guided by provocation, we designed a scenario in which users would be directly exposed to the feeling of being in control, as well as losing control to automation. We searched for an everyday, almost mundane context for our artifact [22] and have finally chosen a basic home chair as the object to support our scenario for interaction.

The assessment before showing the installation in public space followed a qualitative, interpretive approach, consistent with Research through design methodologies (RtD) [32]. Our goal was not to measure user satisfaction or performance but to interpret the experiential, emotional, and reflective responses that emerged during interaction.

4 Controlling Chair

Our final concept proposed an interactive chair where the relationship between user autonomy and automation could be directly



Figure 2: *Controlling chair* is able to detect three interaction states and respond with actuator movements. Leaning forward makes the actuator move up and tilts the sitting position upwards (left), leaning backwards makes the actuator move down and tilts the sitting position downwards (right), and sitting straight stops the actuator in whichever position it was in at the time (middle).

experienced. In this section, we will present *Controlling Chair* in more detail, starting with the interaction, and continuing with the building of the artifact and technical implementation.

4.1 Interaction

Through the artifact, we aimed to give people the experience of user autonomy as well as automation, so they could decide for themselves where their own comfortable balance lies. Balance between who is in control, as well as the balance of the sitting position. We will outline an overview of the interaction below and provide a more detailed scenario of the user journey in the Appendix. A video of the interaction is also available on this link: https://youtu.be/brMR1p6qrU0.

User autonomy was achieved by textile sensors embedded in the seat cushion that detected the person leaning backwards and forwards. Their body movement correlated with the linear actuator responding; when the person leaned forward, the actuator moved up (Figure 2 left), and when the person leaned backwards, it moved down (Figure 2 right). People were encouraged to find a comfortable sitting position and stop (Figure 2 middle).

Accompanying the experience of user autonomy was automation represented in the actuator moving up or down, seemingly autonomously. After people found their comfortable sitting position and stopped interacting, the system would automatically move the actuator to a pre-programmed optimal sitting position. The movement was accompanied by audio output, which made the change more understandable. The optimal sitting position was intentionally tilted upwards (Figure 2 left) to create a slight feeling of discomfort, to provoke [22] people to engage.

We also wanted participants to question why the system assumes a certain posture is the "optimal" sitting position. As research has shown, training datasets are often not as inclusive as they should be [2], and a common solution is to ask users to contribute their own data to improve personalisation. In the *Controlling Chair* experience, we extended this idea by asking participants whether they were willing to be tracked so the system could update their "optimal" position. If they agreed, the chair adjusted its definition of optimal to a more comfortable, preprogrammed horizontal tilt of the sitting position (Figure 2, middle).

4.2 Artifact

We positioned our chair in the (smart) home environment, as one of the most intimate environments we interact with on a daily basis, and tried to communicate this context through the visual appearance of the artifact by choosing a wooden dining room chair as a base object. Since the sitting area would be adapted, we looked for something without cushioning and upholstery.

A second wooden plate was added on top of the sitting area. It was fixed to the chair on the front side and to the linear actuator on the back. This allowed for the sitting area to be tilted backwards and forward as the actuator expanded or retracted. The linear actuator itself was fixed to a plate on the floor on one side, and through a drilled hole into the original chair, to the second sitting plate on the other side. A cushion with integrated sensors was placed on the wooden sitting plate, and textile sheets were added to the sides to make the chair more visually coherent. Since the second sitting plate increased the elevation by about 12cm, a footrest was constructed for shorter people who could no longer reach the floor.

4.2.1 Textile sensors. We manufactured two pressure-sensitive textile sensors [25], which were constructed from three layers of textile: Narrow Stripe Zebra fabric [1] with alternating conductive and non-conductive lines used as the top and bottom layer, and a pressure-sensitive fabric [2] placed between them. Each sensor was 3cm wide and 15cm long, and their top and bottom layers were connected to a wire with de-isolated edges that were connected to the electronics on the other side. One of the sensors was positioned at the front of the sitting area, and the other at the back, as can be seen in Figure 3. They were fixed directly onto the cushion foam and wrapped back into the cushion cover for protection. Their resting resistance was approx. 28ohm and changed to approx. 800ohm after a person sat down.

4.2.2 Electronics and software. The textile sensors were connected to an Arduino board, which controlled the linear actuator that can be seen in Figure 3. We used a DCHOUSE Linear drive, 1500N DC 12V motor [3] capable of pushing and pulling a maximum weight of 150kg. The actuator was controlled by a dual relay, which was in turn controlled by the Arduino.

The Arduino code consisted of controlling the interaction, as well as the automation. Once the user moves forward, they increase pressure on the front textile sensor, and the actuator moves up. Once they move back, the back sensor detects the increase, and

[1] https://www.hitek-ltd.co.uk/
[2] https://eeonyx.com/
[3] https://dcactuators.com/



Figure 3: The sitting area of *Controlling chair* is covered with a cushion with two embedded textile sensors that detect interaction and trigger the movement of the linear actuator that tilts the sitting position upwards or downwards.

the actuator moves down. To communicate automation, several pre-programmed actuator movements were included. The startup movement fixed the sitting position at the horizontal neutral position. After the user was detected as well as when they stopped interacting, the chair moved to a pre-defined optimal sitting position. After tracking was enabled, the actuator made several automatic movements to give the illusion of calibration.

Arduino was also connected to ProtoPie [4], which allowed us to add audio feedback to the whole experience. The audio was triggered by Arduino sending signals to ProtoPie, which played out the responses as designed. Text-to-speech is one of the features offered by ProtoPie, and the default was used. Adding audio output, such as *"Moving to optimal sitting position"* after the automatic actuator movement happened, increased the understanding of what was going on. It made it clear that the actuator movement was not accidental, but deliberate and included the reason for it. Secondly, ProtoPie offered an easy connection to digital devices, such as a tablet, that was given to people who had to tap on a button to enable tracking.

Although the users were asked to allow tracking of their body data, we did not, in fact, collect, analyse or interpret any data to gain insights into user behaviours and preferences. The textile sensors recorded changes in pressure by reading the resistance values in real time; no data was stored or further processed. After the users pressed the button on the tablet, it only updated the starting position of the chair. It was more important for us to have a conversation about tracking in the context of automation, rather than actually implementing it.

[4]https://www.protopie.io/

5 User responses

Our future plan is to exhibit *Controlling Chair* in public space to gather responses from the general public and raise awareness among people who do not usually think deeply about the impact of technology on their lives. As a preliminary step, to test the experience and ensure the safety needed for a public viewing, we showed the chair in a smaller setting with invited participants who joined us at the home of one of the authors during a one-day "exhibition". This meant that several participants were personally acquainted with the researcher. However, rather than compromising objectivity, such familiarity enabled open dialogue and deeper reflection, consistent with RtD approaches [9] where the designer-researcher is part of the inquiry process.

Seven people (4 female and 3 male) interacted with the chair without any prior instructions and participated in a follow-up interview. The interview, shaped as an open conversation, helped us understand if and how the experience provoked deeper thoughts and opinions about the relationship between user autonomy and automation. The interviews were audio recorded, transcribed, and the most important insights are collected below. The detailed user journey and guiding interview questions can be found in the Appendix.

(1) **Potential benefits:** Several people reflected on the topic through the lens of their daily experiences. One participant mentioned that while he hurt his back, the hospital had specific machines that continuously fixed his body position, so he could heal properly (P3). In this context, he reflected, technology may indeed know better than him, and he does not mind giving up control in such cases.
(2) **A stopping option:** Almost all of the participants explicitly stated that if there is automation, there should always be an easy way for them to stop and cancel the change, *"I want to be able to override it, if I deem it necessary"* (P7). They have reflected on this from the concrete experience they had with *Controlling chair*, as several of them tried to stop the automatic movements in various ways and were annoyed that it was not possible.
(3) **Transparency:** Going in a similar direction, two people have mentioned a wish for transparency in automated systems. This would include options of stopping the system, but also e.g. clear communication of progress (P2). The other person positively reflected on the audio feedback present in *Controlling Chair*, *"It's communicating [with me]"* (P1).
(4) **Reactance:** We also noticed the negative emotional reaction when *"[...] someone else is saying I know better than you"* (P2). And when somebody else is a machine, things only feel worse, *"It can be potentially very uncomfortable because it's a machine deciding what is optimal for you"* (P4).

(5) **Familiarity:** Familiarity often plays a big role in user acceptance [23]. One person stated that we may be more open to automation at home in the future, *"It's like maybe it's just a technology that you have to get used to. [...] It's just like a different type of interaction"* (P4).
(6) **Terminology:** We noticed that our participants never used the words "autonomy" and "automation" when describing their experiences. Several people have mentioned (not) being in control, while a few had even more interesting metaphors: *"It feels like [it] has its own brains"* (P3) and *"[...] at some point I felt that the chair wants to play with me"* (P4).
(7) **Tracking:** Interestingly, none of our participants had any issues with allowing data tracking of their bodies. They described the data as *"not so sensitive"* (P4, P6, P7), since their personal data (such as gender, weight, or identity) was not being tracked (P6). One person further elaborated: *"If it was like constantly tracking me, I would feel uncomfortable. But if it's just tracking to set up the parameters, then I'm like, fine, because it's a kind of normal computer interaction."* (P4)
(8) **Balance:** Ultimately, our participants also just wished for a reasonable balance between their own autonomy and automation, *"I would like to always be in control, but that doesn't mean I want to control every small thing, but it's more like being so truthfully informed to what's happening and being able to stop, continue or change direction"* (P2).

6 Discussion

Our main goal with *Controlling Chair* was to provide lay people with an experience that deepens their understanding of technological topics to which they are often exposed only passively, e.g. by reading newspapers, listening to podcasts, or watching TV shows. As mentioned by one participant, *"it was much easier to answer the questions after the experience"* (P1). Without such an experience, she would feel overwhelmed trying to remember what she recently read on the topic.

While the findings from this preliminary study cannot be generalised, they offer valuable insight into how a broader public might react to such embodied engagements. The study primarily served to assess whether our artifact could effectively communicate and provoke reflection on these issues, rather than to produce statistically representative results.

By categorising user impressions, we recognised several of the themes from HCI research, which were successfully communicated through the experience with *Controlling Chair*. Our participants mentioned a wish for a design of automated systems with more communication elements to allow for more transparency on what was going on [19], as well as an easier way to stop or override the system when necessary [30], mentioning that they do not want to be told what to do by a machine [4]. The experience made people understand the underlying benefits and challenges a lot better [20], with several of them reflecting on their daily experiences and imagining how automated systems could fit into their lives. We also noticed that people have not used the terms user autonomy and automation in our conversations, but believe that having the experience and connecting it to the right terminology will leave them with a longer-lasting understanding and memory. Although HCI research highlighted the potential problem of tracking for automation [11], our participant did not express concern in this regard, which may be due to the fact that most of them personally knew the developers or designers of the artifact, but this may not hold true anymore if the developer were an unknown corporation.

The metaphorical and literal balance finding within *Controlling Chair* allowed our participants to have unique experiences and varying reactions. People have mentioned fun, humour, and playfulness, but also annoyance, uncertainty, and giving up. As there is no single answer to the "right" relationship between user autonomy and automation, we will not concern ourselves too much with individual reaction. Overall, however, we can claim that the experience prompted all of the participants to reflect on what kind of future they wished for, and most of them clearly expressed a wish for a balance between being in control and giving up control for automation.

Finally, we must also mention a few downsides of science communication through an experience with an interactive artifact. Logistical constraints delayed us from showing the *Controlling Chair* in public space in time for this publication. From providing electricity to gathering permissions and guaranteeing safety, all require a lot more effort than setting up a traditional user study in a lab environment. Regardless of its presentation environment, we also need to take into account that providing an experience will always reach fewer people than, e.g. an online study, so any kind of general applicability of findings should not be the ultimate goal of such experiences. Instead, the value lies in the situated, embodied understanding that participants developed through interaction. Future work could explore how similar experiences scale to broader public or educational contexts.

7 Conclusion and Future Work

In this paper, we presented *Controlling Chair*, an interactive artifact allowing lay people to experience the relationship between user autonomy and automation to reflect on their own preferences and search for a comfortable balance between the two.

We offered a brief overview of how user autonomy and automation are discussed within HCI, using this theoretical grounding as the foundation for our interactive artifact. We presented *Controlling Chair* in detail, outlining its interaction flow, electronic components, sensor setup, and software implementation. The chair was exhibited during a one-day event, where we observed how participants engaged with the system and reflected on the balance between control and automation in their own lives. Through this experience, we explored how embodied interaction can serve not only as a mode of communication but also as a way to provoke reflection and discussion around otherwise abstract concepts. By physically experiencing the tension between giving up and reclaiming control, visitors could more meaningfully consider the roles that user autonomy and automation play in their daily lives.

As future work, we plan to present *Controlling Chair* in public spaces where it can reach a broader and more diverse audience. Unlike curated exhibition settings, public space installations introduce the artifact to everyday passersby who may not expect or actively seek out such interactions. This shift is important for expanding the

conversation around automation beyond academic or professional circles and into the realm of everyday lived experience.

Acknowledgments

We thank all the participants who came to interact with *Controlling Chair* and shared their thoughts and opinions.

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A User journey

Startup sequence:

- To work precisely, the actuator first resets itself by fully contracting.
- It then moves to a horizontally straight, neutral position (Figure 2 middle) and waits for the user to sit down.

Phase 1:

- As the user sits, the message plays *"User detected. Moving to optimal sitting position"* and the actuator automatically moves to the top (Figure 2 left), making it slightly uncomfortable to sit.
- Once the top position is reached, the user can start interacting with the textile sensors to find a sitting position that they feel comfortable with.
- They can interact by leaning forward or backward, and the actuator follows the movement (Figure 2)
- After 3 seconds of inactivity, the actuator automatically returns to the top and plays the message *"Moved to optimal sitting position"*.
- This can be repeated as many times as the user wishes.
- Finally, the user is asked if they allow data tracking in order to change the optimal sitting position into something more comfortable.

Phase 2:

- If the user agrees, they must press the button on a tablet to turn on tracking.
- An audio message is played *"Tracking enabled"* and the actuator performs a little motor dance to create the illusion of optimisation.
- It then moves to neutral position (Figure 2 middle) and plays the audio message *"Optimal sitting position updated"*.
- Once the neutral position is reached, the user can start interacting with the textile sensors to find a sitting position that they feel comfortable with.
- They can interact by leaning forward or backward, and the actuator follows the movement (Figure 2)
- After 3 seconds of inactivity, the actuator automatically returns to the neutral position and plays the message *"Moved to optimal sitting position"*.
- This can be repeated as many times as the user wishes.

Phase 3:

- After the user is finished with the experience, they are asked if they are willing to answer a few questions about the interaction.
- Guiding questions: Please describe the experience. Did you feel in control? Did you notice the conflict between which seat position you wanted and which the system wanted? What are your preferences on the balance between user autonomy and automation? How do you feel about being tracked so that technology can work better?

Bodies in Dialogue: Generative AI as a Provocateur for Narrative and Motion

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Abstract

This paper investigates how generative AI (GenAI) can serve as a creative provocateur for embodied storytelling. Moving beyond content automation, we explore GenAI's role in prompting movement, improvisation, and narrative co-creation. Through an interdisciplinary workshop, we developed a real-time system using StreamDiffusion and TouchDesigner, allowing performers' movements to influence AI-generated visuals. Participants—artists, technologists, and designers—engaged in collaborative roles as performers, prompt engineers, and technicians. The workshop revealed how GenAI can stimulate physical expression and collective storymaking in real time. We discuss the system's technical setup, interaction dynamics, and key insights into human–AI co-creation in digital performance contexts.

CCS Concepts

• **Applied computing** → **Interactive learning environments**; *Media arts*; • **Human-centered computing** → Interaction design.

Keywords

Generative AI, Live performance, Immersive Environment, Collaboration, Storytelling, Embodiment, Workshop

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1 Introduction

In recent years, generative artificial intelligence (GenAI) has emerged as a powerful tool in creative domains, capable of producing text, images, and audiovisual content in response to prompts or patterns. While much of the attention around GenAI has focused on its role in automating content production, its potential to act as a catalyst for embodied expression and participatory storytelling is less explored.

The convergence of embodiment, storytelling, and machine creativity opens new directions in digital arts and interdisciplinary practice, particularly in contexts where lived experience, spatial awareness, and performative agency are central. Within performance art, dance, and somatic practices, the body is both a medium and an expressive tool. Integrating AI into these domains requires rethinking the technology not as a static content creator, but as an interactive, co-creative agent—one that responds to and inspires physical engagement.

This paper explores how generative AI systems can be designed and deployed not merely as narrative generators, but as positive cues for movement and improvisational storytelling through the body. This paper is grounded in an interdisciplinary workshop that brought together artists, designers, technologists, and researchers to explore how generative AI could prompt embodied storytelling. The central question guiding our inquiry is:

How can generative AI systems act as a meaningful provocateur for movement and narrative-making through the body?

To explore this question, we developed a real-time GenAI system integrated with live performance inputs and immersive projection. Through a series of movement-based exercises, prompt-driven improvisations, and technical refinements, the workshop became both a creative playground and a critical research framework for understanding human–AI co-creation in embodied contexts.

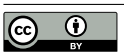
2 Background and Prior Work

The intersection of generative AI, embodied storytelling, and interactive performance opens promising avenues for creative experimentation and inquiry. While GenAI is most often applied in domains like text-to-image synthesis or automated narrative generation, its capacity to serve as a real-time stimulus for movement, improvisation, and co-creation remains largely underexplored. This paper situates its contributions within a broader context of research on embodied interaction, creative AI, and interdisciplinary art–tech practice.

2.1 Embodied Storytelling and Performative Systems

Embodied storytelling positions the body as a primary site of narrative construction—one where meaning emerges from physicality, presence, and spatial orientation. In performance studies and somatic practices, the body is both a medium and a message [1, 26]. Movement-based practices such as Mary Overlie's Six Viewpoints [19] and improvisational techniques from dance and theater emphasize the emergent nature of story through gesture, rhythm, and ensemble play.

Within HCI and interaction design, this embodied perspective has gained traction through fields like somaesthetic interaction [13] where design processes are grounded in the felt experience



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of the body. Likewise, embodied interaction [7] reframes computation not as disembodied symbolic manipulation but as situated and enacted in space and time. These perspectives are essential when designing systems that respond to and provoke physical movement—particularly when the goal is not efficiency or usability, but expressive, performative engagement.

2.2 GenAI and Co-Creative Systems

The past five years have seen explosive growth in generative AI tools capable of producing high-quality outputs from text or image inputs, including diffusion-based models (e.g., Stable Diffusion) and large language models. In creative contexts, GenAI is increasingly explored as a co-creative partner rather than a passive tool [5, 9]. Research in computational creativity has emphasized how such systems can provoke user improvisation, generate unexpected associations, and support open-ended exploration [4, 17].

In our work, GenAI functions as a positive cue—generating visual stimuli that respond to performer movement and verbal prompts in real time. This real-time interaction leverages image-to-image generation to respond not only to prewritten text but also to live, bodily inputs captured from the performance space. This dynamic aligns with principles of designing for emergence [10], where technologies are configured to invite interpretation, surprise, and improvisation rather than producing predefined results.

2.3 Movement, Input, and Visual Response

Artists and researchers have explored how motion capture, gesture, and embodied input can be used to drive computational systems in real time [2, 23]. Systems such as gesture-driven narratives, affective wearables, and somatic interfaces [16] highlight how physical action can be treated as both data and expression. In our workshop, we adopted a similar orientation: performer movement, captured via a ZED 2i stereo camera, became the visual seed for the GenAI's real-time video-to-video image generation process.

The interplay between visual input (body silhouette) and verbal or written prompts became the core mechanic of our system. Participants could influence generation through motion, through language, or through technical adjustments to the denoising and blending parameters within the system. This required the careful coordination of performers, prompt engineers, and technicians—each influencing the system's output in a distinct yet interdependent way.

2.4 Interdisciplinary Workshops

Our method draws on traditions of interdisciplinary workshops as both a research setting and a creative process. Workshops have been widely used in design research and HCI to explore emerging technologies, foster collaboration across domains, and generate both critical insight and creative artifacts [3, 22]. Within this frame, our workshop functioned not only as a testing ground for technical implementation but also as a space for pedagogical experimentation, aesthetic inquiry, and embodied learning.

By inviting participants to inhabit multiple roles—performer, prompt engineer, and technician—we aimed to surface the human–machine negotiation at the heart of generative storytelling. The layered interaction between AI system, embodied improvisation, and narrative construction illustrates new potentials for co-creation in digitally mediated performance.

3 Technical Description

3.1 Image Generation System

The workshop team sought to establish a system for real-time image generation which could respond to the movement of one or more performers. The workshop utilized a desktop computer equipped with an NVIDIA GeForce RTX 4090 GPU and a 13th Gen Intel Core i9-13900K processor. The team researched open-source solutions for image generation compatible with this available hardware. Our team identified Stream Diffusion as the most suitable image generation software solution for the workshop [15]. Stream Diffusion is a diffusion pipeline designed specifically for real-time image generation, citing the ability to generate more than 100 frames-per-second (fps) when powered by an RTX 4090 graphics card using some models.

Stream Diffusion supports two modes of image generation, text2img and img2img, for generating images from either text-only input (text2img) or combined text and visual input (img2img). For the workshop, our team determined that utilizing Stream Diffusion in img2img mode with the lightweight sd-turbo image generation model would allow for rapid image generation responding to visual capture of our performers [24].

In addition to its compatibility with the available hardware, the team chose a system based on Stream Diffusion because of its compatibility with TouchDesigner through the use of community built plugins [6]. TouchDesigner is a node-based, visual programming interface that easily connects visual input and output with the customizable interfaces for controlling the image generation process. Lyell Hintz (aka DotSimulate), a creative and technical artist from Brooklyn, New York, is a prominent member of the TouchDesigner community who maintains a plugin for Stream Diffusion in TouchDesigner that can be accessed through a $5/month Patreon subscription [12]. The use of Hintz' low-cost Stream Diffusion and TouchDesigner (StreamDiffusionTD) plugin empowered the workshop team with a customizable system for controlling real-time image generation integrated with live performers captured in the workshop space. To deploy this system in a live environment, the workshop team configured the following physical and digital setup.

3.2 Workshop Space and Technical Setup

The workshop was conducted in a space with access to an 11-foot tall, 400 square-foot projection cylinder known as the Igloo (Figure 1) by Igloo Vision [14]. The Igloo's six projectors display visuals on its internal surface, creating immersive 360-degree content. It is powered by the proprietary projection software, Igloo Core Engine, which allows for arranging image inputs across the projection map. While the Igloo did not originate with this workshop, the team believed it would be a fitting setting for our explorations, with space for multiple moving performers and an immersive display for the generated imagery. The computer running the Igloo Core Engine connects to the PC used for image generation on TouchDesigner via an Ethernet cable using an NDI output from TouchDesigner.

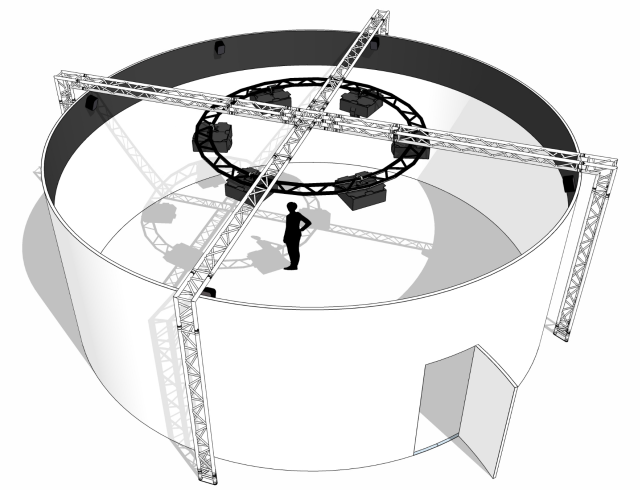


Figure 1: The Igloo System.

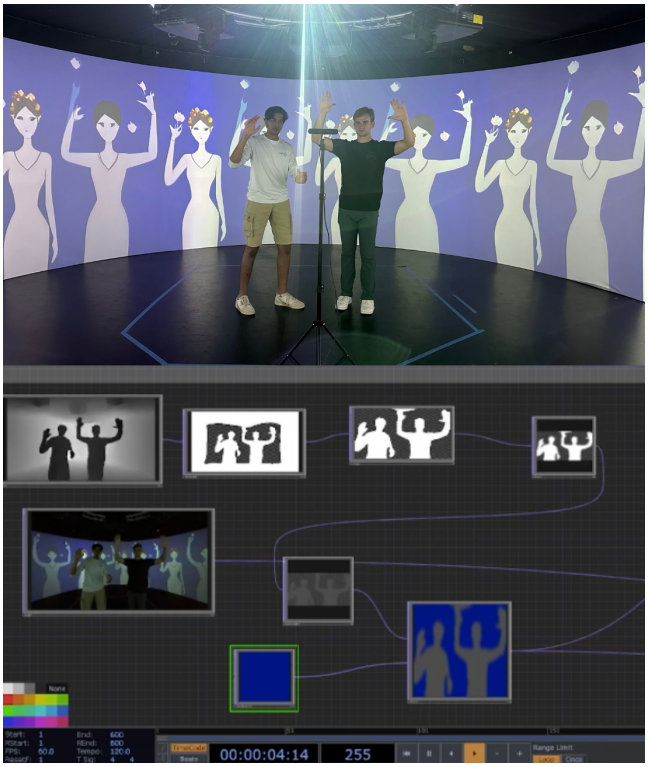


Figure 2: Performers in the Igloo in front of the ZED 2i with the camera's field of view outlined by tape on the ground.

Within the Igloo, a ZED 2i Stereo camera [25] was set up on a tripod to capture the movement of performers within an 8ft x 7ft playing space.

The ZED 2i utilizes neural networking and stereo cameras to produce high-fidelity depth perception. TouchDesigner includes built-in support for ZED cameras, which our team used to isolate a silhouette of the performer(s) from the surrounding architecture.



Figure 3: Performers in front of the ZED 2i (top) and TouchDesigner (bottom) processing raw input into isolated silhouettes using the following chain of operators: ZED, Threshold, Crop, Blur, Color, Overlay.

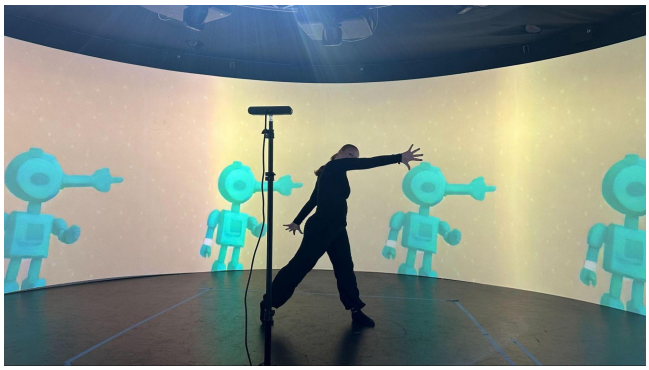


Figure 4: The StreamDiffusionTD operator (center) connected to the visual input (bottom-left) and two text operators (top-left and top-right) for written prompting.

We input the silhouette of the performer(s) into StreamDiffusionTD along with a text-based prompt for the img2img generation. Within StreamDiffusionTD, we opted for two denoising steps instead of the default single step to increase visual coherence without significantly reducing frame rate. We also decided not to use V2V, an optional control for interpolating between generated frames that reduces visual choppiness, due to its significant reduction in frame rate. With these settings – and without extensive hardware acceleration and GPU optimization – StreamDiffusionTD running the sd-turbo model was able to consistently generate between twenty and thirty 512x512 images per second on our computer. We found this frame rate sufficient for the system to remain responsive to performer movement.

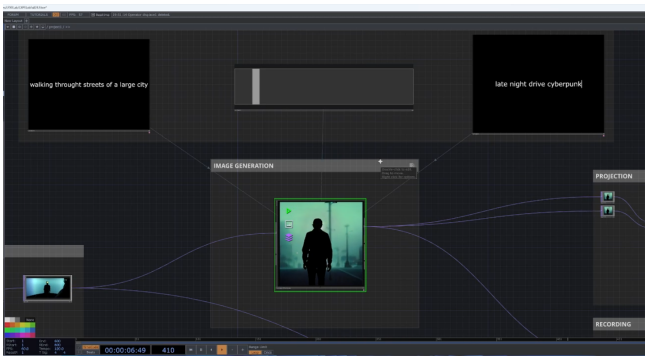


Figure 5: Interior of the Igloo with replicated 512x512 images projected across the interior screen.

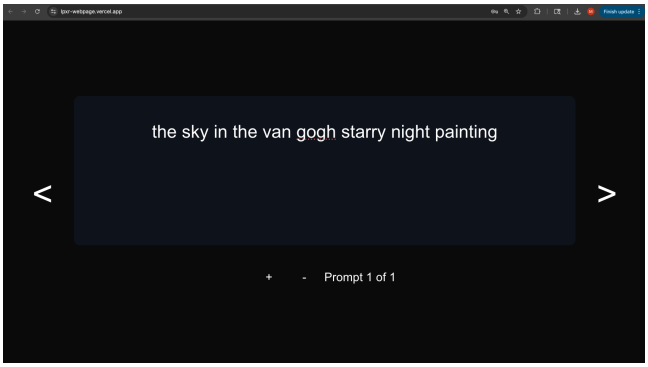


Figure 6: Technicians and prompt-engineers (left) manipulating the capture of the performers within the Igloo (right).

The generated images were output from the StreamDiffusionTD operator into two TouchDesigner operators for recording footage and sending NDI output to the projectors. Within the Igloo Core Engine, the stream of 512x512 square images was replicated to map across the inner surface of the Igloo, producing an immersive and engaging visual effect.

3.3 Upgrade and Improvements

Throughout the workshop series, we introduced several technical upgrades to improve the experience of participants interacting with the system as performers, prompt engineers, and TouchDesigner technicians.

A key aspect of StreamDiffusion's img2img generative process was the interplay between the visual input of the performer and the text-based prompt. We originally intended for all text prompting to take place in TouchDesigner, however we found that prompt engineers could most effectively impact the generation process while inside of the Igloo where they could view the performer without a screen in-between. In order to make the prompting process more hands-free, we connected the StreamDiffusionTD's text prompt parameter to an operator with live audio transcription and a custom web-application for typing in prompts from a mobile phone. The live audio transcription operator was also a plugin developed



Figure 7: Custom mobile web application for controlling prompts remotely running in Google Chrome.

by Lyell Hintz and connected to a microphone that was set up within the Igloo listening for the input of prompt engineers and performers [11]. The mobile web application was a custom ReactJS webpage hosted on Heroku with an interface for typing in new prompts and switching to old ones from a mobile phone [18, 21]. These tools allowed the prompt engineer to more quickly respond to and more precisely influence the image generation and action of the performer.

In addition to these improvements, we made several refinements to another key aspect of the image generation process: the visual input. We originally designed the system for StreamDiffusionTD to receive the performer's silhouette in black on top of a white background. Image generation seeks to match the style of its inputs and we found that the use of black and white constrained the generative output to monochromatic imagery. To create a more dynamic output, we experimented with controlling the color of both the silhouette and background individually. We found that we were able to produce results that more precisely mixed the input imagery with the text-prompt to produce an exciting result, allowing us to switch between prompts which included descriptions of color.

However, about halfway through the workshop series, we happened upon an exciting improvement that made the system much more dynamic and fun to those participating. While continuing to control the color of the silhouette manually, we changed the background color to an animated Perlin Noise generator. The animated Perlin Noise function introduced random pixel variation across hues, ensuring that any color described in a new prompt would likely be present in the input image, thereby accelerating visual adaptation. This allowed StreamDiffusionTD to more quickly respond to changing prompts. For example, when prompt was suddenly changed to "a beautiful river running through a field of green grass", StreamDiffusionTD no longer had to wait for the TouchDesigner technician to change the background to green before it could begin generating images with green. This is because the animated Perlin Noise function ensured the presence of some amount of green at all times. We found that this reduced our reliance on the

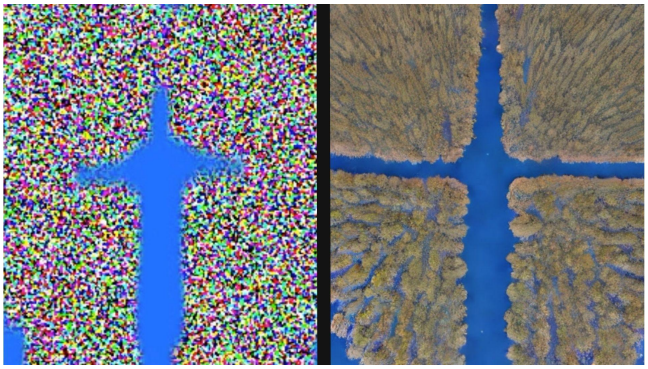


Figure 8: Side-by-side of the performer's silhouette overlaid on a simple orange background (left) and generative output (right) using the prompt "an industrial tower in a naval yard".

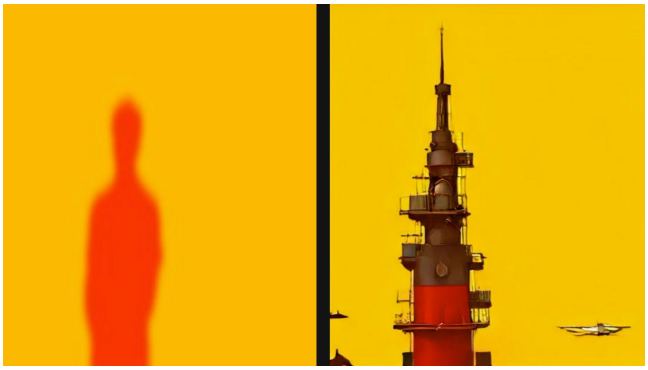


Figure 9: Side-by-side of the performer's silhouette overlaid on a Perlin Noise background (left) and generative output (right) using the prompt "a river cutting through dense forest".

TouchDesigner engineer's response time, lowering the latency from when a prompt is changed and it becomes reflected in the generative output.

3.4 Current Limitations and Future Improvements

The workshop team recognizes a number of limitations with the system which could be improved to make the movement of the performer and the generative output more connected and expressive.

First, due to the architecture of the space and the use of only one ZED 2i camera, performers were limited to a relatively small playing space within the camera's field of view. Performers tended to unintentionally exit the camera's field of view when on the floor or when moving quickly to the extremes of the playing space, limiting their expressivity. This could be improved by capturing movement in a larger space with more depth or adding a second camera to help the ZED software identify the performer from the curved architecture of the Igloo.

Second, while we valued the use of the lightweight sd-turbo model for fast image generation, this model is trained on a dataset

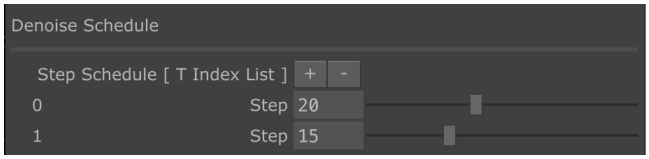


Figure 10: Technical art students participating in the Viewpoints movement warmups within the Igloo.

of 512x512 images, meaning that the system could only produce square images at relatively low resolution. Given more performant hardware or additional graphics cards, StreamDiffusionTD could have utilized models trained on higher resolution images.

Lastly, our system relied on the virtuosity of the human TouchDesigner technician responding to changes in the prompt and movement of the performer in order for the visual and textual inputs to produce a coherent visual output. Understanding the interplay of prompt, color, and the weighted balance of text and visual prompting became an art-form of its own, much like a photographer controlling the focus, zoom, and shutter speed of a camera (see "Parameters and Their Interplay" below). While a skilled technician could create sudden moments of delight, an inattentive or slow technician frequently produced frustration for the performer and prompt engineer waiting for their creative inputs to produce something coherent

4 Participants' Experience

Over the course of the 2024 Fall Semester, we conducted multiple workshop sessions for students and teachers of different backgrounds to participate in improvisational creation with the system. We identified three roles for participants to control and play with the system: performers, prompt engineers, and TouchDesigner technicians. Performer and prompt engineers composed both halves of the input into the Image Generation, with the TouchDesigner technicians controlling the balance between them. This section describes the methodology and learnings for each of these roles.

4.1 Movement Practice

At the start of each session, we led participants through a series of warm-up movement exercises inspired by Mary Overlie's Six Viewpoints System [20]. The Viewpoints exercises were chosen for their accessibility to non-professional dancers, as well as their focus on expanding the mover's perception of their body's shape while improvising. These exercises included simple articulations as well as games for timing movement with the rest of the group. After warming up, improvisation with the image generation system began and participants interested in performing were invited to move into the playing space and improvise for as long as they would like. They were encouraged to focus on the following topics as they improvised:

- Proximity to and from the camera
- Body shape
- Speed of movement and shifts between movement speed

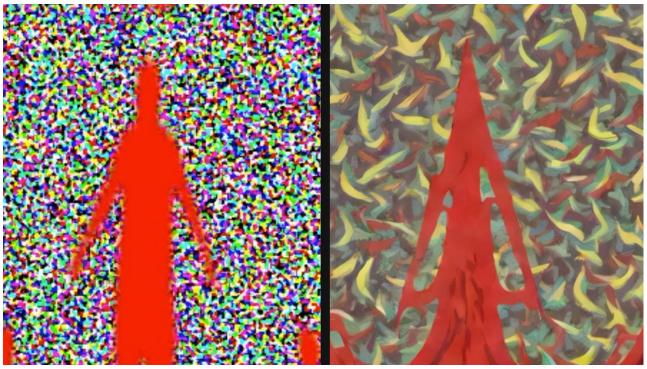


Figure 11: The two sliders within StreamDiffusionTD's Denoise Schedule.

4.2 Prompt Engineering

Throughout improvisation, participants were invited to participate as prompt engineers by typing into the mobile web application or speaking into the microphone with live transcription into TouchDesigner. For those without experience with prompt engineering, we referred them to an online blog post by Foundation Inc. titled "DALL-E Prompt Writing: How To Create Great Prompts" [8]. While originally written for users of the OpenAI DALL-E system, the principles outlined in the blog post were applicable to any image generation system, especially its description of the fundamental parts of good prompt creation:

- Subject Terms - The main subject of the image.
- Style Modifiers - Reference to a specific artistic style.
- Image Prompts - References to other images that provide further context.
- Quality Boosters - Words to enhance aesthetic qualities and details.
- Repetitions - Repeated subject or style terms to focus the image model.
- Magic Terms - Terms to inject randomness or creativity.

4.3 Parameters and Their Interplay

The image generation system required a TouchDesigner technician to control the balance between the input of the prompts and movement, as well as the color of the performer's silhouette overlaid on the multi-color Perlin Noise background. For controlling the balance between the input of the prompts and movement, the technicians used two sliders within the StreamDiffusionTD (Figure 11). These sliders control the Denoise Schedule—a key parameter that adjusts how much the generated image relies on text versus visual input. The minimum value of 0 completely favors the text-prompt, while the maximum value of 42 completely favors the visual input of the performers.

The balance of these two parameters and the silhouette color were essential for having the input of the prompt and movement create something coherent and imaginative. When improperly balanced, images generated were found to be either unresponsive to the movement of the performers or muddled shapes and colors without any relation to the text-based prompt (Figures 12, 13, & 14). The



Figure 12: Side-by-side of input and generative output using the prompt "a brilliant flame". Here, the Denoise Schedule favors the visual input too much, creating muddled shapes and colors.

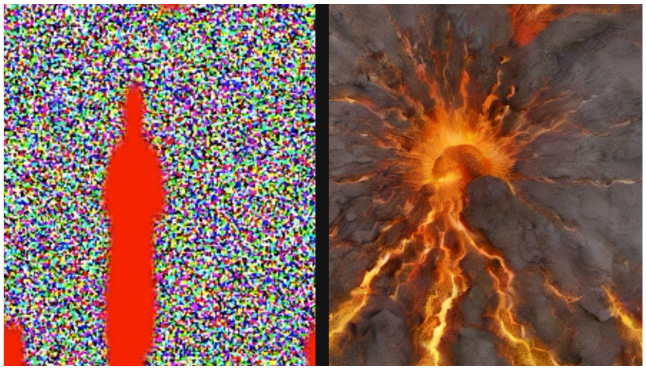


Figure 13: Side-by-side of input and generative output using the prompt "a brilliant flame". Here the Denoise Schedule favors the prompt too much, creating an image unresponsive to movement.

ability of the technician to respond to changes in movement and prompts quickly was also essential for the speed of improvisation to be maintained.

5 Discussion

This study set out to explore how generative AI systems can act as meaningful provocateurs for embodied storytelling—how they can do more than produce visual or textual content by instead stimulating movement, improvisation, and co-creative narrative expression. Our workshop provided concrete insight into this question by allowing participants to interact with a responsive GenAI system in real time, using their bodies and prompts as dual inputs.

At the heart of our system was a design principle that positioned GenAI not as an autonomous storyteller but as a **stimulus for embodied response**. The AI's real-time generation of

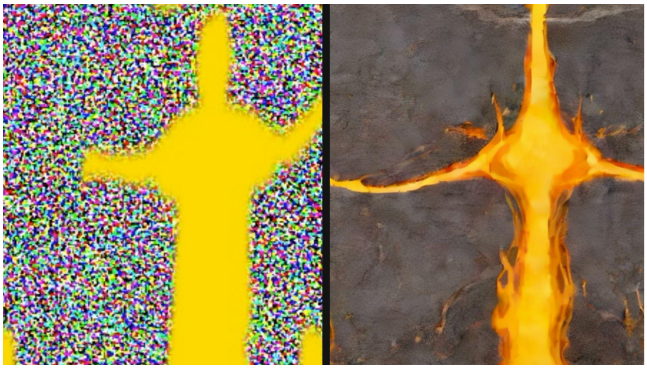


Figure 14: Side-by-side of input and generative output using the prompt "a brilliant flame". Here, the Denoise Schedule is well balanced, creating an image that reflects the prompt and the performer's movement.

imagery—guided simultaneously by live verbal prompts and the performer's silhouette—created an evolving, unpredictable visual environment that dancers and performers could react to physically. This stimulus-response dynamic positioned the AI as a provocateur, not through direct instruction, but through suggestive, ambiguous, and often poetic outputs. When functioning optimally, this provocation invited the body into dialogue with the imagery, triggering narrative gestures, emotional shifts, or compositional exploration.

One way GenAI acted meaningfully was by enabling multimodal improvisation—where visual input, text, and motion coalesced into an emergent narrative. Participants described moments where the imagery seemed to "speak back" to them, prompting new gestures or narrative directions. This interplay mirrored practices in improvisational performance, where story is not pre-scripted but discovered through action. The system's unpredictability, far from being a limitation, was essential to its provocative potential—generating surprise, tension, and opportunities for interpretation. In this way, GenAI helped **scaffold a space of embodied storytelling**, where narrative was not delivered but made through movement and response.

The workshop also illuminated that AI provocation was rarely singular or isolated. Instead, it unfolded as part of a **distributed creative negotiation** between performer, prompt engineer, and technician. Each role contributed to shaping the system's output: through bodily movement, textual prompting, or technical tuning. GenAI's provocations were not imposed but co-constructed through this dynamic. This supports the view that meaningful AI provocation arises not from the intelligence of the system alone, but from its situated use within a human ensemble.

We found that timing and coherence were critical to the effectiveness of AI provocation. When the system lagged or produced incoherent images, performers became disoriented or disengaged. Conversely, when the visuals felt responsive and aesthetically aligned with the prompt and movement, performers described a sense of flow or being "inside the story." Thus, designing GenAI as a provocateur requires **careful balancing of latency, control, and ambiguity**—allowing enough openness to inspire interpretation but enough clarity to sustain narrative momentum.

6 Conclusion

Generative AI can act as a meaningful provocateur for movement and narrative-making when it is situated not as a final storyteller but as an interactive force—one that suggests, surprises, and stimulates. Our findings show that when GenAI systems are integrated into embodied, collaborative settings, they can provoke genuine creative responses by disrupting expectations, feeding imagination, and inviting physical storytelling. To deepen this potential, future systems might incorporate adaptive learning, multimodal feedback loops (e.g., sound, haptics), and greater visual-spatial awareness to respond more fluidly to human motion. As AI continues to enter creative spaces, treating it as a narrative provocateur—rather than a narrative authority—offers a powerful framework for expanding embodied, performative, and co-creative storytelling practices.

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Rob2embrace Enchancing Multicultural Behaviour through Robot Activities with children in Education

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Abstract

Racial discrimination in education remains a critical and widespread challenge that profoundly impacts the mental health, well-being, and academic performance of children, particularly those from marginalized communities. This issue leads to severe psychological consequences such as social exclusion, low self-esteem, anxiety, and even suicidal thoughts [9, 15]. Addressing racial discrimination in schools is essential, as education forms the foundation where social values, inclusion, and future opportunities are built.

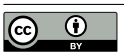
In this paper, a possible social robotics approach is presented for supporting multiculturalism inclusion among children in Primary Education. The project integrates the humanoid robot NAO with two local servers—one for artificial intelligence and another for voice recognition—to create interactive, empathetic, and inclusive educational experiences for children.

The intervention was implemented at CEIP Paz y Amistad, a public school in Seville, through specific creative learning activities facilitated by the robot to promote respect and understanding of racial and cultural differences. Surveys conducted before and after the session showed a reduction in discriminatory attitudes and behaviours, even after just one session, demonstrating the positive impact of this technology in fostering empathy and social cohesion.

Beyond its direct social benefits, this project actively promotes STEAM education (Science, Technology, Engineering, Art, and Mathematics) by introducing students to robotics and artificial intelligence in an accessible and engaging way. This dual approach not only addresses discrimination at its educational root but also empowers children with essential skills for innovation and future inclusion. This work highlights the crucial role of educational robotics as a scalable and effective tool to combat systemic racism in schools and to foster inclusive environments where all students can thrive. Acting through early education is fundamental to building fairer societies and safeguarding the mental health and dignity of the most vulnerable children.

CCS Concepts

• **Computing methodologies** → **Speech recognition**; • **Information systems** → **Language models**; • **Social and professional topics** → **Informal education**; **Race and ethnicity**.



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Keywords

Racial discrimination, inclusive education, educational robotics, artificial intelligence, Roma community, child well-being, STEAM education

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1 Introduction

School coexistence and equal opportunities are fundamental pillars of any modern educational system [3, 16]. However, persistent challenges related to racial discrimination and exclusion continue to impact the school experience of many students—especially those from historically marginalized communities [17]. These forms of discrimination, although sometimes subtle, can severely affect emotional well-being, social integration, and academic achievement [2].

In this context, it is essential to develop and implement innovative strategies that promote equity, empathy, and respect for cultural diversity from an early age [8, 12]. This study presents a pilot intervention that explores the potential of educational robotics—specifically, the humanoid NAO robot—and artificial intelligence (AI) as tools to foster inclusive, emotionally engaged classroom environments [4, 11].

2 Related Work

Social robots have increasingly gained attention in educational settings as innovative tools to support learning and social development [4, 11]. These robots are designed to interact with users in a socially intuitive way, leveraging speech, gestures, and affective expressions to create engaging and meaningful experiences [14].

Previous research highlights the potential of social robots to promote empathy, cooperation, and inclusiveness among students, especially in early education [6, 10]. For example, studies have shown that robots like NAO can facilitate social interaction, reduce anxiety, and support personalized learning [1].

Moreover, the integration of artificial intelligence (AI) with social robotics enables dynamic and context-aware interactions, enhancing the robot's ability to adapt to individual learners' needs and cultural backgrounds [13]. This is particularly relevant in diverse classrooms where fostering respect for cultural differences is crucial [7].

Despite promising outcomes, challenges remain regarding long-term efficacy, ethical considerations, and equitable access to these technologies [5]. Our work builds on this foundation by applying educational robotics combined with AI-driven dialogue systems to specifically address inclusion and empathy in a culturally diverse primary school context.

3 Motivation and Objectives

This initiative stems from both a social concern and a personal motivation: having observed the persistence of discriminatory attitudes in school settings and being a member of the Roma community, I felt compelled to develop tools that not only raise awareness of diversity and respect but also bridge the digital divide through inclusive technology use.

The primary goals of the project were to:

- Foster inclusive and empathetic attitudes among primary school students through interactive activities mediated by a humanoid robot.
- Reduce discriminatory behaviours via participatory storytelling, moral dilemmas, and collaborative dynamics.
- Promote interest in STEAM disciplines—especially among students who typically have limited access to advanced technological resources.

4 Methodology

The intervention was implemented at CEIP Paz y Amistad, a public primary school in Seville renowned for its commitment to diversity and pedagogical innovation in a multiracial neighborhood with vulnerable communities. The central technological component was the NAO humanoid robot, which interacted dynamically with students using two locally hosted AI-based systems: one for speech recognition and one for natural language generation.

4.1 Technical Architecture

Two local Python-based servers ensured low-latency, secure operation within the school network:

4.2 In-Class Execution

Each session began with a greeting from the robot and continued with three pedagogically structured activities:

- **Narrative Storytelling:** The robot narrated stories promoting empathy and inclusion, reacting to children's comments.
- **Moral Dilemmas:** Students were asked to resolve hypothetical situations involving exclusion.
- **Open Dialogue:** Students posed spontaneous questions to the robot, which replied using AI-generated content tailored to a child audience.

Activities were conducted in Spanish and adapted to the cognitive level of children aged 6 to 11.

4.3 Practical Implementation

The study involved nine fifth-grade students (aged 10–12) in a 70-minute classroom session. Using a pre- and post-questionnaire design, the intervention assessed changes in students' attitudes toward diversity. During the session, the NAO robot acted as a facilitator—giving instructions, asking questions, and using gestures to support communication—serving as a guide to maintain engagement and participation. The following table summarizes the five educational activities carried out with the robot, detailing their pedagogical aims and interaction formats.

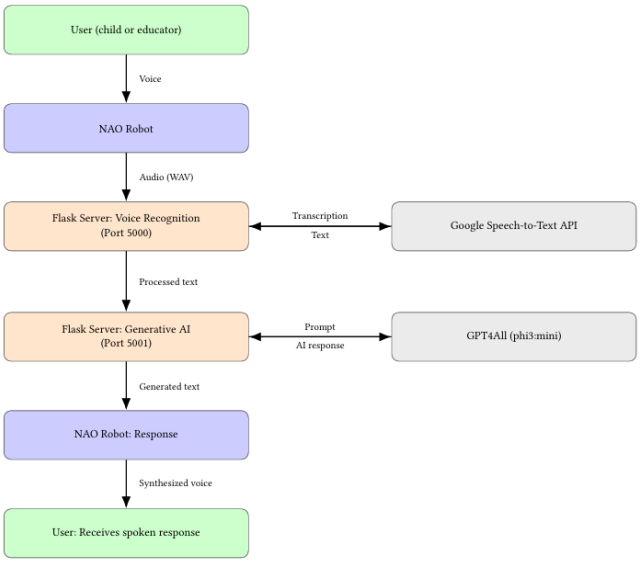


Figure 1: Interaction flow between the user, the NAO robot, and the Python microservices.

NARRATIVE INTRODUCTION: The session began with a story narrated by the robot that illustrated values of empathy, diversity, and respect. Using modulated voice, synchronized gestures, and expressive lights, the robot captured the students' attention and set an emotionally resonant tone. This multimodal storytelling served as a springboard for subsequent personal and dialogical activities. In that case, the NAO robot introduced himself as feeling different to human children and marginalized by this reason, engaging the audience with the social thematic and promoting empathy to this situation.

OPEN Q&A: Students were invited to freely ask the robot questions about emotions, equality, and coexistence. The robot listened, recorded their voice, and responded using AI-generated answers tailored to the children's level of understanding. This activity encouraged authentic curiosity and fostered deep emotional reflections such as, "Why do people treat others badly for being different?" or "Can robots feel lonely too?" The robot's empathetic responses contributed to a trusting atmosphere, where all voices were valued. . For supporting this learning scenario, the capabilities of the NAO robot were specifically enlarged as previously explained

IDENTITY SHARING: In a circle activity, each student was invited to complete the sentence: "My name is..., I am..., and...". This sentence structure encouraged them to share not only their name and cultural or personal identity, but also something they value about themselves or others. After each student spoke, the group acknowledged the speaker, and the robot invited the rest to guess

Activity	Objective	Interaction Mode	Observed Impact
Narrative Introduction	Establish emotional connection and promote respect for diversity through storytelling	Robot narrates a personal story using voice, gestures, and emotions	High emotional engagement, laughter, empathy, and a safe emotional climate for the rest of the session
Red Light and Green Light Game	Promote critical thinking about discrimination through physical movement and moral evaluation	Robot describes situations → Children react physically (jump/crouch) and verbally categorize them	High enthusiasm and critical awareness; some fatigue due to repetition but overall strong motivation and participation
Identity Sharing ("Guess Who")	Affirm personal identity, cultural pride, and peer recognition	Students record identity phrases → Robot plays them back anonymously → Peers guess identities	High participation, excitement, and curiosity; strengthened group cohesion and appreciation for cultural diversity
If Looks Could Speak	Develop empathy and non-verbal communication through eye contact and symbolic connection	Robot guides a group game using string and gaze, creating a symbolic web of connection	Not implemented, but expected to promote inclusion and emotional connection through non-verbal interaction
Open Q&A with NAO	Encourage curiosity, empathy, and open discussion on diversity and fairness using AI-generated responses	Students ask questions → Robot responds using AI with inclusive tone	Emergence of spontaneous, deep questions; promoted reflection, participation, and active listening

Figure 2: Summary of Activities with NAO Robot

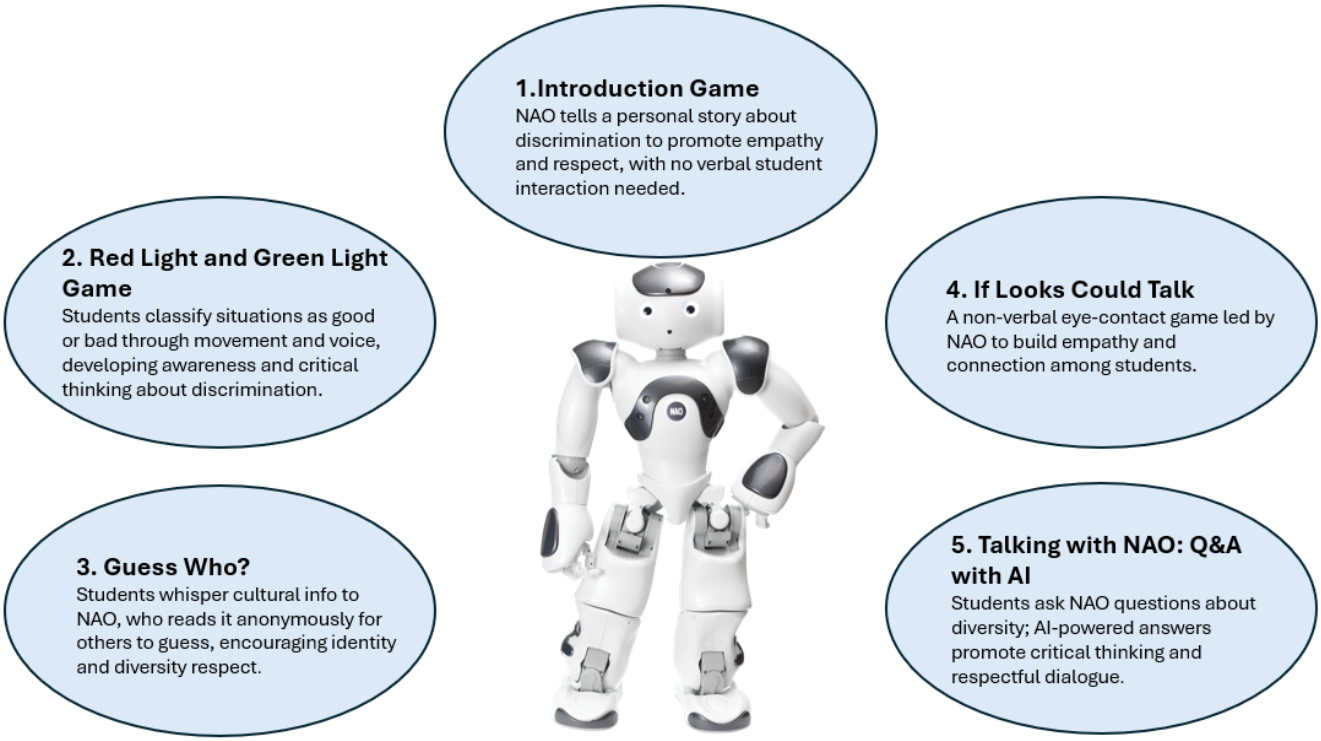


Figure 3: NAO Robot with Activity Summaries.

whose identity had just been described. This activity promoted active listening, mutual recognition, and pride in one's roots.

> *Aitana: "My name is Aitana, I am Roma, and I like helping my friends."*
> *José: "My name is José, I am Latino, and we all deserve respect."*

These creative STEAM activities were reinforced through the robot's expressive capabilities—light changes, posture adaptations, and empathetic tone of voice—which appeared to increase motivation, emotional safety, and willingness to participate. The integration of social robotics into this educational framework thus enhanced both the cognitive and affective dimensions of learning related to diversity and coexistence.

5 Results

5.1 Quantitative Findings

The pre- and post-intervention questionnaires suggested an increase in students' sensitivity toward diversity, even after a single session. The student scores corresponded to a 13-item questionnaire designed to evaluate attitudes toward cultural diversity, empathy, and inclusive behaviour. Each item was scored on a 1–3 scale, where higher scores indicate greater sensitivity and inclusion, resulting in a possible total score range of 2 to 34 points. Example items included: "I enjoy learning about other cultures" and "I treat all classmates fairly, regardless of their background."

The overall student scores improved from an average of 29.56 to 30.89 points on a 35-point scale, indicating a positive trend. Notably, a subgroup of family participants—cousins aged 9 and 11—also exhibited improvements, with the younger cousin showing a 4-point increase, supporting the consistency of the intervention's impact beyond the classroom.

5.1.1 Teacher Assessment. A complementary evaluation was conducted using a 7-item closed questionnaire administered to the lead teacher responsible for the group. The teacher's responses were predominantly positive:

- The teacher confirmed that dialogue about cultural diversity was already present in the classroom prior to the intervention ("Very Frequently").
- Occasional incidents of discrimination or exclusion were noted ("Sometimes").
- The educator perceived the robot NAO as a highly effective tool to foster inclusion.
- The intervention was acknowledged as having a positive effect on the students.
- While the experience was highly valued, the teacher suggested cautious implementation before institutionalizing the approach.
- A perceptible increase in student interest towards cultural diversity was reported.
- The teacher expressed willingness to continue using the robot in future initiatives.

These responses highlight that the intervention occurred in an environment already sensitized to diversity, and it further enhanced students' cultural interest rather than directly modifying inclusion behaviours. The teacher's endorsement underscores the pedagogical value of integrating robotic tools like NAO to stimulate dialogue and engagement around diversity topics.

5.1.2 Student Gains. Surveys conducted before and after the session suggested an increase in students' sensitivity toward diversity, even after one session

Specifically, the average student score increased from 29.56 points in the pre-intervention assessment to 30.89 points post-intervention on a 35-point scale. This represents a gain of +1.33 points, suggesting that the educational activities—including interaction with the NAO robot and cooperative games—effectively enhanced students' sensitivity and understanding of cultural diversity and social inclusion.

Beyond the aggregate scores, the data reveals consistent improvement across most individual items of the questionnaire, particularly those assessing awareness of cultural differences, recognition of discrimination, and empathy toward peers from diverse backgrounds. This pattern indicates that the intervention impacted multiple dimensions of students' learning and social-emotional development.

Moreover, subgroup analysis showed that certain groups of students, including those who initially demonstrated lower baseline scores, experienced more pronounced gains. This suggests that the intervention may be especially beneficial in raising awareness among students who previously exhibited limited engagement or understanding of diversity-related concepts.

The observed improvements are also reflected in students' qualitative feedback, where many expressed increased curiosity and positive emotions regarding intercultural encounters, indicating that the knowledge gains translated into meaningful attitudinal changes.

Sample Size Limitation. It should be noted that the sample size in this study was relatively small (N=9). While the descriptive findings provide valuable insights into students' sensitivity toward diversity and inclusion, the limited number of participants constrains the extent to which these results can be generalized to broader populations. Therefore, the outcomes should be interpreted with caution, and future studies with larger samples are needed to validate and extend these preliminary observations.

In summary, these quantitative results support the conclusion that the intervention successfully fostered greater cultural sensitivity and inclusive attitudes among students. The combination of technological mediation through the robot NAO and engaging pedagogical activities contributed to these positive outcomes, highlighting the potential of innovative, interactive educational tools in promoting social inclusion in diverse classroom settings.

5.2 Qualitative Insights

Open-ended responses from students reveal strong emotional engagement and reflective thought, aligning well with the quantitative results. Key themes emerged around diversity, intercultural curiosity, and anti-discrimination sentiments:

- **On Diversity:** Students expressed happiness and appreciation, stating comments such as "It makes me happy" and "We learn new things."

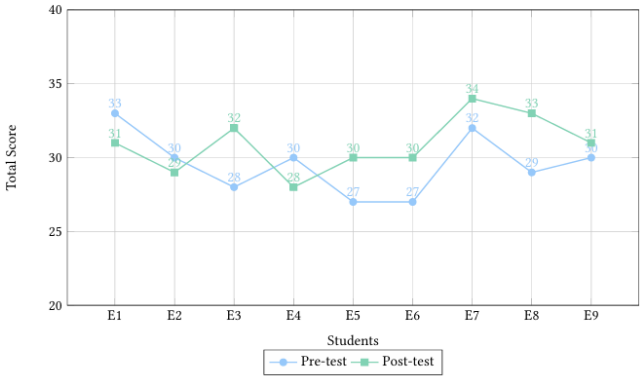


Figure 4: Individual evolution of pre- and post-intervention scores (line chart)

- **On Other Cultures:** Curiosity was reflected in questions like "How do you celebrate holidays?" and "What different foods do you eat?"
- **On Discrimination:** Awareness of equality and fairness was evident in remarks such as "We are all equal" and "It's not right to exclude anyone."

Among the activities, cooperative games like "Guess Who?" and "Red Light" were particularly well-received, effectively combining physical movement with reflection to reinforce learning in an engaging and playful way.

5.3 Supplementary Family Data

To triangulate the findings and extend evaluation beyond the classroom, the same questionnaires were administered independently to two cousins of participating students, aged 9 and 11. Despite the limited sample and different context, the results mirrored those observed in students:

- Both maintained a high overall score level post-intervention.
- The 9-year-old cousin showed a notable improvement of 4 points.
- The 11-year-old cousin's score decreased slightly by 2 points but remained within a high-performance range.

These family data provide informal but valuable confirmation of the intervention's positive effects outside the school environment.

5.4 Comparative Analysis

To evaluate the impact of the intervention, we compared questionnaire scores collected from two groups: students and their family members. Table 1 summarizes the mean scores and standard deviations before and after the intervention for both groups.

The greater variability in the family members' initial responses reflects a broader diversity of baseline views. After the intervention, the decrease in standard deviation in their post-test scores indicates a shift towards greater agreement. This trend suggests that the intervention helped foster a more consistent and shared understanding of diversity and inclusion among family participants.

Group	Mean Pre	Std. Dev. Pre	Mean Post	Std. Dev. Post
Students	29.56	2.07	30.89	1.90
Family	30.50	4.95	31.50	0.71

Table 1: Summary of means and standard deviations for pre- and post-intervention questionnaire scores.

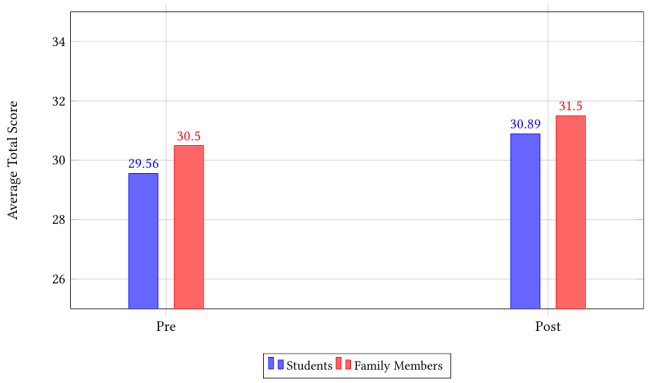


Figure 5: Graphical comparison of pre- and post-intervention means between students and family members.

The bar chart visually illustrates the improvement in average scores for both students and family members from pre- to post-intervention. Notably, both groups show a positive increase, with family members exhibiting a slightly higher post-intervention mean score. This graphical representation reinforces the quantitative data, highlighting the effectiveness of the intervention in promoting more inclusive attitudes across different participant groups.

5.5 Qualitative and Conclusive Remarks

The integration of qualitative and quantitative data provides a comprehensive view of the intervention's impact. The quantitative improvements in sensitivity and positive attitudes toward cultural diversity were complemented by rich qualitative evidence of emotional and cognitive engagement from students.

The teacher's assessment reinforces these findings by situating the intervention within an already diversity-aware classroom, noting enhanced interest rather than immediate behavioural change, and affirming the robot NAO as an effective pedagogical mediator.

Family participation offered an extended perspective, suggesting that the intervention's benefits transcend the immediate school context and contribute to a broader cultural awareness.

In conclusion, the project successfully promoted key concepts of diversity, inclusion, and intercultural understanding through innovative, robot-assisted activities. While promising, further longitudinal studies and cautious integration are recommended to consolidate these initial positive outcomes and support sustainable educational practices.

6 Impact on STEAM Engagement

While the core focus was social inclusion, the intervention had a secondary but important impact on students' interest in STEAM fields:

- Many students asked how the robot worked, how it "understood them", and how to "teach it more things".
- Teachers noted increased curiosity toward programming and AI, particularly among girls and students from underserved backgrounds.

The robot thus served not only as a social catalyst, but also as a technological role model, making invisible systems—such as AI—tangible and inviting.

7 Conclusions and Future Work

This intervention demonstrated that emerging technologies, particularly educational robotics integrated with AI, can play a valuable role in fostering more inclusive, participatory, and respectful school environments. By providing interactive, empathetic, and engaging experiences, the NAO robot supported students' reflection on diversity and inclusion. Additionally, the activities sparked curiosity about robotics, AI, and other STEAM disciplines, motivating students to explore science and technology in an accessible and engaging way. Although this was a pilot study with a small sample, the observed results suggest that even brief, technology-mediated interventions can positively influence students' attitudes when activities are thoughtfully designed. The project highlights the potential of educational robotics to create emotionally engaging learning experiences that promote both social-emotional skills and cognitive development, while simultaneously inspiring interest in STEAM fields.

Future development lines include:

- Increasing the number of sessions to consolidate learning and assess long-term impact.
- Adapting activities for different educational levels and cultural contexts.
- Developing complementary pedagogical materials that can be used by teachers before and after the intervention with the robot.

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Why Open Small AI Models Matter for Interactive Art

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Abstract

This position paper argues for the importance of open small AI models in creative independence for interactive art practices. Deployable locally, these models offer artists vital control over infrastructure and code, unlike dominant large, closed-source corporate systems. Such centralized platforms function as opaque black boxes, imposing severe limitations on interactive artworks, including restrictive content filters, preservation issues, and technical challenges such as increased latency and limiting interfaces. In contrast, small AI models empower creators with more autonomy, control, and sustainability for these artistic processes. They enable the ability to use a model as long as they want, create their own custom model, either by making code changes to integrate new interfaces, or via new datasets by re-training or fine-tuning the model. This fosters technological self-determination, offering greater ownership and reducing reliance on corporate AI ill-suited for interactive art's demands. Critically, this approach empowers the artist and supports long-term preservation and exhibition of artworks with AI components. This paper explores the practical applications and implications of using small AI models in interactive art, contrasting them with close source alternatives.

Keywords

AI models, Small models, Open Source, Interactive art, AI art, Real-time systems, Creative autonomy, Art preservation

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1 Introduction

In recent years, artificial intelligence has significantly expanded the creative possibilities of creative fields such as digital art, film, music, design, and, notably, interactive art [6, 13, 17]. Artists and designers are increasingly incorporating AI into their workflows, but often relying on proprietary platforms. AI methods might allow new creative possibilities, but they are not magic and have many limitations that might consume the same amount of time as before for creatives. For example, Sora's video generation tool in 2023 was received with mixed reactions from filmmakers, with many reporting that only one of the 300 generated clips might be considered usable [19] in specific tasks. These proprietary AI platforms offer easy-to-use systems to attract more users, but hide severe limitations. As Abuzuraiq and Pasquier argue, large-scale closed-source models limit users to simple prompting rather than genuine interaction, reducing their ability to shape AI tools to their specific needs [2].

In addition, big AI brands used artists for advertising and 'artwashing' campaigns, leveraging their work to promote their proprietary AI models without providing real support or fair compensation. A striking example is OpenAI's Sora, which granted selective free access to a handful of artists solely to market the tool while heavily controlling the published outcomes. This lack of transparency and genuine collaboration led to significant backlash from the artistic community, culminating in the petition "Dear Corporate AI Overlords,",[1] , where artists demanded their rights and called for the decolonization of AI technology. This idea of decolonization is one of the inspirations for using small open AI models for the artist.

By small open AI models, we mean locally runnable models whose weights are openly redistributed under permissive licenses. This concept resonates with calls for more artist-centric approaches, such as the notion of 'human-scale models' proposed in the XAIxArts Manifesto [4], which emphasizes the importance of the manageability and accessibility for creative practitioners of these technologies.

The AI industry's reliance on high-performance GPUs exemplifies this growing divide of power and raises concerning issues. These types of GPU are prohibitively expensive for individual artists and even some academic institutions. For instance, NVIDIA's H200 GPUs, released in 2024, costs up to $40,000 per unit, reinforcing the concentration of AI power among a few well-funded corporations.[2] Additionally, as AI models grow in size require multiple and larger GPUs to run the training and inference of these AI models, this approach necessitates increasingly energy-intensive hardware, exacerbating environmental concerns. The NVIDIA A100 GPU, released in 2020, consumed up to 400W, while its successor, the H100, released in 2022, increased power consumption to 700W—a 75% increase in just two years. Although the H200 maintains the same power consumption as the H100, it does so while delivering significantly higher performance, effectively reducing energy use per computation. However, the growing dependence on large-scale artificial intelligence still contributes to the escalating global electricity demand, intensifying concerns about sustainability.

Beyond environmental and financial constraints, the dominance of proprietary AI platforms raises deeper structural issues. These



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[1] https://openletter.earth/dear-corporate-ai-overlords-90668a95
[2] https://www.forbes.com/sites/bethkindig/2024/06/20/ai-power-consumption-rapidly-becoming-mission-critical/

cloud-based services operate as black boxes, offering little transparency about their inner workings (like energy consumption and water), data sources, or biases. Artists and designers lack deep control over these tools and rely on corporations that can determine the inference price, restrict features, ban topics, and discontinue models based on commercial strategies. This dynamic reflects technological centralization, where creative practitioners must conform to pre-built AI models rather than shaping the technology to suit their specific artistic needs, hindering the development of novelty in artistic practices.

Unlike many large models, some smaller open-source models can be run on personal devices (often on consumer-grade GPUs and sometimes on CPUs). These models, including generative and classification AI, allow interactive artists to fine-tune tools with curated datasets, integrate them with various sensors and physical computing setups to develop new forms of input, create novel interfaces, and ensure their artworks remain functional without relying on external corporate services.

The shift toward open-source, small-scale AI aligns with broader movements advocating for technological self-determination. Open foundational models such as Stable Diffusion (image generation), YOLO (object detection with segmentation variants), BERT and CLIP (text and multimodal encoders), Whisper (speech-to-text) and large language models such as BLOOM, Llama, Gemma, and Mistral (general-purpose language modeling) demonstrate how decentralization can empower individuals to develop, modify, and sustain impactful AI tools [12]. Open small AI models provide a pathway toward more ethical, sustainable, and democratized AI practices, particularly within interactive art, a medium where software is executed live during exhibitions rather than presented as a static, pre-recorded form like video or sound.

2 Open Small AI Models for Interactive Artists and Designers

The concept of a *small model* refers only to computational size. Ideally, the size of a *small model* should be compact enough to run inference on a single machine, whether on an artist's local device. However, for these creative uses, it also needs to be open licensed with redistributable weights because this combination enables modification, preservation, and a gain in artistic autonomy.

Notable examples include variants of Stable Diffusion for image generation optimized for realtime like StreamDiffusion [11] [3], video models like LTX-Video [4] or MotionStream [20] and small LLMs, which can run on gaming computers typically equipped with NVIDIA GPUs running Linux or Windows, or on devices Apple computers, widely used within the creative community. Running small models locally can achieve the real-time and low-latency response essential for interactive works.

Artists have already begun integrating small models into their creative workflows, demonstrating the power of local and adaptable AI systems. Evidence from practice includes Varvara & Mar's interactive installations, such as *Dream Painter* (2021) [7] and *Vision of Destruction* (2023) [5], where custom AI pipelines run on local machines, ensuring the real-time responsiveness and complete control necessary for direct audience interaction [5, 9].

A different non-interactive example is Superradiance (2024)[5] , a collaboration artwork between Memo Akten and Katie Peyton Hofstadter that was developed using small open-source AI models within TouchDesigner, ComfyUI and coding, creating a custom pipeline for each chapter [6]. This allows for a highly controllable approach to AI-driven artwork, resulting in an immersive multichannel video installation that explore embodiment, technology exploration, and planetary consciousness .

A broader comparison between small and closed source large AI models illustrates the trade-offs involved in choosing between the two. As shown in Figure 1, large-scale proprietary models can excel in better performance due to their extensive training in larger datasets. However, this advantage comes at a cost, both financially, environmentally, and with less autonomy. Large models require substantial computational infrastructure, which increases operational expenses and energy consumption. Cloud-based AI services, while accessible to users via simple interfaces, often come with hidden costs such as data restrictions, subscription fees, and the risk of discontinuation of services if a company decides to phase out a particular tool.

2.1 Core Characteristics of Open Small AI Models

- **Open Source:** Most open AI models are small. Open models are the most suitable for interactive art because they are available for inference and modification, ensuring artists can maintain and adapt their interactive systems long-term.
- **Selectable Models and Checkpoints:** Open-source models offer users extensive control, allowing them to use older or newer models version and select among different checkpoints (training files used for inference). This is vital for interactive art, allowing artists to design the experience as they want with a specific model version used in a piece, and ensuring preservation. The open models foster diversity, allowing users to choose from various model flavors, each with slight adjustments tailored to specific creative needs. For example, repositories like Civit.ai [7] that contain a large number of community-driven checkpoints for image models provide nuanced options, allowing users to precisely choose a specific style that can be used in their creations.
- **Single-Machine Operability / Local Execution:** Small models are optimized for individual hardware, reducing dependency on cloud infrastructure. This enables offline operation, which is essential for installations in diverse locations (good and stable internet can sometimes be hard to get in some exhibition venues) and provides a lower latency required for seamless real-time interaction. Creating a simpler setup that is free from external network complications and expensive API charges.

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[5] https://superradiance.net/#about
[6] A detailed explanation of the making-of *Superradiance*: https://www.youtube.com/watch?v=B_igdUDzcs4&t=511s
[7] http://civit.ai

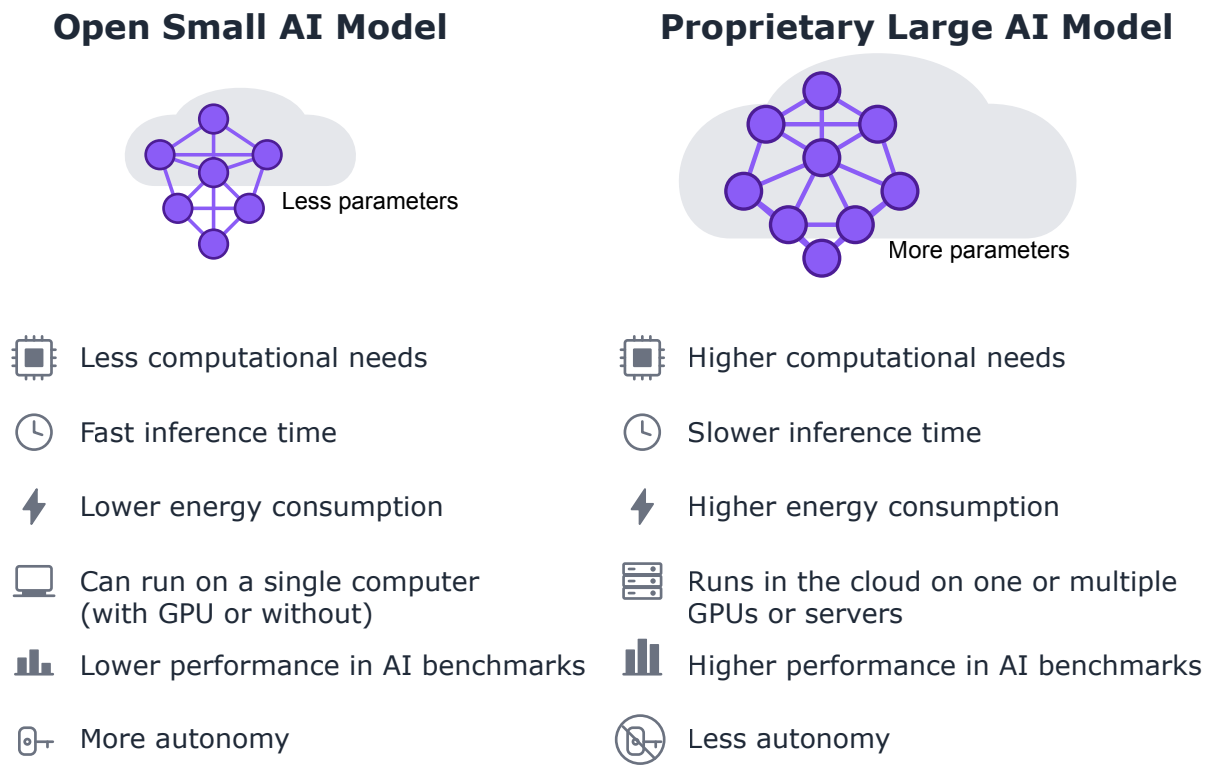


Figure 1: Comparison of small and large AI models across key characteristics.

- **Enhanced Control and Ownership:** By running models locally, interactive artists have significantly greater control over hardware, software, integration with sensors/physical elements, and creative outcomes.
- **Sustainability:** Small models with fewer parameters, capable of running on local machines, consume significantly less energy than large-scale models typically hosted in the cloud [16]. This makes them a more sustainable choice for creators of environmental concerns. Furthermore, these models can be easily monitored on local machines, providing detailed insight into resources being consumed, such as electricity usage. Enabling artists to make more informed and empowered decisions in their artwork design.

Adopting open small models is not just a technical shift, but can be seen as a cultural and ethical movement that redefines how AI is integrated into creative practices. By emphasizing decentralization, sustainability, and user autonomy, small models challenge the dominant AI paradigm and propose a future where technology serves artists rather than the other way around. The choice between centralised and decentralised models will shape the next generation of creative tools as AI evolves. By embracing small models, artists and designers can actively shape this future—one where innovation is driven by independence rather than dictated by corporate AI providers.

3 Advantages of Open Small AI Models for Interactive Art and Shortcomings of Proprietary Large AI Models

For interactive art, one of the core advantages of open small AI models running locally is when real-time responsiveness is achieved. Unlike cloud-based models, which introduce network latency, locally operated small models enable instant interaction—an often critical requirement for installations and performances that engage directly and immediately with audiences or environmental input. Even minor delays in cloud-based systems can disrupt fluid responsiveness, undermining the core of the interactive experience. Small models are therefore highly suitable for interactive environments where immediate feedback is crucial.

The study by Canet Sola and Guljajeva (2024) illustrates this through *Visions of Destruction*, an interactive artwork that leverages generative AI models operating locally to provide seamless audience interaction [5]. The critical importance of low-latency processing is further highlighted by Kyle McDonald's installation *Transformirror* (2023), showcased at the KIKK Festival (2024) in Belgium. McDonald's research found that despite using a high-performance RTX 4090 GPU in Romania through RunPod, cloud-based inference still resulted in significant latency (70-74 ms per frame, with an additional 100 ms delay for diffusion image generation) [18]. This resulted in a significant drop in performance,

reducing the expected 10 frames per second to 5.7 FPS, demonstrating that cloud-reliant AI often struggles to meet the fundamental demands of real-time generative interaction. These findings underscore the potential of small models that run locally for interactive and performance-based works.

When AI models are an integral part of the software pipeline, artists using cloud-based solutions risk catastrophic failure if providers discontinue services, could face changes due to API versions, and restrict certain functionalities that are only possible when you run locally, such as integrating custom input interfaces (e.g. sensors or other peripherals). An interactive installation intended for long-term gallery display can face significant risks relying on such unstable foundations. Locally hosted, open-source models ensure the longevity and maintainability of AI-integrated artworks, allowing creators to archive their models and workflows, guaranteeing future operation independent of shifting commercial policies. This self-sufficiency is particularly vital in media and interactive art, where the preservation of original tools, behaviors, and outputs is integral to the integrity of the art over time [15]. Furthermore, the ability to understand and maintain these models contributes to what Tecks et al. (2024) describe as 'explainability paths for sustained artistic practice,' allowing artists to engage with their AI-driven works over extended periods [21].

One case in which it is appropriate to use cloud-based AI servers, particularly when they can be self-hosted using open small models, is in interactive net-art. An example is *What do you want me to say?* by Lauren Lee McCarthy [8] . In this work, the artist creates a digital clone of her own voice, effectively becoming a puppet that repeats what participants tell her to say. After asking "What do you want me to say?", the cloned voice speaks to the participant's words back to them. The work was originally created in 2021. If the piece were not based on an open small AI model, it would be difficult to show again years after its creation, as seen in its exhibition in 2025 at the Festival de Arte Digital da Trafaria, Periphera (Lisbon).

Another net-art artwork, *Keep Smiling* [9] by Varvara & Mar, simulates a job interview with an AI agent that instructs the candidate to keep smiling while continuously evaluating the quality of their smile as part of an endless interview process [8, 10]. The work is both humorous and critical, offering a playful yet pointed commentary on current practices that involve the use of AI in evaluating job candidates. Moreover, this piece exemplifies how a small AI model can run directly in the browser without relying on external servers, as the model is lightweight enough to operate on participants' regular devices while they interact with the artwork through their webcams.

Another notable example is the long-term collaboration of the Berlin-based painter Roman Lipski's[10] with his *AI Muse* developed using the pix2pix Generative Adversarial Network (GAN) model. The Muse tool was developed in 2016 in collaboration with Florian Dohmann, the programmer. Muse features an innovative interface: a grid of knobs that enables the artist to mix different models, each trained with previous paintings by Lipski. This system generates a high number of permutations and possibility spaces allowing for emergent creative explorations by the artist, which he had used for his painting studio creations, but also in performances and workshops. The process involved integrating AI as an active co-creator and source of inspiration, treating the entire generative pipeline (software, code, and the original Lipski painting dataset) as part of the artistic legacy to be preserved and reactivated in future exhibitions, whether as performances or as a means of showing the artist's process [11]. This highlights the importance of not only archiving the final product, allowing it to be used and explored by the artist over many years, and ensuring preservation of the artistic processes.

As seen in the Lipski example, a major benefit of small models is their flexibility and customization. Unlike proprietary cloud-based AI, which imposes fixed parameters and limited modification options, small models enable artists to fine-tune AI behavior to align with specific artistic styles. This can be achieved through custom checkpoints, dataset curation, manipulation of model parameters, or additional training rounds, giving creators enhanced control over how their AI generates outputs or responds to inputs within an interactive loop. This allows for the creation of unique interactive personalities or responses tailored to the specific artistic concept [22]. Such deep engagement moves beyond simple prompting, allowing artists to truly 'seize the means of production,' as Abuzuraiq and Pasquier (2024) articulate, by actively crafting, adapting, and navigating generative models to suit their expressive needs [1, 2]. A compelling example is Helena Sarin, who personally trained her AI models using a curated dataset of her own artworks. [12] By feeding the AI her drawings, sketches, and photographs, she transforms the model's output into a highly personalised aesthetic, blending algorithmic generation with human artistic intent. Her work showcases how small models empower artists to develop unique machine-learning tools rather than relying on generalised, one-size-fits-all AI systems. Similarly, *xhairymutantx* (2024) [13] by Holly Herndon and Mat Dryhurst explores AI-generated identity through a fine-tuned text-to-image model that allows audience interaction to shape Herndon's evolving digital persona. *xhairymutantx* is an example of an interactive net-art artwork using AI, where the outputs are co-created by the audience, the artist, and the AI system, with the aim of injecting these generated images into future training sets, thereby transforming the representation of Holly within them. Furthermore, these cases illustrate how custom small models facilitate deep artistic exploration and participatory experiences in ways that corporate AI tools often cannot for interactive cases.

Another key advantage of small models is their resilience against commercial restrictions. Cloud-based AI services are inherently vulnerable to policy changes, model discontinuations, and paywalled access. OpenAI's decision to retire DALL·E 2 despite user demand demonstrates how companies control access to AI tools, often prioritizing profit over artistic utility [14] . For an interactive artist mid-project or maintaining an installation, such a decision can be devastating. In contrast, locally deployed models offer stability and independence, ensuring that artists are not forced to abandon or drastically rework functioning interactive systems due to corporate decisions beyond their control.

[8] https://get-lauren.net/What-do-you-want-me-to-say
[9] https://var-mar.info/keep-smiling/
[10] https://www.romanlipski.com/
[11] https://ai-berlin.com/blog/article/interview-with-roman-lipski-ai-artist
[12] https://www.nvidia.com/en-us/research/ai-art-gallery/artists/helena-sarin/
[13] https://xhairymutantx.whitney.org/
[14] https://www.pcmag.com/news/openai-shuts-down-dall-e-2-image-generator

Privacy and intellectual property protection are also significant concerns with cloud-based AI. Many online AI services require users to upload creative data, which raises concerns about data ownership, algorithmic bias, and unauthorised use. By contrast, running AI models locally means all data (potentially sensitive audience interaction data) stays on the artist's machine, ensuring full control over training datasets, generated outputs, and creative processes.

The autonomy granted by small models extends beyond individual projects to broader creative freedoms. Cloud-based AI services enforce content moderation policies that restrict certain themes, such as nudity, depictions of public figures, or politically sensitive material. While these regulations may serve corporate interests, they can limit artistic expression, particularly in experimental, critical, or activist art, including critical or experimental interactive works that might explore sensitive themes through audience participation. With small models, artists retain greater agency over their AI-generated works, free from corporate censorship.

Crucially, this freedom extends to the ability to 'pervert technological correctness,' as Rafael Lozano-Hemmer termed it [14] – the artistic impulse to misuse technology, explore its limitations, and push it beyond its intended functions, rather than adhering strictly to a corporate-defined 'correct' usage. Large, closed systems, often designed to prevent unexpected outputs and enforce specific norms, inherently restrict this type of critical and experimental engagement. Open small models, by providing full control and modifiability, empower artists to engage in such 'perversion,' which can be a vital source of artistic innovation and critique.

Beyond artistic control, small models also align with sustainability efforts. Unlike large, cloud-hosted models, which demand high-powered GPUs and extensive cooling infrastructure, small models run on comparatively energy-efficient local hardware. AI data centers contribute significantly to global energy consumption. In contrast, small models can operate on a fraction of this energy, reducing the ecological footprint and operational cost, making long-term interactive installations more feasible [16].

While cloud-based AI offers convenience through pre-trained, large-scale models with simple interfaces, this ease of use comes at the cost of user control, flexibility, real-time capability, and long-term accessibility/stability. Subscription fees, access restrictions, data regulations, and unpredictable service lifespans further limit the independence of artists, making cloud-based AI a challenging and often unsustainable choice for serious engagement in interactive art. In contrast, small AI models empower users to work on their own terms, ensuring customisation (allow code base modifications to the model, training or fine-tuning), privacy (avoid privacy issues with personal data of participants), responsiveness (reduction latency), stability(allowing preservation of artworks), and sustainability. As AI becomes more deeply embedded in creative workflows, choosing a decentralized and local approach to run AI models, artist-driven technologies will be key to maintaining artistic freedom and ensuring the viability of interactive art in the digital age.

4 Ownership, Accessibility, and Control: Open-Source Licensing in AI

Open-source licenses play a fundamental role in shaping the accessibility, usability, and longevity of AI models for creative professionals. For AI models to best support interactive artists, they should ideally be released under permissive open-source licenses, such as MIT, Apache, or CC0, which guarantee freedom in modification, distribution, and commercial use. These licenses allow artists to integrate AI tools into their workflows without restrictive legal barriers, ensuring that AI models remain adaptable, shareable, maintainable, and archivable for the long lifespan often required by interactive artworks.

However, many models labeled as "open-source" do not fully meet this standard. Some AI developers open-source only the codebase but keep training checkpoints proprietary, significantly limiting practical usability. Without access to training checkpoints, artists cannot fine-tune or modify models meaningfully, restricting the customisation needed to tailor AI behaviour for specific interactive scenarios or the ability to guarantee the long-term function of an artwork. A genuinely open AI model should include both the source code and the training checkpoint; ideally, the training dataset should also be available. This transparency fosters innovation, allowing artists to build upon existing models, modify outputs, and ensure their interactive systems can be preserved and restaged.

Despite the clear advantages of openness, some AI models adopt restrictive licensing policies that hinder creative professionals. For instance, the FLUX.1 [dev] Model, developed by Black Forest Labs Inc., is licensed under the FLUX.1 [dev] Non-Commercial License, explicitly prohibiting all commercial use. [15] This restriction makes the model inaccessible to artists who wish to exhibit or potentially sell interactive works incorporating it, reducing its utility for independent creators, freelancers, and small studios. Such licensing structures conflict with the principles of open-source development by restricting how artists can legally use and distribute AI-generated work and hinder the sustainability of artistic practices that rely on these tools.

A broader issue facing artists working with AI is the forced transition to newer models due to corporate decisions. Many commercial AI providers frequently discontinue older versions of models for financial and strategic reasons, rendering previous tools unusable. This practice disrupts established creative workflows and significantly threatens the preservation and continued operation of digital and interactive art. In interactive and media arts, where AI models function as an integral part of the software pipeline and often interact with custom hardware/sensors, such disruptions can lead to the loss of critical functionalities, forcing artists to re-engineer their works from scratch, often an impossible task if original behaviours cannot be replicated. When proprietary models are shut down or updated without backward compatibility, interactive artworks may become permanently non-functional, making long-term project sustainability highly uncertain.

In the context of media art conservation, AI model longevity, and the specific challenges of preserving interactive systems, Rafael

[15] Licensed under the FLUX.1 [dev] Non-Commercial License by Black Forest Labs Inc. For more information, see: https://github.com/black-forest-labs/flux/blob/main/model_licenses/LICENSE-FLUX1-dev

Lozano-Hemmer's work *Best Practices for Conservation of Media Art from an Artist's Perspective* offers valuable insights [15]. Lozano-Hemmer argues from extensive artistic practice that artists must maintain control over their digital tools to ensure the longevity and integrity of their works, advice that is paramount for interactive art. He advocates for open-source frameworks to preserve media art, aligning with the broader philosophy of transparency, communal improvement, and digital self-sufficiency. His recommendations support the argument that open-source is often the best option for preserving complex, technology-dependent interactive artworks, as they allow artists to continuously update, modify, adapt, and archive their tools without fear of them becoming obsolete due to corporate decisions. This reinforces the notion that open AI models share the same preservation and autonomy advantages as other open-source software components within artistic workflows.

Beyond preservation, the benefits of open-source AI models extend to artistic freedom and long-term accessibility. Open models enable community-driven innovation, where artists, designers and developers can collaborate in building communities to refine AI tools, share knowledge, and expand creative possibilities [3]. This decentralized approach reduces the reliance on proprietary infrastructures, fostering an environment where AI can be used and adapted for specific interactive needs without financial or contractual constraints. Open models also encourage more sustainable AI practices, allowing reuse, optimization, and redistribution rather than forcing users to adopt resource-intensive new models dictated by corporate release cycles, ensuring interactive art can thrive outside the dictates of corporate release cycles.

In conclusion, choosing open-source AI models is not just a technical decision but an artistic requirement for interactive artists that need to ensure creative control, long-term viability, and the archival integrity of their work. Many artistic strategies used in interactive art using GenAI will not be possible if an artist does not have access to source code, training checkpoints, and ideally, training datasets. This choice ensures that artists retain creative autonomy, preserve their work over time, and remain free from the restrictions of corporate-controlled AI infrastructures. As the integration of AI into artistic workflows continues to evolve, advocating for fully open and permissive AI models will be key to ensuring that AI remains a tool for artistic empowerment rather than a means of technological dependence.

5 Discussion

Although open small AI models offer significant advantages for interactive art, their adoption also presents challenges that must be considered. These challenges revolve primarily around hardware limitations, the costs of equipment, and technical expertise. However, as open-source communities grow and AI tools become more user-friendly, many of these obstacles are gradually being addressed, making small models increasingly accessible to interactive practitioners.

One of the main barriers to entry is hardware limitations. Although small models are designed to be lightweight compared to their large-scale cloud-based counterparts, they still often require high-performance GPUs to run efficiently. This poses a challenge for interactive artists lacking access to expensive hardware, particularly in developing regions with higher technology costs, especially when needing reliable, dedicated machines for installations. Limited access to advanced computing power can restrict creative possibilities and exclude certain artists from AI-driven artistic exploration. However, recent advancements in optimization techniques (e.g. quantization like GGML/GGUF, model pruning, or knowledge distillation) have made running small models on less powerful machines possible. These improvements help lower hardware requirements for AI interactive art pieces, making it more inclusive and reducing the technological gap between artists with different levels of access to hardware resources.

Unlike proprietary AI tools that often provide ready-to-use solutions, open small AI models typically require manual installation, configuration, integration into larger interactive systems, and ongoing maintenance. This complexity can discourage artists without programming experience from working with open-source AI. However, recent approaches such as vibe coding, supported by large language models, have begun to reduce some of this complexity. However, community-driven initiatives and user-friendly open-source tools are actively lowering these barriers. Platforms like ComfyUI [16] provide intuitive graph-based user interfaces, allowing artists to experiment with AI models without extensive coding knowledge. Additionally, the availability of step-by-step tutorials on platforms like YouTube and different communities fosters a collaborative learning environment, allowing artists to acquire basic technical skills and integrate AI into their creative workflows. The availability of tutorials on integrating AI with platforms like Processing, OpenFrameworks, TouchDesigner, or microcontrollers fosters a collaborative learning environment.

Other essential considerations are model maintenance and updates, especially for long-running interactive installations. Unlike cloud-based services that automate updates and improvements, artists using small models must manually update and maintain their tools. This can be a burden, particularly for independent artists who lack the time or technical expertise to adapt to new software changes continuously. Furthermore, frequent updates in open-source AI models can disrupt stable interactive systems, requiring users to reconfigure their pipelines. However, active open-source communities help mitigate this issue by providing long-term support, troubleshooting guides, and collaborative development. Platforms like ComfyUI foster environments where users collectively maintain tools, ensuring that even artists who are not deeply technical can benefit from ongoing improvements, offering some stability, although careful version management by the artist remains crucial for long-term projects. The capacity of artists to deeply understand and manage their chosen models, a benefit often afforded by smaller open systems, can also support the "sustained artistic practice" advocated by Tecks et al. (2024), by fostering a more profound and enduring relationship with the technological medium [21].

[16] ComfyUI: A highly modular and powerful diffusion model interface that offers a GUI, API, and backend with a graph/nodes structure for flexible model customization: https://github.com/comfyanonymous/ComfyUI

To address some of these challenges, hybrid cloud solutions that still provide some degree of user control offer a middle ground. Services like Google Colab, Dockerized environments, and locally controllable cloud GPU instances (like RunPod, Vast.ai) enable artists to access powerful computing resources on demand without requiring local high-end hardware, while potentially still allowing local control over the model/code execution for lower latency than pure SaaS APIs. These cloud solutions operate pay-per-use, allowing independent creators to run more complex models affordably while retaining control over their tools and workflows. Balancing cloud accessibility with open-source flexibility, these solutions help bridge the gap between creative autonomy and computing power, though they may reintroduce some dependency and latency compared to fully local setups.

The shift toward small, locally-run AI models can be seen not just as a technical change—it arguably represents a transformation towards reclaiming creative independence from dominant corporate AI platforms. This aligns with the idea of artists 'seizing the means of production' by gaining deeper control over the crafting and adaptation of their AI tools (Abuzuraiq and Pasquier, 2024) [1]. The ability to modify, control, and customise AI tools aligns with the values of many interactive artists and designers who prioritise autonomy, experimentation, and direct audience engagement. As the adoption of small models increases, we may witness the emergence of niche, community-driven AI tools that cater to specific artistic styles, interactive behaviours, and experimental approaches, creating a more diverse and decentralised AI landscape suited to varied interactive contexts.

This decentralisation helps prevent monopolisation in creative AI tools. Large corporations currently dominate AI development, shaping how artists interact with technology by imposing restrictive terms of use and access limitations often incompatible with the needs of interactive art (latency, stability, integration). The rise of small models challenges this top-down approach, ensuring that AI remains an accessible, adaptable, and reliable medium for interactive creation. Small models foster a pluralistic creative ecosystem where unique perspectives and regional artistic traditions can be represented rather than filtered through corporate-driven AI aesthetics or constrained by rigid API limitations by allowing artists to fine-tune and personalise their AI tools.

Open-source AI's collaborative and decentralised nature also encourages cross-cultural exchange in digital art. As more artists engage with these technologies—and some contribute to their development and refinement—open-source communities around tools like Stable Diffusion Web UI and ComfyUI facilitate knowledge sharing across geographical and cultural boundaries. These communities empower artists from diverse backgrounds to actively shape the evolution of AI, ensuring that it reflects a broad range of artistic voices rather than reinforcing dominant Western-centric aesthetics. Furthermore, the instability of proprietary AI services presents a major challenge for artists relying on corporate models. Many companies frequently discontinue models or restrict access to older versions, forcing users to migrate to newer, often more expensive solutions. This lack of backward compatibility can disrupt long-term projects, particularly in fields like interactive and media art, where the AI model itself is embedded into the software pipeline. When proprietary models become unavailable or are altered, artists are often forced to redesign their entire creative process, which may compromise the original intent of their work. In contrast, small open-source models offer the long-term stability essential for preserving and exhibiting interactive art.

An interesting consequence of the rapid evolution of AI technology is that older AI models considered outdated by industry may later be rediscovered and repurposed for artists looking for unique aesthetics. Repositories like Huggingface models [17] are incredible reserves of this huge number of AI models ready to be explored by artists. Ultimately, small AI models encourage experimentation in ways that proprietary tools often do not. Because artists can freely modify, tweak, integrate, and customise these models, they foster a culture of innovation where creators are not merely consumers of AI tools but active participants in developing unique interactive systems. This creative agency ensures that AI remains an open-ended medium for interaction, rather than a rigid, standardised tool dictated by corporate interests.

Moreover, decentralising AI development amplifies artistic voices that might otherwise be marginalised. Corporate AI models often enforce content restrictions based on economic and political considerations, limiting artistic expression in activist art, socially critical works, or experimental interactive digital aesthetics that might challenge norms. Small models remove these constraints, ensuring that AI can serve as a platform for radical creativity, self-expression, and cultural critique.

By allowing artists to develop their own AI-driven tools, particularly for interactive art, open small models ensure that AI does not become a static, commercialised product but remains a dynamic, evolving medium shaped by the communities that use it. This shift represents a move away from passive AI consumption toward active AI creation, where artists are no longer just users of AI but co-developers of the tools that shape their art.

Finally, as educators in art institutions teaching courses on interactive art and creative generative AI, you face an important choice: you can either purchase subscriptions to proprietary tools or invest in infrastructure by acquiring computers capable of running open-source models.

The first option, subscriptions, requires ongoing payments and in many cases these services use a credit-based system. This means that if a student wants to pursue a project, they might quickly run out of credits and be forced to pay more. The second option, running open source models locally, empowers students and increases their knowledge, as they have full control over AI, computer, and all aspects of the technology stack (gaining control over the creative infrastructure). Although open source models might not always match the quality of proprietary ones, they offer more flexibility and can be adapted to better suit all creative needs.

It is also important to note that for those outside the field, there is a significant difference between buying a server, running AI in the cloud, and running it locally. For interactive art, running locally often makes more sense, as input devices, such as cameras or sensors, are typically connected to the same computer. Simple factors like internet connectivity can become complicated in exhibition spaces, and if your piece relies on an external API, a stable internet

[17] https://huggingface.co/models

connection, and a computer, the chances of one of those components failing increase. Unless your interactive art is a net-art that uses AI, then you will need an AI server.

6 Conclusion

Open Small AI models present a compelling and often necessary alternative to centralized commercial AI services, offering interactive artists greater creative autonomy, sovereignty, flexibility, customization, real-time performance, and long-term stability. Open small models prioritize artistic exploration and independent innovation, unlike proprietary AI models, which operate within profit-driven frameworks often incompatible with the demands of artistic practices like interactive art. By providing enhanced control over training, fine-tuning, integration, and deployment, artists can shape AI as a tool that aligns with their personal vision and the specific needs of their interactive systems, rather than being constrained by corporate interfaces, policies, and the inherent instability of closed platforms.

While large AI models developed by major tech companies will continue to be popular due to their convenience and power for non-real-time tasks, small models offer a different and often essential value for interactive contexts—one rooted in self-sufficiency, transparency, customization, low latency, and longevity. Their typically open-source nature fosters collaboration and knowledge sharing, creating a more decentralized and diverse AI ecosystem that empowers creators of interactive experiences rather than limiting them to predefined outputs or ephemeral tools.

As technology advances, more interactive artists and designers will likely embrace open small models, benefiting from their independence and control over creative practice. This shift ensures that AI remains a medium for artistic expression and allows many types of innovative interactive interface, rather than being restricted to a corporate controlled tool prone to obsolescence. By engaging with open-source communities, artists can contribute to the expansion, refinement, and accessibility of open small AI models, playing an active role in shaping the future of reliable and artist-driven AI creativity.

For those with a hacker's spirit, especially interactive artists needing to integrate diverse technologies, small models offer a playground for experimentation, customization, and innovation, a space where AI is not merely used, but actively co-created, integrated, and redefined. This open-ended approach fosters a richer, inclusive, and diverse landscape for digital and interactive art, ensuring that AI remains a force for creative empowerment rather than creative limitation imposed by closed systems. Ultimately, open small AI models ensure that interactive artists remain the authors not only of their artworks but of the systems that shape them.

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Cosmic Echoes: Interdimensional Ensemble Systems and Pulsar Acousto-Optical Translation

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Abstract

This work proposes an interdisciplinary art installation "Cosmic Echoes" that transforms pulsar signals (from rapidly rotating neutron stars) into human-perceptible audio and optical experiences through AI-mediated processes. Human-Pulsar Ensemble is powered by satellite-acquired data, existing astronomical databases, AI-driven filtering and transformation, an online music-generation platform, and interactive projection with light-cube hardware. Users become both experiencers and co-creators of the artwork, engaging in real-time interaction to influence projected pulsar visualizations. Our main goal is to transform astronomical data into emotional experiences, creating an affective channel for cosmic information through participatory creation. This effort breaks the paradigm of traditional one-way communication in astronomical data presentation, offering a new framework for the convergence of astrophysics and art.

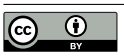
CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; Arts and humanities; Sound and music computing.

Keywords

Pulsar Acoustics, Real-Time Interactive Art, Cross-Sensory Experience, Democratization of Cosmic Data, Human-Pulsar Ensemble, Collective Creation System

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1 CONCEPTUAL MOTIVATION: THE SENSORY REVOLUTION OF THE SILENT UNIVERSE

1.1 Pulsars: the universe's natural metronome

Pulsars are rapidly rotating neutron stars that produce electromagnetic pulses at millisecond intervals with stability rivaling atomic clocks. These active cosmic objects create rhythmic patterns that have become invaluable tools for astrophysical research [1]. However, current public engagement with pulsar data remains limited, with most astronomical information existing solely in digital form within scientific databases.

Traditional astronomical art typically visualizes data as static images or unidirectional audio tracks, failing to address the sensory isolation problem: humans cannot physiologically perceive rhythms from light-years away [2, 3]. This installation proposes a core proposition: can humans develop emotional resonance with active cosmic phenomena through technological mediation? By constructing bidirectional interactive systems, users become both participants in galactic compositions and co-creators of cosmic experiences.

1.2 Artistic Objective Framework

Liberating pulsars from scientific instruments and turning them into interactive sensory experiences for the general population is a step toward democratizing science.

Breaking the Boundaries: Art Introduces Cosmic-Level Randomness and Breaks the Homogenization of Music Creation (e.g., Rhythmic Decay Due to Pulsar Rotation Deceleration) [4].

Conceptual explorations: investigating whether technology can help people understand the difference between cosmic scales (light-years) and human space-time scales (seconds).

2 TECHNICAL REALIZATION: ARTISTIC TRANSLATION OF INTERPLANETARY SIGNALS

2.1 System architecture

This technology closes the loop from pulsar signal to art experience using a six-layer collaborative design (Figure 1):

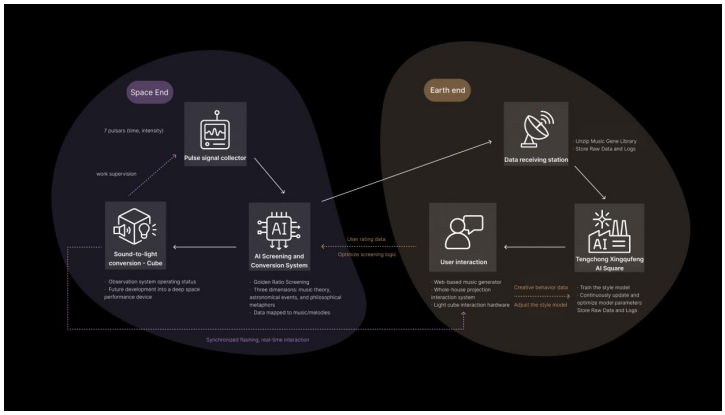


Figure 1: Description of the technical implementation and participant experience flow

2.2 Signal Capture Layer

2.2.1 Space-end system. A specially designed CubeSat payload (6U size) equipped with a high-sensitivity radio receiver array (frequency range 400MHz-2GHz) is launched from the space end. The system uses a time-division multiple access (TDMA) access mechanism to assign 200ms observation time slots and locks seven-millisecond pulsars as target sources, such as PSR J0437-4715 with a period of 5.757ms and PSR B1937+21 with a period of 1.558ms. The particle signal collector's work monitoring mechanism, which calculates the signal-to-noise ratio (SNR) in real-time and automatically switches to the backup source when SNR<30dB is detected to maintain data continuity, is the main innovation. After being time-stamped at the millisecond level (with an accuracy of less than 10 μs), all signals are sent over the X-band downlink (with a delay of less than 1.5 s).

2.2.2 Ground-side system. The ground RF receiving station creates a dual-modal processing channel, feeding the real-time signals into an acousto-optic converter cube and storing the raw signals in a 1PB capacity RAID array. The core uses the sound pressure-light intensity mapping concept, while the cube translates electromagnetic pulses into acousto-optic signals:

$$I = kP \ (k = 1,\ 2)$$

where I is the light cube brightness output and P is the sound pressure intensity (dB). The feedback closed loop optimizes the user rating data in order to prioritize the high-rating star source data and optimize the signal screening weights.

2.3 AI Agent-Driven Data Filtering, Transformation, and Model Training

Our AI agent system conducts an in-depth analysis of pulsar signals across three dimensions, serving as the decision-making foundation for data filtering and musical interpretation. In the astronomical dimension, the system evaluates physical properties such as rotation period and magnetic field strength, classifying pulsars and assigning them anthropomorphic roles—for instance, labeling millisecond pulsars as "Cosmic Dancers" or young pulsars as "Stellar Newborns". In the mathematical dimension, the AI performs harmonic analysis to identify rhythmic patterns and frequency ratios within the signals, exploring potential connections to mathematical constants like the golden ratio, thereby providing a mathematical basis for musical structure. In the philosophical dimension, the system imbues the signals with narrative meaning, interpreting stable periods as "Cosmic Meditation" and linking signal anomalies to concepts like "Stellar Mortality". Based on this comprehensive evaluation, the AI filters the most scientifically and artistically promising signal segments from the vast dataset and generates cross-dimensional explanatory notes for each selection.

The filtered pulsar data are transformed into unique "cosmic sound-prints". Using techniques such as frequency modulation and amplitude mapping, the signal's time series and energy intensity are mapped to musical parameters like pitch, rhythm, and timbre. For instance, rapidly spinning millisecond pulsars generate dense percussive rhythms, while slow, regular pulses form deep melodic foundations. Subsequently, these transformed audio data are used to train dedicated AI style models for specific pulsars. By fine-tuning pre-trained music generation models, we enable each pulsar to develop a distinct "musical personality". For example, PSR J0437-4715 might specialize in generating long-form ambient music, whereas the Crab Pulsar PSR B0531+21 might lean towards producing powerful electronic rhythms.

2.4 Online Interactive Generation Platform and Multi-Sensory Experience

We have built an online platform whose core is the deployment of pre-trained AI style models on the cloud, each representing the unique "musical personality" of a different pulsar. Instead of creating music from scratch, users interact with a specific pulsar (e.g., "the Vela Pulsar") through a conversational interface. When a user inputs a prompt like "Create a piece with a sense of mystery and epic atmosphere", the platform does not call a generic model; instead, it precisely invokes the corresponding, pre-trained "Vela Pulsar Style Model". This model fuses the user's natural language instruction with the inherent musical characteristics embedded within it (such as the pulsar's signature rhythm patterns and harmonic tendencies), generating music that meets the user's emotional request while

bearing the distinct soul of the celestial body. This process allows users to intuitively experience the contrasting "personalities" of different pulsars, engaging in a unique musical dialogue with a star light-years away.

All user creations are collected by the system and converge into a continuously evolving and growing "Universal Score." This score is a massive, collaborative audio archive. It is not merely a collection of human ideas but a collective representation of the fusion between human inspiration and cosmic stellar characteristics via AI, forming an ever-enriching "Cosmos-Humanity" collective soundscape.

The act of music generation on this platform is not just an auditory output but the starting point for a complete multi-sensory artistic experience. The music generated by the user real-time drives a powerful backend visualization engine. The core Light Cube installation is deeply integrated with professional multimedia engines like TouchDesigner. These systems no longer respond to raw pulsar data but instead perform real-time analysis of the audio stream of the generated music itself (including its rhythm, melody, harmony, and dynamics). The emotion and structure of the music are translated into jumping points of light, flowing colors, and evolving shapes on the Light Cube, achieving a "visual embodiment of sound". In larger-scale installations, immersive projection systems surround the user, expanding the music into an encompassing visual universe. Users can even interact with these visual elements through gestures or voice, influencing the movement of particle systems or altering the direction of light flows, thereby completing the ultimate experiential loop from "passively listening to the stars" to "actively dancing with the stars", achieving true harmony with the cosmos's rhythm.

3 CRITICAL PERSPECTIVES ON AI MEDIATION IN COSMIC ART

3.1 Transparency, Interpretation, and Co-Evolution

Our project acknowledges that AI is not a neutral translator but an active interpreter of cosmic phenomena. To make this interpretive role visible and subject to critique, we have embedded transparency at the core of the experience.

The platform presents users with a tripartite view for each musical generation: the original pulsar data (e.g., period, intensity), the AI's multi-dimensional reasoning for its selection and musical mapping, and the final generated music. This juxtaposition does not seek to validate the AI's choices as "correct", but to expose the artistic and algorithmic decisions that bridge the gap between cosmic signal and human composition. It invites users to contemplate the profound questions inherent in this translation: What is lost and gained when a mathematical rhythm becomes a musical one? How does the AI's "philosophical" framing shape our emotional connection to a star?

Beyond passive observation, users are empowered to rate the AI's output. Their collective evaluations on the coherence, beauty, or "cosmic feel" of the music are aggregated as a form of collaborative wisdom. This data is not merely for display; it is contemplated for its potential to fine-tune the AI's future selection and interpretation processes. This introduces a profound, meta-critical layer: the human aesthetic response becomes a guiding force in the AI's evolving understanding of how to "listen" to the universe. The system enters a state of co-evolution, where human intuition and machine logic intertwine to collectively redefine the poetics of cosmic translation.

3.2 Astronomical Poetics as a Wellspring of Novel Inspiration

A central critical ambition of this work is to challenge the conventional boundaries of musical inspiration. We posit that the complex, non-human patterns of pulsars—their immutable rhythms, resonant frequencies, and statistical anomalies—constitute a vast, untapped library of musical forms.

The AI does not simply force these patterns into existing musical genres. Instead, by faithfully translating their intrinsic mathematical and temporal structures, it generates novel sonic textures and compositional frameworks that lie outside the conventional paradigms of human music theory [5, 6]. The erratic "glitch" of a dying star might inspire a new form of rhythmic rupture; the steady, billion-year spin of a millisecond pulsar might give rise to a minimalist aesthetic of unprecedented depth.

Thus, the project reframes the role of the algorithm from a mere tool for automation to a mediator of cosmic creativity. It leverages AI not to imitate human art, but to extend the sensory and creative palette of humanity by channeling the authentic, alien logic of the cosmos. The resulting compositions are not "songs from space" in a simplistic sense, but are profound collaborations with the universe itself, offering a wellspring of inspiration that is fundamentally other and, therefore, fundamentally new.

4 FUTURE DIRECTIONS

Installation contributes to evolving discussions about effective science communication in the digital age. By creating embodied, interactive experiences with astronomical data, the work challenges traditional boundaries between scientific education and artistic expression.

This approach aligns with recent research on "citizen science" and participatory research methods that engage public audiences as active contributors to scientific understanding rather than passive recipients of information. The installation's emphasis on collaborative creation reflects broader trends toward democratizing scientific knowledge and fostering public engagement with complex astrophysical concepts.

The installation opens pathways for future research in several domains: The Expanded Cosmic Data Sources: Future iterations could incorporate data from other astronomical phenomena, including gravitational waves, solar wind patterns, and exoplanet atmospheric compositions.

Advanced AI Collaboration: Development of more sophisticated AI agents capable of engaging in deeper philosophical and aesthetic discussions about cosmic phenomena.

Global Collaborative Networks: Expansion of the platform to enable worldwide participation in cosmic music creation, fostering international dialogue about science, art, and human-cosmic relationships.

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The Eye of the Sun — A touch and motion-sensitive, interactive, audio-visual sculpture combining curiosity and solar physics

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Abstract

In this paper, we present *the Eye of the Sun*, a solar composition for visitors, sensors, speakers, computers, lenses, mirrors and video projectors, in aluminium and acrylic. *The Eye of the Sun* is a motion- and touch-sensitive digital sculpture representing a gigantic human-like eye with a realistic aesthetic. The size of a human being, it is spherical, white and vascularized. It is connected to the surrounding world by an electrical optic nerve, has its own behaviour and is animated by rapid eye movements to scan the space around it. When spectators interact with the Eye in the right way, it unveils to the public the Sun as seen in the ultraviolet spectrum. *The Eye of the Sun* is a play on curiosity that seeks to redefine the spectator-artwork relationship.

CCS Concepts

• **Applied computing** → **Media arts**.

Keywords

Interactive Art, Digital Art, Audio-visual, Touch-sensitive, Solar Physics, Astrophysics



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1 Introduction

Our need for stimulation and information is insatiable. Curiosity is one of the most powerful and laudable engines of the human being. Curiosity is also a disparaged and pernicious feature. On the one hand, it may be unhealthy but, on the other hand, it does urge the discovery of the world and the encounter of others. Curiosity drives exploration, inquiry and learning. Curiosity is an inner desire, an emotion that modifies our psychic and physical state. In other words, it is a state that is reproduced in very different contexts and therein defines us. It is the emotional rapture of curiosity and the ambiguity of its consideration that inspired *The Eye of the Sun*, a solar composition for visitors, sensors, speakers, computers, lenses, mirrors and video projectors, in aluminium and acrylic.

Space-times of feeling and understanding, knowing and sharing, motion and emotion, art and science tend here towards reciprocity. In a multidisciplinary experimental laboratory, they keep an eye on each one of us. Wide open to any primary interaction, such as touching or nearby movement, *The Eye of the Sun* invites everyone

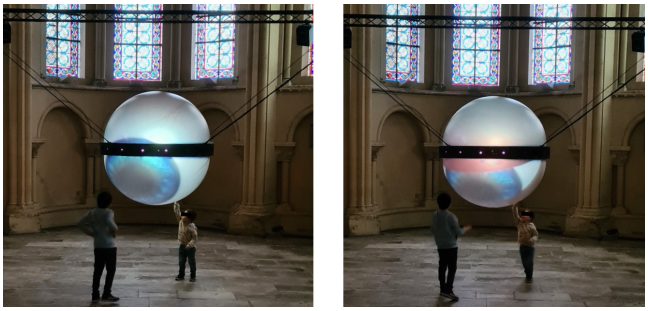


Figure 1: Young visitors interacting with the Eye (left). The Eye squints after being touched (right).

not to avert their eyes but to cross looks in dynamic exchange and sharing (Figure 1).

2 Concept and technical details

2.1 Concept

The Eye of the Sun is a motion- and touch-sensitive digital sculpture representing a gigantic human-like eye with a realistic aesthetic. It consists of two hemispheres with a diameter of 1.7 m which act as hemispherical screens for two on-board video projectors. The installation is a play on curiosity. It seeks to redefine the spectator-artwork relationship. Upon arrival, visitors find themselves face-to-face with the Eye which looks at them (Figure 1, left), periodically blinks, squints (Figure 1, right), changes its iris colour, and follows visitors around as they move and try to walk around it. The result is an inversion of the established roles: it is now the artwork that is curiously watching the human visitor. When curiosity is returned and the visitor performs the right gesture (see Table 1), the Eye opens up and reveals its interior, an interactive simulation of the surface of the Sun (Figure 2) showcasing images of the solar corona captured at different extreme ultraviolet wavelengths ($\sim 10 - 170$ nm) by NASA's Solar Dynamics Observatory satellite [5]. The Sun is no longer this serene eternal yellow orb suspended in the sky but a living celestial body with its own internal dynamics that can be perceived once we go beyond the visible light spectrum. Taken for granted and for good, the Sun is here laid open with nuclear reactions deep inside, γ photon emission and diffusion to the periphery, their propagation and partial absorption down to Earth. The Sun paves the way for research that pushes the boundaries of knowledge and understanding further.

2.2 Technical setup

The two hemispheres on which the images of the Eye or the Sun appear are connected by a 15-cm-thick central technical disk that houses the two video projectors alongside the required optical equipment (lenses and mirrors), a network router, a sound card, and the several power supplies and cables (Figure 3). Moreover, 16 infrared cameras, 8 loudspeakers and several ventilation fans are positioned around this technical equator. Along the light path, each video projection system is composed of a long focus video projector fixed horizontally to an equatorial metallic plate located inside the technical disk, two optical lenses that aim at focusing

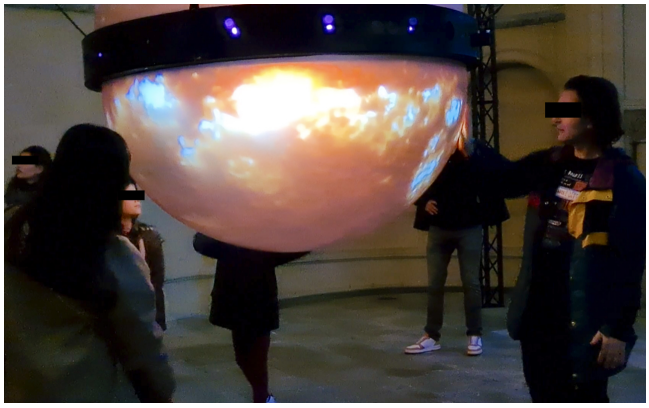


Figure 2: Visitors exploring the surface of the Sun and causing coronal perturbations with their touches.

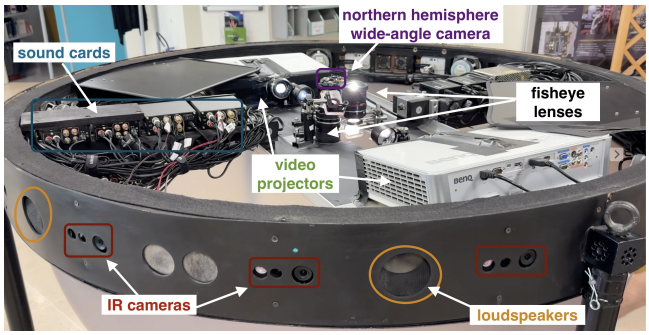


Figure 3: The Eye with its northern hemisphere taken off to reveal the technology hidden inside it.

the image produced by the video projector on a small area (1-2 cm in diameter) where an oblique mirror directs the projection either upward or downward, and a very short focus (quasi-hemispherical) optical lens to project the image on an even smaller surface (1-2 mm in diameter) where a fisheye lens is set to cast the image over the whole hemisphere.

The 16 infrared cameras are used to detect motion around the Eye. The loudspeakers provide spatialized sound effects when the Eye blinks, squints, moves or when certain interactions are performed (Table 1). Finally, two more wide-angle infrared cameras are installed centrally on both sides of the equator disk allowing for hand detection through the semi-transparent hemispheres. The motion- and touch-detection, interaction responses, graphics and audio are controlled by custom-developed codes on a Dell Precision 7920 computer located a few meters away from the Eyeball and connected to it via two RJ45 cables for sound and video streams.

2.3 Software development and interactivity

The Eye and the sun are rendered using a proprietary OpenGL [2] game engine implemented in C# and Microsoft's .NET framework [4] (Figure 4, bottom row). A custom motion-detection algorithm developed in Python using the OpenCV library [1] allows the Eye to *see* and follow visitors moving around it. The input to the algorithm

	User interaction	Triggered event
Eye mode	movement around the Eye	Eye changes its gaze direction, focussing on nearest, largest motion cluster; large movements are accompanied by a "swoosh" sound
	continued walking around the Eye, leading it to do a half-turn	Eye opens up to reveal the sun + impact sound
	touching the Eye	Eye squints, gaze directed at hand + shrill ringing sound
	touching the Eye when Sun can be seen through its pupil (happens every 60-120 seconds for a few seconds)	Eye opens up to reveal the sun + impact sound
Sun mode	short static touch (<2 s)	triggers concentric ripples in the solar corona propagating outwards from the touch position + popping, impact sound
	prolonged static touch (>2 s)	plasma protuberances (coronal mass ejections) start growing radially outwards from the touch position
	touch performing an azimuthal swipe motion	another layer of the solar corona (corresponding to a different UV wavelength) is uncovered; once the swiping motion crosses a threshold angle, the transition to the next layer completes automatically and a swoosh sound is played

Table 1: Interaction modalities and triggered events implemented in the Eye and Sun modes.

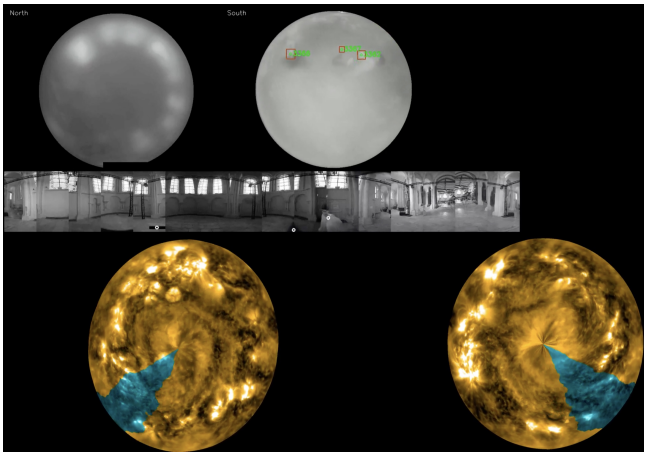


Figure 4: A screenshot illustrating the different camera inputs and how the Sun is rendered. Top row: Views of the northern and southern hemispheres captured by the two wide-angle cameras hidden inside the Eye. In the south, three touch events are detected (red rectangles) and tracked with unique identifiers (green numbers). Middle row: A panorama of the Eye's surroundings stitched together from the 16 infrared cameras positioned around the equator. Clusters of motion are detected and marked by a white circle. Bottom row: The images rendered for the north and south hemisphere video projectors. The touches of a visitor are about to trigger a transition between two coronal layers (yellow and blue sections). Note the distorted circle shapes which compensate for aberrations along the optical path and assure a neat final projection onto the acrylic glass hemispheres.

is a panoramic view of the Eye's surroundings (Figure 4, middle row), stitched together from the images of the 16 infrared cameras distributed around the technical equator. To localize clusters of motion, the differences between consecutive images are computed, filtered and joined by size and proximity. The new target for the Eye's gaze is calculated as a function of the size of the motion clusters and their distance from the current gaze direction.

A peculiarity of the Eye is its multi-touch sensitivity. This is achieved through two wide-angle infrared cameras installed on either side of the equator disk which allow it to survey the northern and southern hemispheres from the inside (Figure 4, top row). An object detection model based on the nano version of the YOLOv8 architecture [7] was trained on 800 manually labelled images to recognize hands touching the two hemispheres of the Eye (Figure 4, top right). This haptic interface opens up different interaction possibilities with the Eye (which will twitch and squint when touched — like a real eye) and especially with the Sun where users can trigger ripples in the solar surface (Figure 2), cause coronal mass ejections or swipe between coronal layers captured at different wavelengths (Figure 4, bottom row). Table 1 lists the implemented interaction modalities alongside the corresponding events triggered in Eye and sun mode.

3 Exhibition during *Nuit Blanche* 2024 and immersion study

The Eye of the Sun was installed in the Museum of Arts and Crafts, Paris, and more precisely in the apse of the St-Matin-des-Champs church belonging to the exhibition spaces of the museum. The spherical sculpture was suspended from a 4.5 m-tall aluminium structure that was erected specifically for this occasion. Eight more loudspeakers as well as two subwoofers were installed on and around the aluminium structure to provide the ambient soundscape

and a standard 24-inch computer screen was attached to one of the aluminium pillars to represent a "thermometer", indicating the temperature and wavelength of the current coronal layer when in Sun mode. The installation was included in the usual museum admission and was accessible to the general public during the event *Nuit Blanche* 2024, where it was seen by over 3000 visitors, and for the two weeks following the event. *The Eye of the Sun* was included in a comparative field study together with three other experiences of varying degrees of immersivity in (1) virtual reality (VR), (2) cylindrical 360° video projection, and (3) floor and wall video projection. Subjective user experiences were assessed for each installation using a questionnaire that primarily addressed the spatial presence in immersive environments, SP-IE [3]. The study results suggest that the intuitive interaction design of the Eye (motion and touch detection) as well as its realistic aesthetics lead to a high perceived affordance and realism of the installation, exceeding even the scores reported for the VR experience considered in the study [6].

4 Conclusions

Presence is usually expected to increase with the degree of technical immersivity of a system. Even though the immersivity of *The Eye of the Sun* is very low with respect to enforced virtual reality systems with head-mounted devices or 360° videoprojection, the behavioural function and the natural interaction with the Eye and the Sun capture visitors' attention, promote their engagement and encourage a constructive personal or collective exploration of the work [6]. *The Eye of the Sun* is where art and science meet. It challenges visitors' curiosity and plays with their emotions and reason. It also challenges the demands of immersion, as visitors are not immersed in the artwork. They see it from a distance. They turn around it. Sometimes they touch it. Such interactions create a strong bond between the visitors and *The Eye of the Sun*, so that they can engage in a real dialogue with the artwork and feel drawn into its reality.

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The Loop — A 360-degree immersive and interactive stage for collective space-time experiences

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Abstract

Advances in immersive technology continue to enrich the breadth, depth, and intensity of the audience experience. *The L∞p* is a 360-degree immersive and interactive stage for the creation and dissemination of new augmented forms of live performance and digital installation that engage artists, scientists, and audiences, say experiencers, in an unconstrained multi-sensory collective experience. In one of the settings, experiencers stepped into *Spacetime Prospectives*, a series of tales about time and space as described differently by the



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laws of physics. With *The L∞p*, we intend to set the experiencers' imaginations in motion and augment the experience of time and space in many ways.

CCS Concepts

• **Applied computing → Media arts**; • **Human-centered computing → Empirical studies in interaction design**.

Keywords

Interactive Art, Digital Art, Audio-visual, 360 degree projection, Real and Virtual Environments, Multi-User, Tracking, Kinect Camera, Spacetime, Symmetry, Quantum Physics, Field Study

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1 Introduction

In the upheaval of recent years, Blanca Li's *Le Bal de Paris* [9], developed by BackLight, involved ten spectators equipped with VR headsets dancing with the company's dancers on the stage of a virtual social world. London's Royal Opera House, with Figment Production, opened the opera to hyper-reality for four lucky spectators equipped to see, hear and touch a 15-minute multi-dimensional virtual opera in a box built on the Opera House stage itself. The Finnish National Opera is also trying to go elsewhere with Violet Disruption and Vitamin Studio, bringing not artists but avatars to the stage. Opera Beyond is developing an XR stage design platform to make virtual and augmented reality tools available to directors, set designers, lighting designers and producers. Charles Ayats' and Vincent Dupont's creative project *No Reality Now* equips all spectators in a room with VR headsets for a double show between the magic and augmentation of theatre and those of digital immersion, while the dancers, dressed in motion-tracking suits, move around the stage [4].

Advances in immersive technology are an important driver of the experience economy in cultural centres. Immersion is now seen as a requisite for art whether it is live performances, installations, or exhibitions. It may be overused with the mere idea of surrounding the spectator or visitor with videos or paintings. It may be enforced by capturing the experiencer's senses with head-mounted displays (HMDs) and headphones or by confining the experiencer in a controlled environment — typically a dark and isolated room – with a set of video and sound projections like at Atelier des Lumières [3], the Musée océanographique de Monaco [6], or at SAT [2]. It might also be embedded in public spaces to induce unconstrained immersive experiences in an open environment where spectators would then be passers-by with no intention whatsoever to follow the proposed reality shift. Immersion in public spaces is thus a challenge that we propose here to investigate in *The L∞p*, a 360-degree immersive and interactive stage for collective space-time experiences.



Figure 1: *The L∞p* is a 360-degree coaxial 2 m and 10 m cylindrical audiovisual projection immersive and interactive system integrated in a 11.3 m outer cylindrical black box. Top: External view of *The L∞p* and visitors taking off their shoes before entering the structure. Bottom: Visitors inside of *The L∞p* moving around the central cylinder screen and causing a virtual grid to warp under their feet in LP2.

2 Related work

The L∞p was created upon the art-science work *See me through you* [10] which was originally created and exhibited at the Cité des Sicences et de l'Industrie, Paris, France. In *See me through you*, visitors find themselves immersed in deep space, gravitating around a black hole and witnessing space-time distortions as described by general relativity. The distortions are created by the mass of the black hole at the center of the installation and made visible by the light of galaxies that follow the visitors around. Through an interactive 360-degree video and sound projection, visitors were both the observers and the distant celestial bodies of the others at the same time. Visitors could see themselves through them. The hard- and software developed for the video projection systems and multi-user tracking in *See me through you* laid the technical basis for the creation of *The L∞p*.

The L∞p also benefited from Pierre Jodlowski's pioneering work *Grainstick* [7]. Created in 2010, the installation heralded the emergence of new spatialised interactive musical forms that allowed exploring the relationship between space, body and sound, and the way in which different art forms (music, dance, theatre, film and design) approached the notion of space in relation to the body and sound, in the light of advances in technology (spatialisation of sound, image synthesis) and scientific knowledge (physics, cognitive science) of the time. Christophe Berton's scenography for



Figure 2: Top row: The Arrow of time 1 (LP1) in *The L∞p*, an immersive and interactive 360-degree tale; Left: Time arrows as fishes following Boids flocking behaviours; Middle: A child running after a planet before breaking it breaks into pieces when approaching the big crunch; Right: Promoting wave formation under Christopher Columbus' boats. Bottom row: The Arrow of time 2 (LP2) in *The L∞p*, an immersive and interactive 360-degree tale; Left: Flying time arrows as birds following Boids flocking behaviours; Middle: Chessboard where space and time are swapped with squares illuminated at the visitors' presence; Right: Quantum time clock with entangled entities associated with visitors.

Grainstick was designed for the general public as a single entrance 10 m cylindrical visual and sound immersive space where users could interact in a highly intuitive way and navigate through a range of characteristic sound and visual proposals that they could immediately grasp, but which gradually reveal a richness of evolution and construction that took them far beyond a simple demo.

3 Technical details and implementation

The L∞p is a platform for the creation, production and dissemination of new augmented experiences of the living and the digital. It consists of a black cylindrical structure (11.3 m in diameter, 4.5 m in height) which can be entered by up to 20 users simultaneously (Figure 1, top) and which inside is equipped with 14 video projectors, projecting onto two 360-degree cylindrical screens (an outer 10-m-diameter cylinder and a central 2-m-diameter cylinder) as well as the floor (Figure 1, bottom). Moreover, 16 Kinect V2 cameras mounted onto the central cylinder enable the detection and tracking of users, while 16 loudspeakers, with two subwoofers, positioned on the central cylinder and around the outer cylinder screen, provide spatialized audio. One Shuttle XPC nano mini-PCs per Kinect camera is used for real-time streaming of the three-dimensional body pose data of the users while the main computation work (integration of the body pose data, interaction processing, graphics rendering, audio playback) is done by two Dell Precision 7920 computers equipped with a total of five Nvidia Quadro A4500 graphics cards. *The L∞p* represents a 360-degree stage where the tools of art and science are merged to forge a new grammar with which new narratives of immersion and interaction can be written and represented.

4 Exhibition *Spacetime Prospectives* at *Les Ateliers des Capucins*

During two months, *The L∞p* was exhibited in the cultural and shopping centre *Les Ateliers des Capucins* located in Brest, France. *Les Ateliers des Capucins* can be qualified as a typical third place, featuring a cinema, a theatre, a library, a museum, several shops, cafés and restaurants as well as a leisure space where individuals, friends and family can meet or do indoor sport activities. Visitors of *The L∞p* could freely participate in one of the two interactive, 20-min-long experiences entitled *Spacetime Prospectives* about physical concepts concerning time, space and symmetries. In both tales, the presence of experiencers activates one of the multiple universes that could derive from Albert Einstein's theory of special relativity. Events are then spatial, temporal or luminous. Evolving masses define space and time. Effects can occur before causes. Space and time are identical. Time can be fixed and rational or flexible and emotional, it flows back and forth. It loops, stops or jumps indefinitely. When visitors enter *The L∞p*, they become the centre of reference for the generation of lines that fade in all kinds of shades of blue onto the outer and inner cylinders. These lines are fired from the entrance in opposite directions on the external cylinder (Figure 2, top row, left). The soundscape becomes more prominent. Sound waves propagate with timelines. Localized in space, voices emerge and build a dialogue. They resonate wherever participants move:

> **Voice 1:** The arrow of time was never really very well released. Do we even know if it ever left?
> **Voice 2:** Some still attach meaning to it. Others, another.
> **Voice 1:** Does it care? Hasn't it left? Hasn't it defined the first elements of reality? The arrow.
> **Voice 2:** A cause precedes an effect.
> **Voice 1:** Only if it goes straight. If we follow it. The arrow.

In the first scenario (LP1), time flows periodically such that night and day follow each other without a beginning nor an end, the time arrows associated to each visitor travel away like flocking birds (Figure 2, top row, left), the big bang and the big crunch alternatively give birth and death to our universe, Christopher Columbus goes back and forth from 15 March 1493 to 4 August 1492, from East to West, and the arrow of time might remain suspended. Visitors can see dawn and dusk on Earth, change their appearing period according to the quantity of motion they have, interact with the ocean that Columbus' boats cross, induce waves while moving around, precipitate the tide and promote a storm (Figure 2, top row, right), reveal galaxies out of the deep universe, deviate the trajectories of planets, crack them, and bring the universe to collapse (Figure 2, top row, centre) so they finally appear as vertical lines in a large clock. Along the way, they were invited to play red light, green light during which the whole installation would stop and turn red when and where someone had moved.

In the second scenario (LP2), time and space are exchanged such that visitors are all invited to walk the same way, along the single arrow of time (Figure 2, bottom row, left), along an infinite Möbius ribbon, while events start happening by surprise, there and not

there. Visitors walk into a running clock on the floor. They are grasped by hands into a space-time grid that their presence distorts (Figure 1, bottom). They become entangled with entities that appear where they are walking (Figure 2, bottom row, right). They turn on every square of a big chessboard they are jumping on (Figure 2, bottom row, middle). On the shore, they leave footprints in the sand and repulse the sea water that comes toward them from a central clepsydra.

The experiences were in French, free of charge and accessible, six days a week, from 11 a.m. to 7 p.m., during a period of two months. LP1 was played the first month. LP2, the second. LP2 was developed in light of the first feedback we collected and the observations we could make during LP1. We especially tried to limit complex multi-visitor interactions and enforce intuitive single-visitor interactions.

5 *Spacetime Prospectives* study

The L∞p was included in a comparative field study [14] together with three other experiences of varying degrees of immersivity in (1) virtual reality (VR)[1], (2) floor and wall video projection[11], and (3) spherical video projection [12]. Subjective user experiences were assessed for each installation using a questionnaire that primarily addressed the spatial presence in immersive environments (SP-IE) [8]. The SP-IE questionnaire consists of 20 items rated on a 5-point Likert scale, with the following subscales:

Spatial presence (SP): evaluates the sense of "being there" (4 items),
Affordance (AFF): assesses how well the environment supports interaction (4 items),
Enjoyment (ENJ): participant enjoyment (3 items),
Reality (REAL): evaluates the perceived realism of the environment (3 items),
Attention (ATT): attention paid to the activity (2 items),
Cybersickness (CYB): captures any discomfort or motion sickness (2 items),
Social presence (AVAT): measures the perception of other users' presence when avatars are present (2 optional items).

Two hundred and sixty visitors of *The L∞p* volunteered to participate in the study and a detailed presentation of the study methodology and results has been published previously [14]. It was found that *The L∞p* induces a slightly weaker sensation of spatial presence than the VR experience but a stronger sensation than the other two installations considered. The mean scores of the seven subscales of the SP-IE questionnaire are reported in Figure 3 for the two scenarios of *The L∞p* LP1 and LP2.

The perceived affordance (AFF) was significantly higher in LP2 than in LP1 ($p = 0.006$) together with a slightly higher but not quite statistically significant attention (ATT) paid to the activity ($p = 0.193$). Interestingly enough, the user's age did not seem to affect the experience along any of the investigated subscales of the spatial presence (see [14]) which aligns with the findings of previous studies evaluating the effect of age on immersive experiences [13]. Indeed, the reported data suggest that *The L∞p Spacetime Prospectives* can be considered "all ages". Finally, significant differences in spatial presence (SP), attention (ATT), and cybersickness (CYB) were found between male and female (see [14]) users with slightly higher scores for female users as observed in other studies [5] but

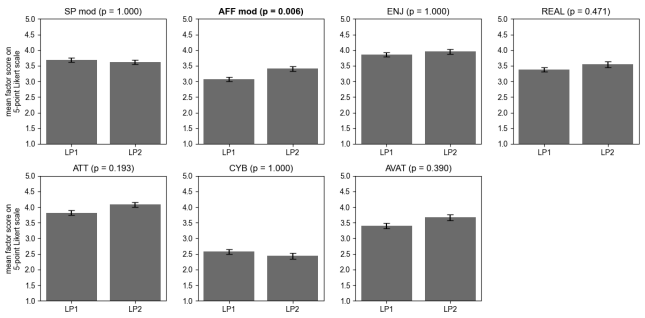


Figure 3: The SP-IE factor scores for the two scenarios, LP1 and LP2, in *The L∞p* on spatial presence (SP), affordance (AFF), enjoyment (ENJ), reality (REAL), attention (ATT), cybersickness (CYB), and social presence (AVAT). The markers indicate the mean value while the error bars correspond to the standard deviation. The p-value of a Kruskal-Wallis test is stated for each factor. The scores for LP1 and LP2 were similar across most of the factors. A significant difference was observed only for AFF with participants reporting a higher affordance in LP2.

in contradiction for spatial presence (SP) and attention (ATT) to others [13].

Beyond the technical challenges raised by such an immersive and interactive installation, there were also several unexpected issues regarding user interaction with the installation, which can largely be attributed to its novelty or visitors' unfamiliarity with this type of experience. *The L∞p* was originally conceived to be openly and freely accessible to visitors of *Les Ateliers des Capucins*. However, many children (often poorly or not at all supervised by their parents) regarded the structure as a playground. They ran around, brought their shoes and even bicycles inside, tried to catch the virtual objects and threw themselves against the screens. Overall, *The L∞p* was very popular and the number of visitors far exceeded the capacity of the enclosed space. This quickly led to the structure degrading, resulting in the inner cylinder screen tearing from its mount, and *The L∞p* had to be closed for maintenance. At the other end of the interaction spectrum, most adults remained passive spectators during the experience, often missing out on the proposed interaction possibilities. Two principal measures were taken to address this situation. Firstly, access was regulated by introducing 20-minute sessions and putting a security guard in charge of controlling visitor entry and exit. The guard also reiterated the rules of conduct inside *The L∞p*, which had previously only been presented on a note at the entrance. Secondly, each session now began with a short introductory sequence in which a voice, accompanied by visuals, briefly explained the general concept of the installation, asked young users to behave calmly and encouraged adult users to participate actively. While these measures proved effective, they also altered the initial intention of *The L∞p* to provide free access and an unbiased experience.

6 Conclusions

The L∞p is a digital installation providing a 360-degree, interactive stage for creating and disseminating new augmented art forms, ranging from multi-user experiences to live performances. Bringing together artists, scientists and audiences, the system offers a new approach to developing unconstrained, multi-sensory, collective experiences. From January to April 2024, *The L∞p* was exhibited at the cultural and shopping centre *Les Ateliers des Capucins* in Brest, France. There, visitors could experience two 20-minute, interactive, multi-user experiences (*Spacetime Prospectives* LP1 and LP2) that explored the physical concepts of time, space, and symmetry. Despite the difficult and varied physics concepts underlying *The L∞p*, visitors' spatial presence was felt in both scenarios (SP >3.5). Implementing a more direct interaction mode in LP2, which provides users with clear and immediate feedback on their actions, could further enhance the experience, as revealed by the reported higher affordance in LP2 than in LP1.

The L∞p could be used in future research to further explore the influence of adaptive systems on the subjective user experiences of immersion. Adaptive systems have the potential to tailor immersive experiences to the needs of individuals and groups, thereby further promoting everyone's spatial presence. Personalisation can occur at two levels:

(1) Behavioural adaptation: Systems can detect whether a user is passive or active and adjust the complexity of interactions accordingly. For example, novices may benefit from simplified tasks, while experienced users could access advanced features.
(2) Physiological feedback: Biometrics such as heart rate, skin conductance, or breathing patterns can inform real-time adjustments. For example, environments could adapt lighting, sound, or interaction speed to reduce stress or enhance comfort.

Integrating these techniques into immersive installations is expected to create adaptive experiences that respond dynamically to users' emotional states, thereby enhancing engagement and satisfaction. Human-machine interaction is an obvious key to immersion, as is already understood in the gaming industry.

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Performance in Audiovisual and Multimedia: Fixed and Dynamic Systems

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Abstract

This article outlines what performance is in the arts and discusses the cross-disciplinary nature of these concepts in audiovisual and multimedia contexts. To achieve this goal, it examines the evolution of multimedia and audiovisual performance, multimedia from various perspectives, and suggests categorising the different aspects, notably the definition of fixed or dynamic systems. It is also argued that multimedia performance is not exclusive to interactive systems and that performance can exist with fixed or autonomous systems. In summary, this article outlines the trajectory of a practice that has become increasingly common and widespread to facilitate understanding and study of it.

CCS Concepts

• **Human-centered computing** → Human computer interaction (HCI); Interactive systems and tools.

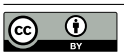
Keywords

Art, Audiovisual, Performance, Multimedia

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1 Introduction

The interactive and performative systems in multimedia contexts have become increasingly widespread, both in the arts and in entertainment, enabling the audience and users to engage with technology in playful and expressive ways. From an educational perspective, degree and master's programs in audiovisual and multimedia fields increasingly include curricular units dedicated to these systems, reflecting their growing relevance. However, despite this expansion, the conceptual framework surrounding performance in audiovisual and multimedia remains insufficiently defined. This stems, in part, from the broad and sometimes ambiguous meaning of the term "performance," which, even when restricted to the arts, encompasses a wide range of practices and interpretations.



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As a multidisciplinary domain, audiovisual and multimedia performance intersects with performing arts, installation art, and exhibition practices, creating a diverse and complex landscape that defies simple classification. For example, a multimedia system that augments a traditional musical instrument by extending its sonic capabilities differs substantially from another system where a computer autonomously responds to performers' actions in real-time, acting as a creative partner. While both examples fall under the umbrella of performance, they operate according to distinct artistic logics and interaction models. This diversity highlights the need for a clearer conceptual framework to better understand and categorise the different systems involved in audiovisual and multimedia performance. This article addresses this gap by proposing a theoretical taxonomy that distinguishes between performative and non-performative systems and between fixed and dynamic structures. A performative system, whether driven by human or autonomous action, contributes artistically within a context recognisable as performance, while a non-performative system may produce interaction or audiovisual output without fulfilling an artistic or expressive role. Likewise, fixed systems follow predetermined trajectories, whereas dynamic systems incorporate interactivity or autonomous processes that shape the outcome during the performance itself. For example, a video synchronised with a score represents a fixed system, whereas a generative environment reacting to a performer's gestures exemplifies a dynamic system. The key contribution of this article lies in the proposal of this taxonomy as a theoretical advancement over previous classifications, which often focused on the technical or interactive aspects of multimedia without sufficiently addressing the systems' artistic agency. By clarifying the distinction between fixed and dynamic performative systems, this work provides a conceptual tool for understanding how multimedia systems actively participate—or do not—in the performative process.

Throughout the article, the term "performance" refers specifically to artistic contexts, and the discussion focuses on systems intentionally designed with performative goals. Accordingly, the article explores the notion of performance in the arts, distinguishes between performative and non-performative systems, and analyses the ways in which audiovisual and multimedia technologies intersect with performative practices in contemporary artistic contexts.

2 Methodology

This study adopts a qualitative and conceptual research approach, aligned with the exploratory nature of the work. Following the perspective of Creswell [1] and Flick [2], conceptual analysis is

appropriate for clarifying complex constructs and proposing theoretical frameworks, particularly in fields where empirical data is fragmented or where practical exploration precedes theoretical consensus. The research methodology combines conceptual inquiry with illustrative case analysis. Firstly, a critical examination of existing literature in performance studies, media art, human-computer interaction, and computational creativity was conducted. This allowed for the identification of key dimensions relevant to multimedia systems in performance, particularly focusing on the concepts of autonomy, performative agency, and system responsiveness. Authors such as Dixon [3], Salter [4], Bay-Cheng et al. [5] and Eigenfeldt [6] form the theoretical foundation of this analysis. Secondly, selected case studies from the audiovisual and multimedia performance field were analysed as illustrative examples. These cases - namely Musebots [7] Comprovisador [8] and Dreaming of New Musical Interaction [9] - were not studied through empirical observation or data collection but selected due to their relevance in demonstrating distinct types of computational agency within performative contexts. The cases function as exemplars to clarify and ground the theoretical distinctions proposed in the taxonomy, following an illustrative logic common in conceptual exploratory studies [10]. The proposed taxonomy is conceptual and focused on the agency of multimedia systems within performative contexts. It does not claim exhaustiveness but rather seeks to clarify a fundamental distinction between systems that contribute performatively to the creation of an artistic outcome and those that merely facilitate media delivery. This classification should be understood as an initial theoretical contribution, open to refinement through empirical studies, further theoretical debate, and interdisciplinary dialogue. Through this conceptual and illustrative approach, the article develops a taxonomy that is both theoretically grounded and practically applicable to the analysis and design of multimedia performance systems.

3 Audiovisual and Multimedia

The term audiovisual refers to the combination of audio and visual elements through a concept more linked to cinema and television, providing a more technical rather than conceptual connotation [11, 12]. Audiovisual and multimedia converge, and if we think of multimedia in a broader sense as the simultaneity of at least two media, we can admit that audiovisual is part of multimedia. However, multimedia can extend beyond audiovisual as it can incorporate different media that may move away from the link to television and cinema.

Specifically concerning multimedia, it is a designation that emerged in the late 1950s [13-15], and has evolved continuously to arrive at this century and the concept of New Media [16], that definitively positioned the computer as a central part of multimedia. This idea is reinforced by Zagalo et al. [17], who define multimedia as a multidisciplinary area based on art and technology - essentially computational technology. If we then think of multimedia as a vast field in which digital media art is inserted, we also acknowledge the computer as pivotal in at least one of the following three stages: creation, storage and compression; diffusion [13, 18, 19]. Havaldar and Medioni [19] further assert that there are four central characteristics of multimedia: digital, voluminous - referring to the size of data files, interactive, and real-time or synchronised.

Due to computers' centralisation and capacity to process data, the software has developed, replacing various media channels created over the last century and functioning in networked collaboration with other software or equipment. If we consider the computer as the first meta medium—a combination of existing media and those yet to come—and using the metaphor of Darwin's theory of evolution in media, the computer, through programmers and new software, is a medium that is in constant evolution, becoming a *metamedium* [20]. This evolutionary metaphor can be applied to multimedia in various ways; for example, a patch that serves a specific project/purpose, while functional, may never be replicated or used by other users. Others may be replicated numerous times and used in multiple applications. As Manovich points out, we can compare this to the theory of the evolution of species, as it reaffirms that the computer, to some extent due to software development—and, of course, the hardware that enables its use—has become a hybrid machine capable of accommodating countless forms of media and meta-media, with such variety that a natural selection arises inadvertently. Embedded in software —but far from exclusive— it is important to mention Artificial Intelligence (AI). Today, AI is present in various media products; think of how Machine Learning is an integral part of various software, providing significant support in content production [14]. If we analyse, for example, the proceedings of The International Conference on New Interfaces for Musical Expression (NIME) or xCoAx [21-25], there are numerous systems we can find that explore AI. In summary, computers are a central medium in today's multimedia landscape through their transformational and adaptive power.

4 Performance

The origin of the word "performance" is ambiguous because, on the one hand, some authors state that it derives from the Italian *per formare*, which means to give shape to a concept [26]. On the other hand, some claim that the word, although it has a French origin, comes from English [27]. Regardless of its origin, there is a widespread consensus that the meaning of the word has broadened, and today, "performance" can even be used to describe the performance of a car engine, for example. We can divide performance into three types: (1) cultural or social performance – which refers to the performance of social activity or task, such as sports performance; (2) performance as performing arts – theatre, music, circus arts, and dance; (3) performance as an artistic movement that derives from the avant-garde movements of the 1960s [28, 29]. If we limit our focus to performance as a performing art – since the audiovisual and multimedia performance discussed in this article is not restricted to a particular artistic current or social activity – Carlson mentions that this is a specific event, presented by performers and witnessed by an audience, in which both agree that there is material to be interpreted, reflected upon, and engaged with emotionally, mentally, and possibly even physically [28]. Zumthor, referencing Josette Féral, explains the importance of context and involvement in performance and gives the example of an event in which someone is confronted for lighting a cigarette on the subway

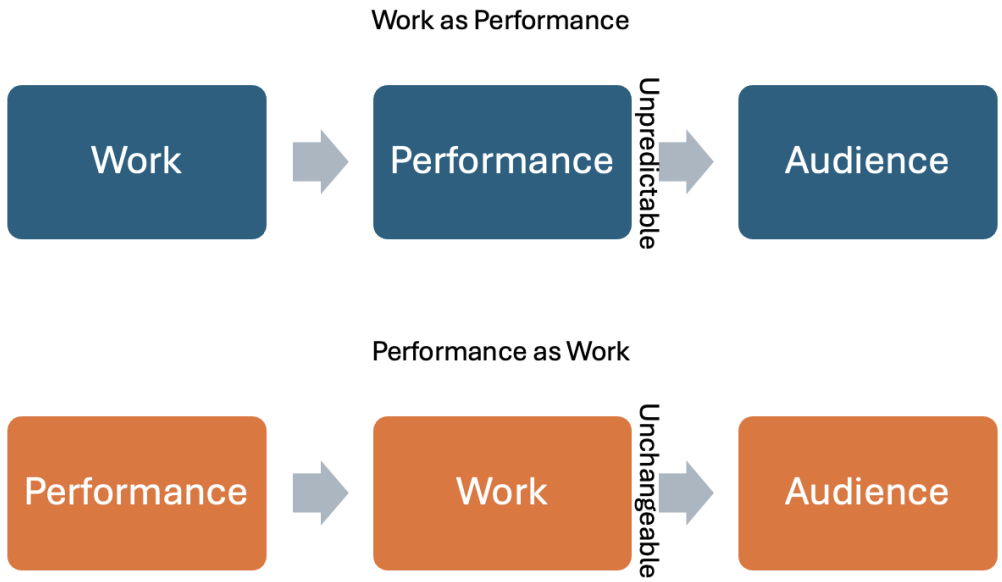


Figure 1: Work as performance Vs. Performance as work

[27]. For the people witnessing this event, it is an occurrence, but for one of the individuals who knows that this event is an anti-smoking action, the event is a staging. Another example is when we encounter a theatre set that is already assembled; it is filled with scenic and performative content because it transports us to another reality without requiring any intervention from an actor or agent. Thus, we can understand that in the context of performing arts, the medium and the involvement of events are crucial for the recipient's understanding in determining whether or not they are witnessing a performance. Therefore, this process has a cognitive component, both for the performer and the recipient.

5 Performing Arts

In the specific case of performing arts, we need to address the issue of works as performances and performances as works. In other words, some performances are recreations of works and performances that are the works themselves. One way to better understand this concept is, for example, if we think about Beethoven's Ninth Symphony. This is a work that the public generally considers a milestone in the history of music, and if we attend this work, we expect to have a good experience. However, a disastrous performance can turn an expected good experience into a bad one, thus highlighting the role of the performance. Just as a performance can alter a work for the worse, it can also do the opposite, transforming what could be a less interesting work into something exceptional through performance. Thus, a performance, even if it is a work that has been executed countless times, can always emphasize something new or different, and this is a cross-cutting aspect of all performing arts. Another aspect is that there is no enjoyment if there is no experience. In other words, to appreciate, for instance, a theatrical piece, it is necessary to experience/visualize the performance [30].

Concerning performance as a work, we have, for example, a painting where the act of painting created the work, and that work is not changeable. If it is the work that functions as a performance, it is subject to the unpredictable because there is a living element inherent to human action and the act of performing. In a performance as a work, that result has already been achieved and becomes fixed from the artist's task perspective (Figure 1). Beethoven's Ninth Symphony can be performed simultaneously by various orchestras in different geographical locations. For example, the Mona Lisa by Leonardo da Vinci can only be seen in France at the Louvre Museum. If there are more paintings of the Mona Lisa, they will be copies. At the same time, the various performances of Beethoven's Ninth Symphony are considered recreations/interpretations that have a recognized influence on the overall assessment of the work—adding, altering, or subtracting value from the work. This is a central issue that separates and categorizes some forms of art as performing arts.

Another relevant aspect of the performing arts is that they can arise from the process of a technical and artistic non-performative process. For example, in written music, there is, in the first phase, a work carried out by the composer that gives rise to the piece. Furthermore, interpretation of the work can generate interactions that allow the composer to make revisions or new editions [31]. However, this is not a rule because, if we think about a completely improvised performance – for example, free jazz – this eliminates the first process mentioned.

In summary, and reusing Carlson's definition, performative art is an act that presupposes at least one human action in real-time and is made for an audience within a context and environment that

they can recognize as a transfiguration of the real [28]. There is also intellectual and emotional involvement among those involved, and possibly physical involvement as well.

6 Performance in Audiovisual and Multimedia

The evolution of multimedia performance can be divided into three key periods: the Futurist years in Europe, 1910s, the Fluxus and Avant-Garde movements of the 1960s, and the digital era of the 1990s [15]. Bay-Cheng et al. further reinforce this perspective, noting that live performance with media components first emerged at the turn of the 20th century through cinematic experimentation [5]. These practices evolved into a variety of forms, as seen in Josef Svoboda's projection experiments in the 1950s, Allan Kaprow's happenings in the 1960s, and Billy Klüver's explorations around 1980. Dixon proposes four historical trajectories in multimedia performance: from analogue experimental practices to the emergence of the computer as a medium, from responsive interactivity to the contemporary conception of performative ecologies and non-human agents [3]. This framework clarifies the debates and technological shifts that shaped the field from the 1960s onward. During this period, performance definitively aligned with technology, resulting in an increase in performances that integrated visual projections, overshadowing the verbal components traditionally found in theatre. Over time, the field transitioned from debating whether these were performances with multimedia components or multimedia works with performative elements to recognizing them as unified performances with converging components [32]. This evolution also led to an aesthetic reconsideration of liveness. Initially, only human performance was considered live. However, drawing from the concept of a performative ecosystem—where technologies, bodies, light, and the environment dynamically and co-constructively interact—the notion of the human performer as the sole performative agent was challenged. This perspective paved the way for a heterogeneous and expanded network of performative agents [4]. Within this integrated framework, everything occurring in the performance is considered live [33].

The concept of the audience as a performative agent emerged during the 1950s and 1960s. For instance, in John Cage's 4.33', the audience became part of the performative ecosystem. Similarly, in Kaprow's 18 Happenings in 6 Parts, audience participation was chaotic and spontaneous. Later, Klich & Scheer noted that in the 1980s and 1990s, multimedia performance largely focused on exploring the performative body and technological mediation [15]. Only in rare instances did spectators play an active interactive role, such as in the works of Myron Krueger and Jeffrey Shaw. The conceptual shift toward audience participation and user-centered design became clearer in the early 21st century, following the digitalization of the 1990s and the adaptation of HCI processes in the arts. From the 2000s onward, creators increasingly offered the audience a dramaturgical role, positioning them as performative agents who influence the final outcome rather than merely triggering events [3]. Finally, autonomous systems emerged. Salter and Hayles discussed autonomy not as a purely computational phenomenon but as ecological, where devices, sounds, and environments act together without centralized control [4, 34]. With the introduction and evolution of AI, systems were developed that removed the human element from performance entirely, exemplified by projects like Musebots [7]. In this context, Eigenfeldt argues that true artistic collaboration with computational systems requires these systems to possess autonomy and the ability to influence creation, rather than merely reacting or executing commands [6].

Historically, precursors to interactive performative systems can be found in works such as Rauschenberg's Broadcast (1951), where the audience influenced sonic outcomes by tuning a radio. With the advent of digital technologies, interaction evolved from basic participatory gestures to systems capable of autonomous, real-time responses. For example, Eduardo Kac's Time Capsule (1997) introduced the concept of Bio Art, demonstrating interaction through biological data processing [35]. More recent explorations of these evolving dynamics are discussed in the proceedings of the xCoAx and NIME conferences, and in the taxonomy by Bay-Cheng, Parker-Starbuck, and Saltz [36, 37], which outlines five dramaturgical functions—three related to space and two to time—positioning multimedia as a performative partner in real time. An interesting aspect of this evolution is that such practices are not always transparent to the audience. The audience feels more engaged when they can discern the performative process by relating the physical movement of the performer to the outcome [36, 37]. As Carlson notes, performance inherently involves a physical dimension [28]. While theatre, circus arts, and dance naturally possess physical expressiveness, music—which may initially seem purely auditory—also involves physical interaction among performers that contributes to its performative dynamics. Thus, while there is a demand for expressiveness connecting the physical with the final product of computational performance, we might speculate that this demand reflects the audience's unconscious acceptance of multimedia performance as a discipline within the performing arts. Among the various works analysed, some constants emerge: audiovisual and multimedia performance results from interaction with a computational system; this interaction is mediated by an interface that can take various forms and processes; and the performer can be someone other than the creator, such as the audience. However, not all interactive systems qualify as performative in an artistic sense. For example, in a system where a user controls audiovisual output through voice pitch, the action of singing or talking alone may not be recognized as artistic performance within traditional or contemporary frameworks.

Another important perspective concerns augmented or enhanced instruments. These involve sophisticated performative systems that actuate or enhance traditional instruments. In many cases, the computational component transforms the instrument's sonic capabilities, though it may not specifically transform the audiovisual or multimedia elements. A particularly illustrative case is Comprovisador [8, 38], where a soloist improvises, providing sonic material to a computational system. This system, mediated by a performer who manages the accompaniment in real time through a unique notational system, alters the sonic outcome executed by other musicians. Here, the computational system mediates the interaction between musicians, creating a dynamic sonic environment. This mediation constitutes artistic content within a concert setting, positioning the computational system as a co-performer rather than merely a tool. Another example is the project Dreaming of New Musical Interaction [9]. This audiovisual and multimedia system

involved performers and audience members interacting to shape the scenery and sound design in a spectacle that combined music, dance, and theatre. However, a computational system that simply offers functionalities to a performer may be equated with other musical devices, such as synthesizers, without necessarily functioning as an independent performative partner or fulfilling a mediating role that adds a distinctive component to the performance.

7 Critical Discussion

It is possible to observe that there are several disparate performative systems with different characteristics involving multimedia. This diversity highlights the need to categorise these models, distinguishing between systems that merely facilitate multimedia presentation and those that actively participate in the performative process. In this regard, the conceptual distinction between fixed and dynamic systems becomes relevant. Building on Eigenfeldt's reflections in the field of musical *metacreation* [6], it can be argued that a computational system only becomes a true performative partner when it autonomously influences the artistic outcome. Extending this reasoning to multimedia contexts, fixed systems are those that produce predetermined or purely reactive outputs, while dynamic systems possess internal processes capable of shaping the performance in real time, beyond simple stimulus-response mechanisms. It is essential to note that this autonomy does not exclusively depend on artificial intelligence. While AI and machine learning represent sophisticated contemporary forms of computational agency, dynamic systems can also emerge from generative algorithms, adaptive feedback loops, or stochastic processes that operate independently of human input during the performance. This broader perspective expands the understanding of computational agency in performance, encompassing a wider range of creative systems. These distinctions raise additional critical questions: how much independent action is required for a system to move from being a tool to being a co-performer? Can a system be considered performative if it shapes the temporal and aesthetic flow of the performance, even without exhibiting complex cognitive behaviours? Addressing these questions is essential for refining the theoretical framework of multimedia performance and understanding how agency is distributed across human and non-human components in performative ecologies.

Beyond these theoretical considerations, the proposed taxonomy of fixed and dynamic systems, and of performative versus non-performative media, has practical implications for creators, curators, and educators. For creators, it offers conceptual tools to reflect on the agency of their systems, helping them to design multimedia setups that actively shape performance outcomes rather than simply deliver pre-programmed outputs. For curators and programmers, this framework enables a more critical assessment of contemporary performances, distinguishing works where media act as active performative agents from those where technology functions merely as a support structure. This distinction is particularly relevant for curatorial decisions in digital arts festivals and performance series focusing on technological innovation. In educational contexts, the taxonomy supports the development of analytical skills in students, allowing them to critically distinguish between different modes of multimedia interaction and encouraging them to conceive performative systems that move beyond reactive paradigms. Overall, this categorisation contributes to the field by providing a conceptual and practical lens for analysing and designing multimedia performances within increasingly complex technological ecosystems.

8 Definition Proposal

This distinction clarifies ambiguities in current artistic practices, providing a framework to differentiate between sophisticated reactive systems and those that act as autonomous performative partners in the creative process. Ng et al. (2008) define Interactive Multimedia Performance as involving one or more performers interacting with a computer within a multimedia system. However, moving beyond a definition of performance as mere execution, we propose expanding this concept by distinguishing between systems that are expository and those that are performative, particularly since this article focuses on artistic performance within the performing arts. Furthermore, interactivity, although prevalent, is not an essential characteristic of a performative multimedia system, as fully autonomous systems exist. For example, Eigenfeldt and Pasquier's Kinetic Engine [39] is a real-time music generation system capable of autonomous output, though its classification as a performative system might be questioned if physical action is considered essential to performance. Likewise, Salaris et al.'s Robot Choreography demonstrates a system capable of autonomous movement and staging, operating independently of human interaction [40]. These examples demonstrate that multimedia performance is not exclusively dependent on real-time human interaction. Based on these considerations, it is proposed that multimedia systems in performance can be categorized into two broad types: fixed and dynamic systems. Fixed performative systems contribute to the performance but do not alter their output in response to the unfolding performance environment. They align with the notion of "performance as work," where the multimedia content, although performative in presentation, functions similarly to a pre-composed element. In contrast, dynamic systems can modify their output during performance through interaction or autonomous processes, thus participating in the creative evolution of the performance in real time. This corresponds to "work as performance," where the system itself becomes an active agent in the artistic outcome. This distinction is visually summarised in Figure 2, which illustrates a hierarchical categorisation of interactive systems according to their performative and dynamic characteristics. The diagram shows how interactive systems can be classified as either performative or non-performative, and, within performative systems, as fixed or dynamic, the latter encompassing unpredictable and autonomous behaviours. Examples of fixed performative systems include Svoboda's *Laterna Magika*, where pre-recorded projections accompany live theatre; Anderson's multimedia performances such as *The United States* and *Delusion*, where visual and sonic media follow a fixed structure; and Robert Lepage's *The Andersen Project*, where digital scenography enhances the performance without responding to the performers. Contemporary theatrical productions such as *Frozen*, *Anastasia*, or *The Curious Incident of the Dog in the Night-Time* also utilise sophisticated scenic projections that are

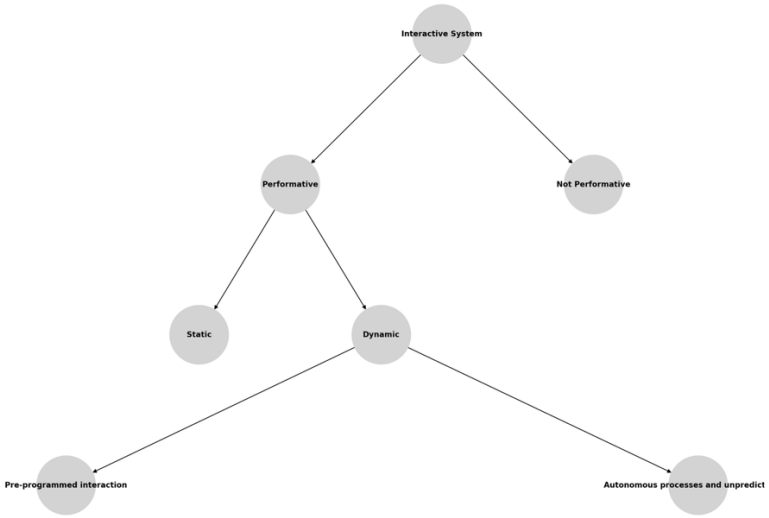


Figure 2: Interactive systems for multimedia performance.

pre-programmed, contributing performatively without changing in response to live actions.

Conversely, dynamic systems introduce variability to the performance, either through real-time interaction or autonomous processes. Examples include Musebots, where autonomous musical agents collaborate without human intervention to create ever-changing sonic textures [7]; Comprovisador, in which a computational system mediates between a soloist and accompanying musicians, shaping the harmonic structure live [8]; and *Dreaming of New Musical Interaction*, where performers and the audience interact with a computational environment that alters scenography and sound design in real time [9]. Eduardo Kac's *Time Capsule* also exemplifies dynamic interaction through biological data, further blurring the boundaries between human and machine agency in performance [35].

One point of clarification concerns the distinction between variability in human performance and dynamism in the multimedia system. A fixed multimedia system does not preclude interpretative differences by human performers; rather, it refers specifically to the media components, which remain constant regardless of variations in live interpretation. This nuance reinforces the need to distinguish between the variability inherent in human artistic practice and the autonomous agency of multimedia systems themselves. Therefore, multimedia performance encompasses both fixed and dynamic systems. Both types can function in real time, but they differ in their contribution to the final artistic outcome: fixed systems reproduce pre-determined results, while dynamic systems—although pre-programmed—generate variable results shaped by real-time interactions or autonomous decisions, allowing for differentiated artistic expressions in each performance.

9 Conclusion

The evolution of performance in the audiovisual and multimedia context has shown an increasing complexity in the relationship between artists, technology, and the audience. This article proposes a distinction between fixed and dynamic performative systems to provide a more precise theoretical framework for categorizing these practices. It highlights how multimedia can operate as a performative partner rather than merely as a technical support medium. The main contribution of this research is the recognition that real-time interaction is not an essential requirement for a multimedia system to be considered performative. This demystifies the idea that only responsive interfaces can be integrated into artistic performances. Furthermore, by differentiating between fixed and dynamic systems, a broader understanding of the various technological approaches applied to performance is developed, allowing for a more in-depth dialogue between theorists and practitioners. However, this study does not exhaust the discussion. The rapid evolution of artificial intelligence, generative computing, and automation opens new avenues for multimedia performances that may further challenge established categories. Future investigations could deepen the analysis of the impact of AI as an autonomous performative agent and the influence of multimedia on the audience's perception of what constitutes an artistic performance. Finally, the proposed taxonomy is hoped to serve as a tool for researchers, artists, and technologists working at the intersection of art and technology, helping to delineate more clearly the limits and possibilities of multimedia performance in the contemporary landscape.

10 Limitations

Despite the conceptual clarity of this taxonomy, it is important to acknowledge certain limitations. The current framework does not fully address more complex hybrid scenarios in which additional agents—such as the audience, the environment, or spatial systems—exert autonomous influence over the performance. In such cases, the boundaries between fixed and dynamic, or between performative and non-performative systems, become even more fluid and context-dependent. These situations highlight the need for

future refinements capable of encompassing multisystemic ecologies, where agency is distributed beyond human and computational actors alone. Nevertheless, this taxonomy provides a conceptual foundation for further exploration. As artistic practices continue to evolve through advances in artificial intelligence, machine learning, and ecological computing, the distinction between fixed and dynamic multimedia systems will likely require re-examination. The performative role of adaptive, generative, and self-organising systems challenges traditional notions of authorship and control, inviting deeper inquiry into how creative agency is distributed across human and non-human actors in performative ecologies. In this broader context, even the proposed distinction between fixed and dynamic systems may evolve to categorise entire ecological configurations, rather than individual system behaviours alone. Lastly, although no supplementary video documentation is provided, the included figures and descriptions aim to convey the performative dynamics of the systems under discussion.

Acknowledgments

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El amor que pasa. Resignifying Monumentality and Gendered Violence through Transmedia practices.

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Abstract

This paper presents a comprehensive examination of *El amor que pasa*, a transmedia video-performance that critically intervenes in public memory by re-signifying the Glorieta de Bécquer in Seville, a site both celebrated for romantic symbolism and marked by a traumatic case of gendered violence in 2016. Drawing on feminist and postcolonial theory, contrasexual critique, and memory studies, the work employs intrusive camera work, poetic voice-over, and embodied performance to expose the aestheticization of passivity, narrative erasure, and patriarchal romanticism embedded in monumental discourse. Through a detailed methodology that integrates site-specific filming, non-linear editing, and live enactments, the project foregrounds ethical considerations in representing trauma and audience engagement strategies. By embedding images extracted from the artwork within the analysis, this study articulates how transmedia practices can catalyze reflective engagement with suppressed histories and foster emancipatory potential against systemic gendered violence. The paper concludes with implications for feminist-media methodologies in public art interventions.

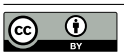
CCS Concepts

• ; • **Social and professional topics** → User characteristics; Gender; User characteristics; Cultural characteristics; • **Applied computing** → Arts and humanities; Media arts; • **Information systems** → Information systems applications; Collaborative and social computing systems and tools; • **Human-centered computing** → Collaborative and social computing; Empirical studies in collaborative and social computing;

Keywords

Traumatic Monumentality, Inert Body, Systemic Gendered Violence, Perpetuated Objectification, Feminist Performance art, Site-specific

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1 Introduction

Public monuments frequently encapsulate idealized collective memories while occluding unsettling histories of violence, particularly gendered violence. The video artwork *El amor que pasa* critically engages the Glorieta de Bécquer in Seville, commonly valorized for its poetic homage to Gustavo Adolfo Bécquer's romantic Rimas, by revealing its entanglement with a real case of sexual violence and death that occurred in 2016.

A 30-year-old woman was discovered deceased in the vicinity of the Glorieta de Bécquer. Preliminary findings indicate that she had arrived at the location in the evening and ingested a substantial quantity of sedatives in what appears to have been a suicide attempt. Although the dosage was significant, it was not immediately fatal, and she remained unconscious at the site. During this period of incapacitation, an individual known to frequent the area engaged in non-consensual sexual activity and violence with the victim, inflicting injuries that ultimately proved fatal. Forensic authorities later confirmed that the cause of death was exsanguination from genital trauma. [1] Initially, both the media and law enforcement prioritized the theory of suicide over sexual assault. Notably, it was a municipal park cleaner who urged the police to further investigate, ultimately uncovering the reality of the crime. [2] This tragedy, muted by impartial media coverage and the discomfort of trauma in a touristic space, forms the impetus for this intervention.

Consequently, this artwork wishes to interrogate how monuments can function as aesthetic repositories that sanitize traumatic events, perpetuate patriarchal norms, and naturalize passivity. Framed within feminist, postcolonial, and memory studies, the project seeks to disrupt sexist narratives by bringing embodied practices into dialogue with critical theory. The guiding research questions include: How can transmedia art practices resignify public space to foreground suppressed traumas? In what ways do inert sculptural forms carry imprints of gendered power relations, and how can they be activated as sites of resistance? What ethical frameworks are necessary when representing traumatic events through artistic media? By addressing these questions, the paper advances a methodology for feminist media engagement with monuments that balances theoretical rigor, creative practice, and ethical responsibility.

Given that a monument is, strictly speaking, an ideological declaration intended to legitimize a social and political status, inscribed within temporality itself and therefore transmitted to future civilizations as a form of knowledge, what, in the process of its creation, forms and forges a monument? Notoriously, it is its "affect" [3], that is, the social impact that the subject or event commemorated has

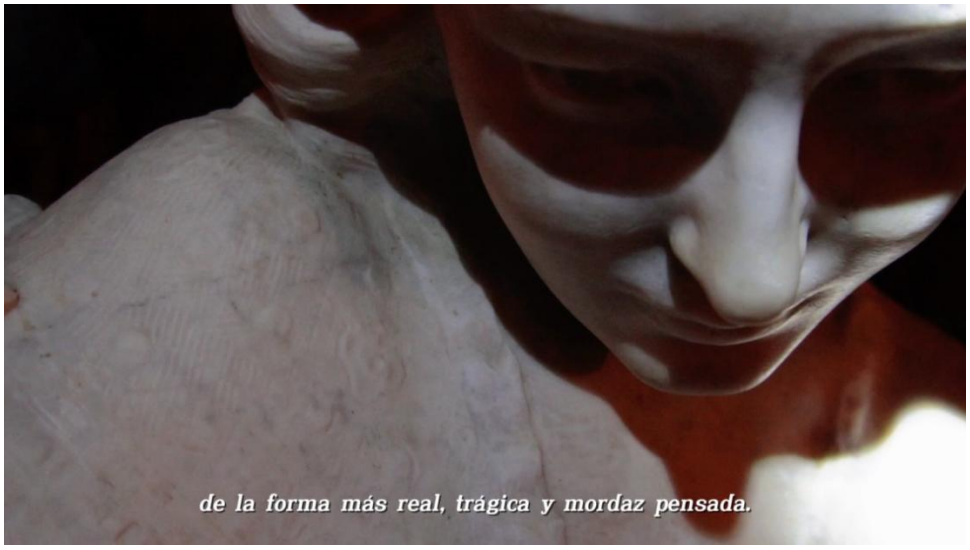


Figure 1: Footage extracted from the artwork *El amor que pasa*, 2025. Example of the duality between authorized text and G. A. Bécquer's Rimas (1836-1870), shown in subtitles.

had on a given community. The power inherent to monumentality manifests in its capacity to establish meaning; consequently, memoryscapes, or landscapes of monumentality, serve as instruments of governmental power to shape the desired prevailing reality and thus reinforce structures and mechanisms of power [4]. Political subjectivities thereby become conditioning ideological objectivities that delimit alterity.

The Glorieta's statues, representing the phases of romantic love (expectations and illusion, passionate love, and absence and disenchantment) are framed in the artwork not only as passive figures but as complicit agents. Through extreme close-ups and unsettling proximity, the work asks: What does it mean for a statue to witness a crime? Can it be both an accomplice and a victim? And what ethical demands arise when attempting to embody such a site of violence through artistic practice?

A critical dimension of this intervention lies in its commitment to reframing aesthetic pleasure as ethically accountable. Bécquer's verses, often cited as the pinnacle of Spanish romanticism, are recontextualized in *El amor que pasa* to reveal their latent complicity with gendered scripts of silence and passivity. Verses extracted from the rhymes like "¿Es el amor que pasa?"- "Is it love that passes?" [5], become ironic refrains that echo through the visual intrusion of the camera on sculpted stone, mimicking the footprint of the aggressor. The romantic never had a place in sexist patterns of behaviour; it is spectral, disturbing, and morally fractured.

Moreover, the artwork employs poetic voice not as a narrative overlay but as a spectral invocation. It blurs the boundary between the living and the inert, the past and the now. A narrating voice represented by the author, empathising and delving into the victim's perspective, mixes personally written excerpts with layered fragments of Bécquer's poetry, enacting a dialogue that was never permitted in life. In doing so, the work stages a counter- monument: a refusal to forget, a refusal to aestheticize, a refusal to remain silent, while impersonating the invasion that occured on the victim.

The purposes and techniques of the artwork are rooted in transdisciplinary practice. It combines site-specific filming, transmedia montage, and live performance in a reflexive, iterative process. Each aesthetic decision is informed by ethical considerations: how to represent trauma without reproducing it, how to maintain anonymity while still making violence visible, how to critique without sensationalizing. These questions are not answered once and for all; rather, they unfold through each iteration of the work, and moreover, they do not opt for a solution, they simply reveal the complexity of perpetuating patterns and how new forms of artistic resistance are ultimately difficult to resolve.

Ultimately, this paper argues that *El amor que pasa* offers a model for feminist media practices that engage public space critically and ethically. It exemplifies how art can function as both research and intervention, unearthing the ideological sediments of monumental culture while proposing alternative ways of remembering. In the face of systemic violence and institutional forgetting, the artwork stands as an ephemeral monument to that which has been erased. It is therefore necessary to reclaim and expose the customary mechanisms of cruelty, power, and violence underlying the established order and law, and we must also become aware that the roots of sociological thought conceive each society as culturally instituted [3], internalizing diverse modes of collective existence rather than merely interpreting them.

2 CONCEPTUAL FRAMEWORK

2.1 Postcolonial Memory Critique and Hysteria

The theoretical grounding of *El amor que pasa* draws on feminist memory studies that examine how public monuments encode selective collective memories, often marginalizing subaltern perspectives. The construct of "female hysteria" exemplifies a medical and cultural label historically employed to pathologize women whose

behaviors deviated from patriarchal and heteronormative expectations. According to Oxford Languages, "hysterical" states were defined as "intense nervous excitation, provoked by anomalous or imperceptible circumstances, producing excessive reactions such as cries or tears" [6].

From a feminist standpoint, this medicalization reveals mechanisms of control over the female body: hysteria functioned less as a natural illness and more as a discursive tool to subordinate and silence women who challenged gender norms or exercised sexual and political autonomy. A postcolonial critique extends this analysis by highlighting parallels between the construction of the "hysterical woman" and the colonial subject. In both cases, subaltern bodies and voices are delegitimized by hegemonic discourses. Silvia Federici's work on the transition to capitalism demonstrates how, in late medieval Europe, certain bodies (especially those of peasant women) were systematically excluded from official narratives that justified new social and economic hierarchies. Practices labeled heretical or non-reproductive (e.g., early forms of contraception or abortion) were reinterpreted as threats to social order: "when population growth became a fundamental social concern during the profound demographic crisis at the end of the 14th century, heresy began to be associated with reproductive crimes, especially 'sodomy,' infanticide, and abortion" [7]. Such associations reveal how control over reproduction served capitalist accumulation, situating the pathologization of women's reproductive autonomy within broader regimes of economic exploitation.

Rita Segato further underscores how official historiographies valorize patriarchal narratives that render invisible the traumatic experiences of subaltern groups. She argues that monuments and sanctioned accounts frequently elevate elite, male-centered perspectives while silencing gendered violence and colonial traumas [8]. From this vantage, hysteria can be read as part of a genealogical silencing: the medical label circulated within Eurocentric scientific discourses that excluded indigenous or alternative epistemologies concerning bodily autonomy and collective well-being. Moreover, an inert or paralyzed body is the cathexis of an accumulative oppression imposed on dissident corporealities within the patriarchal system, pouring forth the corrupt desire to silence the lives, traumas, and experiences of these subjects. This hardness and behavioral violence, inherent to the stony condition of monumentality, manifests across the broad threshold of oppressive political subjectivity; we observe such rigidity and rejection in issues transversal to coloniality, such as international asylum and the problematization of borders. Sarah Ahmed insightfully addresses these questions, suggesting that metaphors of "softness" and "hardness" applied to political openness toward immigration reveal how emotions become "attributes of collectives, which are constructed as 'being' through 'feeling"' [9]. In this way, the national body that is soft or permeable is interpreted as "a feminized body, which is 'penetrated' or 'invaded' by others" [9].

Returning to the terminology of hysteria, Paul B. Preciado's analysis of the clinical search for the "cure," namely genital massage and early vibrators, reveals a technologically mediated control over the female orgasm, construed as a "hysterical paroxysm" divorced from the subject's agency [10]. Such practices illustrate the instrumentalization of the body which, when re-signified through contra-sexual frameworks, may be repurposed as tools of resistance: the vibrator, once reclaimed outside clinical contexts, can subvert reproductive paradigms and patriarchal constraints, enabling modes of pleasure decoupled from procreative imperatives [10].

Interweaving feminist and postcolonial perspectives around hysteria necessitates acknowledging how both frameworks critique the imposition of universalizing (Eurocentric and patriarchal) norms on local bodies and desires. The label "hysteria," historically applied across Europe and colonized territories, functioned as a mechanism to naturalize the subordination of women deemed "deviant," whether they practiced alternative healing, engaged in non-procreative sexuality, or expressed political dissent. In *El amor que pasa*, this intersection informs artistic strategies of resignification: by intervening in monuments, the project destabilizes their ostensible neutrality and reveals the layers of violence and discipline imposed on female and subaltern bodies.

To further situate these structural and monumental interventions, two reference projects are especially relevant. On the one hand, prepared for Hyundai's 2019 commission at the Tate Modern, Kara Walker created *Fons Americanus* (2019), a large-scale public sculpture inspired by the Victoria Memorial (1911) near Buckingham Palace. The monument seeks to rupture the originating narrative of official historical memory by addressing one of the principal colonizing powers (the British Empire), and by staging an allegory of the African diaspora that exposes the interconnection of slavery and genocidal violence emanating from European colonialisms. It aims to demonumentalize an oppressive tradition and to revivify history in a more pluralized and encompassing manner.

Secondly, Alexandra Pirici's *Titled Arc* (2014) is a documentation of a performance staged in Biel, Switzerland, in which a chain of people reenacted Richard Serra's original *Tilted Arc,* the steel sculpture that was removed from Federal Plaza in New York after intense public debate. Through performance, Pirici explores the ephemerality, anchorage, and public effects of monuments, probing the capacity of human bodies to intervene upon objects that carry potent ideological meanings in both their making and their removal.

Finally, integrating reflection on the pathologization of women's bodies and the attribution of emotion as a subjectified characteristic, viewed both historically and in its contemporary symbolic persistence, challenges ongoing practices that delegitimize women's autonomy and emotional expression, as well as the colonial legacies that determine which bodily knowledges are recognized as legitimate. This approach encourages methodologies that recover suppressed narratives and render visible embodied practices of resistance. By tracing a line from medieval and medicalized instruments of control to contemporary artistic resignifications, the work contributes to dismantling power structures that have historically used "hysteria" as a label of exclusion, thereby opening space to imagine more inclusive and plural models of memory, health, and desire.

2.2 Contrasexual Theory and Objectification

As mentioned before, Paul B. Preciado's contrasexual theory provides a critical lens for understanding how sexual norms are constructed through technologies and objects. Preciado's notion that "the dildo is the other villain, more akin to the nineteenth-century



Figure 2: Kara Walker. 2019. *Fons Americanus* [Site-specific sculpture]. Tate Modern, Turbine Hall, London, United Kingdom. https://www.tate.org.uk/art/artists/kara-walker-2674/kara-walkers-fons-americanus

representation of female sexuality than to that of male sexuality" [10], illuminates how technologies of pleasure and coercion entangle to produce gendered power dynamics, and as a form of resistance, contrasexual practices estrange these objects from their castrating context in order to liberate them toward more emancipatory and conscious practices. In the context of *El amor que pasa*, the statue becomes an analogous 'object' whose inert form evokes both allure and enforced passivity. Judith Butler's concept of bodies as performatively constituted through repeated norms [11] further elucidates how the sculpted femininity of Bécquer's statues can perpetuate normative ideals of passive, waiting femininity.

By enacting an intrusive camera gaze that mimics the objectifying perspective, the work enacts a reversal: the audience experiences the discomfort of objectification, revealing its underlying power logic. As Audre Lorde asserts, "Women today are still required to build bridges across the chasm of male ignorance and to educate men about our existence and our needs. This is an age-old and fundamental tool of all oppressors to keep the oppressed occupied with the concerns of the master…" [12]; this project repurposes the monument itself, normally a master's tool of reverence, into a site of subversive critique, reconstructing obsolete discourses through embodying and unifying practices that challenge traditional forms of knowledge.

3 Methodology and Artistic Process

An exploratory, iterative research design guided the development of *El amor que pasa*, combining theoretical inquiry with embodied practice. Initial site visits and archival research established the historical context of the *Glorieta de Bécquer* and the 2016 incident. Ethical frameworks were developed in consultation with feminist ethics literature [13, 14], emphasizing anonymization, third-person referencing, and participant briefing. This artwork's methodology interrogates prevailing prejudices and proposes a critical reflection on the role of public art in disseminating patriarchal ideologies that may ultimately contribute to gender-based violence or the objectification of the female body. The artistic research presented seeks to contribute to the creation, production, and dissemination of knowledge aimed at fostering transformative change within human societies, as well as a new path for expanding other forms of knowledge and community that overexceed academic authority or the coloniality of the knowing [15]. Furthermore, the creative process oscillated between theoretical reflection and practical experimentation in firsthand video shooting, editing, and performance staging, consistent with practice-based research methodologies in the arts.

The development of this work traces back to 2024, when an earlier academic project was carried out, centered on the Glorieta de Bécquer, along with a parallel case study involving the analysis and reinterpretation of the Hellenistic statue *Venus Callipyge* and Bruce Nauman's artwork *Walk with Contrapposto* (1968). These initial explorations focused on the gender roles enacted and perpetuated by statues and included both a direct, intrusive performance-based intervention at the Glorieta de Bécquer and a more ironic performative act engaging with the Venus Callipyge and Nauman's satirical take on classical sculpture. This foundational stage eventually gave rise to the current project, which addresses a more serious and socially relevant subject: sexual violence. In this phase, the elements of intrusion and performativity are retained but redirected to operate solely through the camera and the subject behind it.

The central video component, approximately 13 minutes in length, currently exists as a first version of the artwork, which the author intends to remaster and finalize in a second, definitive iteration. The piece was filmed at the Glorieta de Bécquer over the course of an irregular one-year period, with the author making regular visits to the city. It was shot primarily under natural and predominantly nocturnal lighting conditions in order to capture contrasting atmospheres of leisure, the idealization of the statues, and in contrast, an underlying sense of threat.

Equipment included a high-definition handheld camera to record proximity, breath sounds, and tactile interactions, as well as light equipment and a microphone thought for the voiceover. Filming protocols adhered to ethical guidelines: no identifiable individuals were recorded; all interventions with statues were conducted in accordance with local regulations, avoiding permanent alteration. The camera's movement was choreographed to alternate between lingering close-ups of sculptural details and abrupt shifts, simulating the disorienting experience of violence. Editing embraced



Figure 3: Alexandra Pirici. 2014. *Tilted Arc.* [Time-based sculpture], Reconstruction of Richard Serra's "Tilted Arc", produced by the Swiss Sculpture Exhibition "Le Mouvement". https://vimeo.com/105118002



Figure 4: Footage extracted from the artwork A superioridade das estatuas, 2024. Documentation of the Glorieta de Bécquer, with the author/performer in the monument.

non-linear cuts, abrupt silences, and overlapping soundscapes to reflect media fragmentation of victim narratives [14].

Voiceover narration interweaves excerpts from Gustavo Adolfo Bécquer's Rimas with a fictionalized third-person interior monologue reflecting the victim's perspective. This layering creates dialogic tension: familiar poetic lines acquire dissonant meanings when heard against images of statues under intrusive gaze. Sound design includes ambient park sounds, amplified breath, and silence sequences to evoke unease. Linguistic complexity and ambiguity were prioritized to avoid oversimplification of trauma.

4 CRITICAL REFLECTION AND CONCLUSION

El amor que pasa demonstrates how transmedia art interventions in ostensibly sanitized commemorative spaces can foreground gendered trauma and subvert dominant aesthetic frameworks. Through the integration of intrusive camera work, poetic dissonance, and embodied performance, the project cultivates a disruptive encounter in which viewers become aware of their own complicity in consuming idealized or neutralized images of femininity. This reflective process reveals the contingency of gender norms and the potential for art to unsettle ingrained perceptions. Interaction with audiences includes both the on-footage encounters and their subsequent public visibility. At present, the video retains an academic character and remains in a process of consolidation, so the effects of its exhibition will need to be assessed over time. Nonetheless, during filming passersby behaved with curiosity and surprise given that what was being recorded was explicitly performative. The images captured in the document register varied performative adaptations: one in which a performer occupies the space, and another in which the

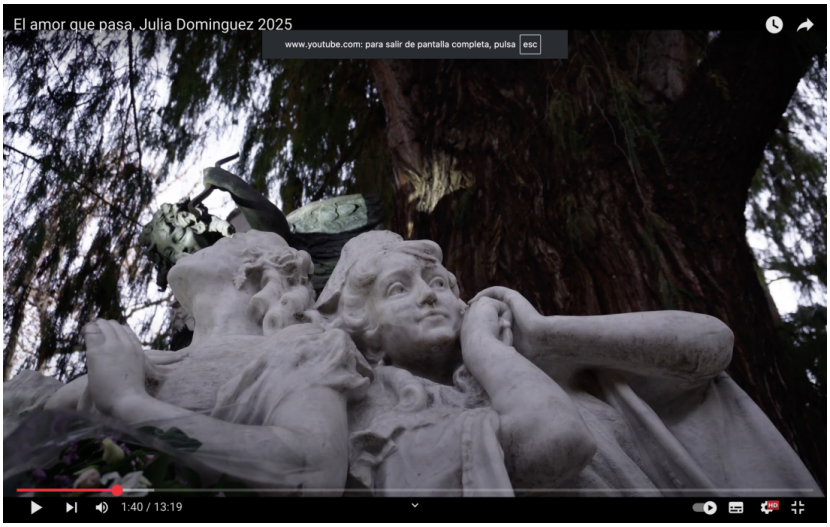


Figure 5: Footage extracted from the artwork El amor que pasa, 2025. Documentation of the statue "Glorieta de Bécquer", at the Parque de María Luisa, Seville, Spain.



Figure 6: Footage extracted from the artwork El amor que pasa, 2025. Figure of a wounded Eros, the god of love in Greek mythology. In the monument, he represents the counterpart to Cupid's painful and visceral form of love.

camera itself functions as the aggressor's performative prosthesis, reflecting a misguided and corrupted desire.

On the other hand, the project also highlights both the possibilities and the limitations of artistic interventions: while such work can catalyze critical dialogue, it may not yield systemic change without alignment with broader institutional and policy support. The tension between exposing trauma and avoiding its perpetuation remains central; theoretical insights from trauma studies [16] and feminist ethics continue to inform iterative adjustments in practice, and methodologies of performativity, attentive listening, and care are presented as potential tools of resistance and as means to re-signify monumentality, thereby making visible the attendant traumas.

By resignifying the Glorieta de Bécquer through a comprehensive transmedia approach, *El amor que pasa* exposes the paradox of monuments that beautify while concealing histories of violence. Embodied interventions transform inert sculptural forms into active sites of critique and solidarity. This work advocates for feminist-media methodologies in public art that balance creative innovation with sustained ethical reflection, aiming to foster critical awareness and collective reckoning rather than mere spectacle. To praise the oppressive nature and the political subjectivity of monuments is to problematize and call into question the presumed historical



Figure 7: Footage extracted from the artwork El amor que pasa, 2025. Invasive footage of the women depicted in the statue.

academic neutrality that often prevails in these contexts: within a shared frame of white-supremacist, heteronormative, colonialist, patriarchal, racist, and objectifying supremacy, academic neutrality becomes, in itself, a form of commemorative complicity, "therefore it is crucial that scholars be explicit about the values and the ethical-political commitments they bring to their work in the field of memory studies" [4]. In this light, the artwork becomes a vanishing point for emancipatory potential, inviting viewers and communities to confront suppressed traumas and to envision more inclusive practices of memorialization.

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Akousis

An AI-Driven Sonification of Botanical Taxonomy

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Abstract

Akousis is an art project that utilizes AI to contort the taxonomy of the natural world as defined by the coupling of visual and language. Using Pl@net API that identifies the scientific names of the flowers through visual identification engine, such identification is then used as input for musical cryptogram to create musical composition of a flower based on its nomenclature and visual indexing. In this way, Akousis explores the potential of AI in facilitating the possibility of linking knowledge taxonomy with hearing, simultaneously bridging the realms of botany, machine learning and musical expression. As the generated music emerges as a sonification of botanical taxonomy, it embodies a form of experimental and improvised index of the world, where the inherent qualities of each flower, encoded into musical motifs, give rise to a diverse array of sonic textures and structures. Akousis aligns its focus on performative systems and experimental music.

CCS Concepts

• **Applied Computing**; • **Arts and Humanities**; • **Sound and music computing**;

Keywords

Nomenclature, Sonification, Computer Music, Artificial Intelligent

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1 Introduction

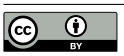
We navigate the world by identifying, naming, and classifying the things around us, which reinforces our sense of human dominance over the environment we inhabit. By recognizing and labelling animals, insects, plants, shapes, or objects, we can communicate more effectively about our surroundings. This process of organizing entities into a hierarchical structure is called taxonomy. Taxonomies shape our understanding of the world and influence how we interact with it by describing, identifying, and crucially naming or nomenclature to classify accordingly [1]. In this way, taxonomies construct our view of the world and our interactions within it, and we constantly identify and categorize things. Arguably such classifications are often meaningful only to humans and does not capture the any underlying essence of the very things we categorize [2]. When taxonomy is probed further, especially its history, the name Carl Linnaeus dominates the story of the origin. He is said to have revolutionized the way we categorize and understand the diversity of life on Earth. Often referred to as "The Father of Taxonomy," his most significant contribution is recognized as the development of binomial nomenclature [3]. Specifically, what he did was to create a formal system of naming species using two Latin words, one for the genus and one for the species.

This system, which he introduced in his work Systema Naturae in 1735, laid the foundation for the modern classification of all living organisms [4]. Before Linnaeus, the classification of plants and animals was believed to be a chaotic and inconsistent endeavor. Various naturalists and scholars used different systems, often leading to confusion and misunderstandings about species relationships. Linnaeus's binomial nomenclature provided a standardized, universally accepted way of naming species, making it easier to communicate and study the natural world. His system is still in use today, serving as the cornerstone of biological classification. Linnaeus's work went far beyond naming species. His approach to classification influenced other scientific disciplines, from evolutionary biology to ecology. This is because the Linnaeus's ordering system is thought to be objective and neutral thus enabling a framework for future research. John Stuart Mill explains Linnaeus' method of creating taxonomy by stating,

"The Linnæan arrangement answers the purpose of making us think together of all those kinds of plants, which possess the same number of stamens and pistils" [5].

While this statement invites deeper analysis, one key point to highlight is the essentialist approach Linnaeus used to establish order - creating categories based on characteristics that are visible [6]. In other words, the classification of the natural world followed the method of identifying defining properties through observation. For example, the act of noting the "number of stamens and pistils" is a process of visually identifying and naming what can be directly observed. The "visual" thus becomes a foundation for empiricism, where empirical evidence plays a crucial role in validating categorization. In this sense, observational affirmation is considered superior to human-imposed classifications, supporting the idea of objectivism within taxonomic systems.

Visual observation plays an essential role in taxonomy, particularly in botany, where plants were carefully studied and illustrated to document their traits, characteristics, and anatomy, before being



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classified and named accordingly [7]. The history of taxonomy, therefore, warrants close attention to the "visual" because many contributions to the field were guided by observational methods, as noted by Peter Stevens [8]. It is also important to ask whether taxonomy has historically been reliant on specific forms of evidence—namely, visual documentation—which was facilitated by collections, gardens, and classification systems that made plants more accessible for European study and profit.

Building on this foundation, Carolus Linnaeus developed a universal system of naming specimens, a Latin-based nomenclature that intentionally detached plants from the cultures they originated from while elevating European authority [9]. The argument here is that our modern understanding and use of taxonomy carries the weight of a research method closely tied to colonial history. This method, based on visual categorization, risks distorting or limiting the way we engage with the world today. The legacy of Linnaeus' taxonomy remains a powerful influence, shaping not just how we classify, but also how we perceive knowledge itself – ushering the reshuffling of the natural world whereby causing everyone to inherit the legacy of colonial botany.

2 AKOUSIS

An art project was conceived to critically examine the classification of plants and natural species, which has traditionally relied on visual observation and linguistic categorization. Specifically, colonial-era taxonomies heavily depend on Latin naming systems that link plant species to specific, observable visual characteristics. This project, titled Akousis - meaning "to hear" in Latin - was intentionally named as a call to "hear" rather than to "see" using the same language that has historically defined nature to the world. The project operates on two levels: first, it aims to shift from a visual to an aural perspective, challenging the privileging of the written word (particularly Latin) through the very language used for classification. Second, the transition from visual to aural serves as a reminder of the crucial role Linnaeus played in laying the foundation for scientific racism with his theories on human variation [10]. This perspective has shaped contemporary understandings of racism, particularly through "epidermal marking" or visual cues [11], which treat race as a biological fact rather than a social construct.

At the same time, adhering strictly to Linnaeus's model of categorizing the world, especially plants, undermines other forms of taxonomy grounded in metaphysical phenomena. This reductionist approach turns the material world into ontological entities, stripping away the metaphysical aspects and dismissing alternative understandings of plants as backward, primitive, or even superstitious. In discussing this issue, prominent Malaysian scholar Ismail Zain notes the role of plants in Malay culture, highlighting that their characteristics, which transcend Euclidean and Aristotelian logic, stand in direct opposition to a rational, secular approach to nature [12]. One could argue that those who reject the logics of colonial theories, practices, and attitudes are often labelled as confused or primitive, as seen in the misunderstanding of species relationships mentioned in the introduction.

It is important to recognize that before Linnaeus, other taxonomic models existed but are often overlooked. For example,

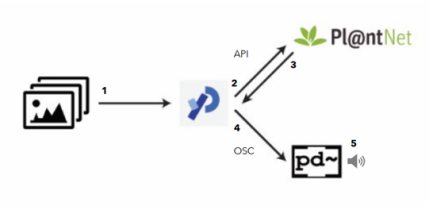


Figure 1: Akousis's operational principle

Nidhami Arudi, a 12th-century Muslim scholar, made significant contributions to evolutionary thought [13]. The earliest known document resembling a taxonomy date back to 3000 BC, in a pharmacopeia called the Divine Husbandman's Materia Medica, written by Shen Nung, the Emperor of China, which listed 365 medicines derived from plants, minerals, and animals [14]. In Egypt around 1500 BC, medicinal plants were depicted in wall paintings, and one of the oldest papyrus rolls, the Ebers Papyrus, classified plants based on their ability to treat various diseases of the time [15]. Acknowledging that Linnaeus's model is just one of many, the art project aligns with Foucault's argument that knowledge is relative to the conditions that enable it to emerge [16]. The project seeks to create a new condition, one driven by our sense of hearing. What Akousis aims to uncover is not the real empirical process between the botanist and their object of study, nor the facts that make taxonomy, but the underlying conditions that prompt the botanist to select an object, pose a question, organize it, and discuss it in a particular way.

2.1 Materials

The implementation of akousis requires a combination of software platforms that enable plant identification, data processing, and sound generation. The project makes use of the pl@ntnet application programming interface (API), an artificial intelligence-powered platform designed to recognize plant species from images [17] [18]. This API serves as the foundation for plant identification, providing a scientific framework for classification. It was decided to use processing [19] to handle tasks such as accepting image as input, making API requests, and mapping returned plant names to musical frequencies. To generate sound, pure data [20] was used, a visual programming language designed for real-time audio synthesis. Communication between processing and pure data is facilitated by open sound control [21], a protocol that enables data transfer between programs.

2.2 Methods

The first step in the implementation of Akousis involves plant identification through the Pl@ntNet API. Users begin by uploading an image of a plant into Processing, which then sends a request to Pl@ntNet for species identification. The API analyses the image and returns a response indicating the closest matching plant species based on its extensive botanical database. This approach ensures that the project is working with real-world plant classification data rather than a predefined dataset. Once the plant species is identified, the next stage involves converting its name into sound. Figure 1 illustrates the operational principle of Akousis.

Table 1: Alphabet to Frequency mapping

Pitch	a	b	c	d	e	f	g
Oct.0	A	B	C	D	E	F	G
	220.0	246.94	261.63	293.66	329.63	349.23	392.0
Oct.+1	H	I	J	K	L	M	N
	440.0	493.88	523.25	587.33	659.25	698.46	783.99
Oct.+2	O	P	Q	R	S	T	U
	880.0	987.77	1046.50	1174.66	1318.51	1396.91	1567.98
Oct.+3	V	W	X	Y	Z		SPACE
	1760.0	1975.53	2093.0	2349.32	2637.02		0.0

The transformation from text to sound is achieved through an alphabet-to-frequency mapping system within Processing. In this step, the plant's scientific name is broken down into individual letters, each of which is assigned a corresponding frequency as seen in Table 1. The mapping follows a structured scale similar to cryptogrammatic musical notation, a technique historically used by composers to encode words or names into musical sequences. This simple and straight forward approach allows the plant's name to be represented as a unique sonic pattern, maintaining the integrity of its identity while shifting the mode of representation from visual to auditory. Once the sequence of mapped frequencies is generated, it is sent to Pure Data (PD) using Open Sound Control (OSC), which then synthesizes the corresponding tones. The one-to-one mapping ensures that each plant species produces a distinct pitch sequence, making it possible to differentiate between different plants based on pitch alone.

To add rhythmic variations, playback of the pitch sequence is structured using principles of Euclidean rhythm, a mathematical approach that distributes beats and silences as evenly as possible across a defined time interval. With this, Akousis ensures that the generated sound sequences have rhythmic coherence rather than appearing as arbitrary tones. The Euclidean rhythm provides a balance between repetition and variation, reinforcing the perception of each plant's unique sonic signature. The approaches used in this project ensures that each plant name produces a sonically recognizable identity by maintaining a systematic coherence in the mapping process. To create a Euclidean rhythm pattern, two parameters are required as the input. The first parameter is the number of hits, while the second parameter is the total number of steps in the rhythmic pattern. Pitch sequences received from Processing are branched out to three paths to create rhythmic variations using Euclidean rhythm. The first path of the pitch sequence is used as is, with 3 hits and 4 steps as the parameter. The second path of the pitch sequence is multiplied by 0.5, bringing the frequencies in the pitch sequence down by one octave. For the second path, parameters used for Euclidean rhythm is 3 hits and 8 steps. While for the third path of the pitch sequence, each frequency is multiplied by 0.25, bringing the pitch sequence down by two octaves with 3 hits and 16 steps used as the parameters for Euclidean rhythm. This approach creates a poly-rhythmic output without distorting the frequency to pitch mapping.

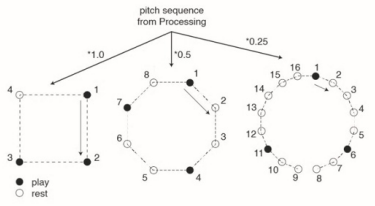


Figure 2: Euclidean rhythm patterns used in Akousis.

3 RESULTS

This section presents the results obtained from the implementation of akousis, focusing on the translation of plant identification data into sound. By mapping plant species names to musical frequencies and structuring them through euclidean rhythms, the project demonstrates the feasibility of sound-based knowledge representation. This section outlines the key findings from the system's operation for selected plant species.

3.1 Image collection

Images used in this project were collected from the Perdana Botanical Garden, located in Kuala Lumpur, Malaysia. This location was deliberately chosen for its historical and cultural significance to the nation-state. Established in 1888, it is one of Malaysia's oldest parks, carrying historical value from the British colonial era. Today, it serves as a public recreational space, offering jogging paths, picnic areas, and themed gardens such as the Orchid and Hibiscus Gardens. The garden also plays an educational role by showcasing a diverse range of plant species and promoting environmental awareness. As a major park in the heart of Kuala Lumpur, it contributes to the city's aesthetic and cultural identity, balancing urban development with nature and heritage. Crucially, it operates as a visual marker of colonial legacy, a reminder of past rulers through an orchestrated botanical landscape. In this context, botany functions as a powerful historical and cultural symbol, reinforcing a specific legacy as part of the national narrative, particularly by recalling the era of colonial rule.

3.2 Plant Identification

The Pl@ntNet API identifies various plant species from uploaded images, providing species names with a varying degree of accuracy. The accuracy of identification was assessed based on the confidence

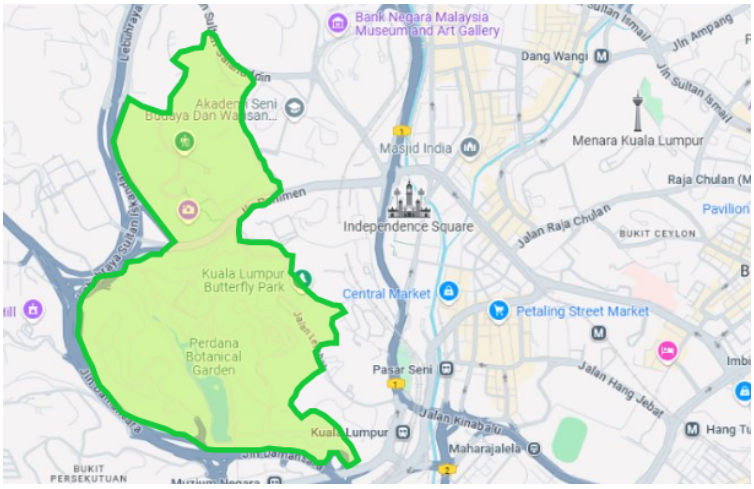


Figure 3: Location of image collection, highlighted in green [Public domain], via Google Maps. (https://maps.app.goo.gl/C3ks79Jty9wZvz9T9)



Figure 4: Samples of collected images

scores provided by the API. In cases where multiple species were suggested, the system selects the species with the highest confidence score to ensure that the subsequent sound generation process is based on a reliable identification framework. Once the species names were obtained, Processing maps the plant names to their corresponding musical frequencies. The alphabet-to-frequency mapping system produced distinct sequences for each species, ensuring that the transformation from textual data to sound is consistent and reproducible.

The mapped frequencies were successfully transmitted from Processing to Pure Data (PD) through Open Sound Control (OSC). The system converted textual information into structured sound sequences, with each plant species producing a distinctive auditory output. The integration of Euclidean rhythms contributed to the coherence of the sound patterns, preventing random or chaotic sequences. By distributing beats and silences in an even manner, the rhythm-based structuring ensures that each plant name has a recognizable temporal pattern. Analysis of the generated sounds revealed that the rhythmic structures introduced a perceptible variation between different plant species. The Euclidean rhythm algorithm balanced uniformity and complexity, allowing the sounds to be both systematic and musically engaging. This rhythmic structuring creates melodic patterns, reinforcing the distinctiveness of each plant species in the sonic domain.

3.3 Auditory Differentiation of Plant Species

In this section, the alphabet to frequency mapping for five samples are presented from table 2 to 6.

4 DISCUSSION

This project has demonstrated an alternative method for engaging with botanical knowledge through sound. However, there remains significant potential for further exploration and refinement. Future developments could incorporate additional biological variables, advanced sound synthesis techniques, and interactive elements that deepen the sensory experience. This topic outlines key areas

Table 2: Hibiscus Schizopetalus (native to Kenya, Tanzania, and Mozambique)

#	H	i	b	i	s	c	u	s	<space>				
Hz	440	493.88	246.94	493.88	1318.51	261.63	1567.98	1318.51	0				
#	S	c	h	i	z	o	p	e	t	a	l	u	s
Hz	1318.51	261.63	440	493.88	2637.02	880	987.77	329.63	1396.91	220	659.25	1567.98	1318.51

Table 3: Ixora Javanica (native to Java and Malaysia)

#	I	x	o	r	a	<space>		
Hz	493.88	2093	880	1174.66	220	0		
#	J	a	v	a	n	i	c	a
Hz	523.25	220	1760	220	783.99	493.88	261.63	220

Table 4: Hibiscus Moscheutos (native to southeastern United States)

#	H	i	b	i	s	c	u	s	<space>	
Hz	440	493.88	246.94	493.88	1318.51	261.63	1567.98	1318.51	0	
#	M	o	s	c	h	e	u	t	o	s
Hz	698.46	880	1318.51	261.63	440	329.63	1567.98	1396.91	880	1318.51

Table 5: Hibiscus Ovalifolius (native to Senegal, Eritrea, South Africa, and Pakistan)

#	H	i	b	i	s	c	u	s	<space>		
Hz	440	493.88	246.94	493.88	1318.51	261.63	1567.98	1318.51	0		
#	O	v	a	l	i	f	o	l	i	u	s
Hz	880	1760	220	659.25	493.88	349.23	880	659.25	493.88	1567.98	1318.5

for expansion, including the integration of flower aging, timbre modulation based on plant traits, real-time interaction, spatial audio design, and ecosystem-based soundscapes.

4.1 Translating Age of plant as audio effects

One of the proposed developments for Akousis is the incorporation of flower aging as a variable in the auditory transformation. In the current system, plants are represented through mapped frequencies and rhythmic structures, but this approach does not account for their temporal changes. By introducing a method to assess the age of a flower, the generated sounds could evolve over time, reflecting the plant's natural lifecycle. To sonically represent this aging process, audio effects such as bit-crushing - a digital audio effect that reduces bit-depth to introduce distortion - can be applied. In this approach, younger flowers would produce clean, high-resolution sounds, while older flowers would exhibit increasing levels of distortion, signifying their progression toward decay. This technique offers a perceptible transformation that parallels the biological reality of aging, making the auditory output more dynamic. Additionally, parameters such as sample rate reduction or filter degradation could be explored to simulate environmental wear over time, reinforcing the relationship between botanical aging and sonic decay.

4.2 Expanding botanical dataset with additional traits

Beyond age, the auditory representation of plants could be enriched by incorporating additional biological traits such as seasonality, growth stage, leaf texture, or environmental conditions (e.g., soil quality, light exposure, temperature fluctuations). These traits could

Table 6: Hibiscus Arnottianus (native to Hawaii)

#	H	i	b	i	s	c	u	s	<space>		
Hz	440	493.88	46.94	493.88	1318.51	261.63	1567.98	1318.51	0		
#	A	r	n	o	t	t	i	a	n	u	s
Hz	220	1174.66	783.99	880	1396.91	1396.91	493.88	220	783.99	1567.98	1318.51

be mapped to different sound characteristics, influencing the timbre, frequency range, or modulation depth. For example, plants that thrive in humid environments might be associated with longer reverb tails, mimicking the effect of sound traveling in dense air, while those adapted to arid conditions could have shorter, more percussive tones. Similarly, plant movement or photosynthetic activity could determine the level of dynamic variation in the sound. By expanding the dataset beyond taxonomic names, the project could generate a more intricate and biologically accurate sonic representation of plant life.

4.3 Timber modulation for biological traits

While the current system primarily relies on frequency mapping, introducing variations in timbre could further differentiate plants based on their unique properties. Timbre, which defines the tonal quality of a sound, can be shaped using granular synthesis, frequency modulation (FM), or subtractive synthesis to create a richer auditory experience. For example, the structure of a plant's leaves or petals could influence the harmonic complexity of its sound, with broad leaves producing deeper, resonant tones, while fine, delicate structures might result in higher, more shimmering textures. The colour of the flower could also be linked to spectral filtering, where darker flowers correspond to lower frequency emphasis, while lighter flowers are represented by brighter, high-frequency tones. Such an approach would enable a multidimensional auditory mapping, making plant characteristics more perceptually distinct.

4.4 Real time adaptation

Another potential extension involves making Akousis more interactive by allowing the generated sounds to evolve over time, either in response to external stimuli or user interaction. Instead of producing a static representation of a plant species, the sound could be continuously modified based on real-time biological or environmental data. For example, by integrating sensor-based technology, the project could adapt its sound output according to changes in light exposure, temperature, or moisture levels. A plant in bright sunlight might produce an expansive, open sonic texture, while one in shade might sound muted and dampened. Similarly, a plant that is wilting due to lack of water could exhibit gradual pitch bending or fading amplitudes, reflecting its physical decline. By creating a system where plant sounds evolve dynamically, the project could provide an ongoing, living representation of botanical states rather than a fixed translation.

4.5 Spatial Audio Integration

Given the growing interest in immersive media, another avenue for development is the integration of spatial sound design to position plant-based sounds within a three-dimensional auditory space. Instead of presenting individual plants as isolated sonic entities, a spatialized approach could place them in a virtual soundscape, allowing users to navigate and experience different species from different locations within an environment. This could be particularly effective in a multichannel audio setup, where plant sounds could be distributed across multiple speakers, creating an immersive sound field. The spatial characteristics of each species could be determined by their native environment, with tropical plants positioned in denser clusters with overlapping textures, while desert plants might be more isolated, with distant reverberations.

4.6 Multi-species interaction and ecosystem soundscape

Rather than treating plant species as isolated entities, Akousis could explore the creation of ecosystemic soundscapes, where multiple plants interact sonically to represent entire habitats. Instead of each plant species producing an independent sound, their interactions could be modelled after real-world ecological relationships, where pollination, cohabitation, and biodiversity density influence the collective sound. For instance, a plant that depends on cross-pollination could have its sound dynamically altered when another related species is introduced, creating harmonic interplays or rhythmic synchronization. Similarly, the presence of multiple species could lead to the formation of layered sound textures, mimicking the complexity of natural environments. This approach could provide an auditory simulation of ecological balance, where changes in biodiversity affect not just ecosystems but also their sonic representations.

4.7 Human interaction and biofeedback systems

Another possible direction is enabling human interaction with plants to influence sound output. By integrating capacitive touch sensors or biometric feedback systems, users could modify the sonic characteristics of a plant simply by touching its leaves or placing their hands near it. Changes in electrical conductivity or temperature could trigger variations in pitch, reverb, or modulation, making the interaction tactile and responsive. Additionally, biofeedback sensors that measure physiological responses such as heart rate or brainwave activity could be used to establish a two-way interaction between humans and plants. A person's emotional state could modify how the plant "sounds," creating a real-time relationship between different biological systems. Such an approach could be particularly valuable in therapeutic or meditative contexts, where plants serve as interactive sound objects that respond to human engagement.

5 CONCLUSION

The results of Akousis demonstrate the feasibility of converting plant taxonomy into sound through the combined use of artificial intelligence and algorithmic sound synthesis. Using the Pl@ntNet API, the system provided reliable identifications of plant species, which were then algorithmically translated from textual data into musical frequencies through Processing and Pure Data. The integration of Euclidean rhythms contributed to the musical and temporal structuring of the sonic output, ensuring both aesthetic coherence and perceptual differentiation between species. Each plant generated a distinct auditory signature, suggesting that taxonomic data can be effectively rendered in the auditory domain. These results affirm that sound-based knowledge representation constitutes a viable alternative to conventional visual and textual methods of classification, enabling the articulation of taxonomic relationships through structured sound patterns. In doing so, Akousis invites reflection on how sonic media may expand the sensory possibilities of

scientific and cultural understanding, particularly in contexts where alternative modalities of perception are desirable or necessary.

From a postcolonial perspective, however, Akousis extends beyond a technical exploration of data sonification; it critically engages with the epistemic histories that underpin contemporary taxonomic systems. Modern plant taxonomy remains indebted to the Linnaean framework of classification, a system that codified scientific nomenclature through Latin. It is a symbolic medium of authority and universality that historically rendered local and Indigenous naming systems peripheral or invisible. By transforming these taxonomic identifiers into sound, Akousis performs a subtle yet critical act of epistemic reconfiguration. The project does not reject taxonomy outright; rather, it destabilizes its authority by translating its visual and textual forms into an auditory and temporal experience. In this sense, sonification becomes a method of undoing the fixity of colonial classification, rearticulating knowledge through a medium that resists the visual regimes of observation and control historically associated with colonial science. Sound, unlike the visual image or the written word, is inherently relational, temporal, and embodied. It invites listening rather than looking and this orientates toward the world that privileges connection, resonance, and participation over distance and objectification.

Nevertheless, it is crucial to acknowledge that artificial intelligence cannot substitute for, nor authentically represent, Indigenous or decolonial knowledge systems. AI operates within computational logics and data infrastructures that remain shaped by the epistemic legacies of colonial modernity. Its algorithms are trained on datasets that reflect the classificatory impulses of Western science, often reproducing the very hierarchies they might seek to critique. In Akousis, AI functions not as a surrogate for Indigenous knowledge but as a mediating tool - a technological instrument through which strategies of decolonial reimagining may be enacted within systems still marked by colonial structures. The sonification process thus operates as both a creative and critical intervention. It reveals the limitations of algorithmic representation while simultaneously opening a space for rethinking how knowledge might be sensed, shared, and experienced differently.

By translating plant names and classifications into sound, Akousis does not claim to recover suppressed Indigenous epistemologies. Rather, it gestures toward the possibility of listening differently to data, to plants, and to the world itself. The project's value lies in its ability to provoke critical reflection on the politics of perception and the conditions under which knowledge becomes legible. Through sound, the work makes audible the tension between the universalizing aspirations of scientific taxonomy and the multiplicity of lived, local, and sensory knowledges that resist such containment. In this way, Akousis exemplifies how artistic and technological practice can simultaneously expose and reimagine the epistemological legacies of colonialism, inviting new modes of sensing and understanding the living world.

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Processed Experience: A Contemporary Discourse on Existence with Spatial Installation

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Abstract

Now, we see proliferation of information and things of experience. We undergo numerous digital experiences, yet overwhelmed by their splendor and quantity, we struggle to articulate what we have experienced. This excess of experience dilutes the density of condensed experience and punctures our sense of being. This demands philosophical reflection. In response, this paper proposes "Processed Experience" as a conceptual framework for understanding how digital experiences are constructed through discontinuous, fragmented units rather than continuous flows. Drawing from information theory and media aesthetics, we introduce three analytical axes: Medium (material conditions of information), Frame (quantum segmentation of time), and Attention (selective information capture mechanisms). These three dimensions project experience into discrete units we call "Dice", which are formed through Encoding and Processing within information field. To reveal the framework as phenomenon, we present a spatial installation using Apple Vision Pro. Participants are surrounded by three-dimensional graphics and audio manifested by different processor—RGB differentials, AI interpretations, and interpolated graphics. The installation places the outputs of different processors (electrical circuits, algorithms, language models) in front of another processor—the human participant. The three-minute immersive experience progressively overwhelms participant, forcing them to confront their own processing. By confronting participants within others' processed outputs, it prompts questions about how digital experiences are constructed through encoding and processing. This research presents "Processthetics"—an aesthetic attitude where processing is experience itself. Rather than being confused by excess, understanding experience in novel framework opens new interpretive possibilities for digital experience and existence in the contemporary era.

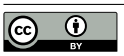
CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Digital Experience, Information Theory, Media Aesthetics, Extended Reality, Spatial Experience

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1 Introduction

Experience has become cheap. If novel works—those with high information quantity—are more likely to leave lasting impressions, then thousands of never-before-seen videos accessible with a single click, or hundreds of images generated from a single prompt, should etch themselves into our minds. Before sleep, we traverse the globe through countless 15-second shorts, attend K-pop concerts while lying down with immersive displays, and skim through friends' thoughts via platform snapshots. Yet none of these stays with us. After three hours of watching shorts, what remains is not concrete memory but a vague emotion and fatigue. Despite hundreds of swipes, nothing coalesces. The vast materials organized by LLMs leave us feeling simultaneously informed while overwhelming us with proliferating questions and doubts. What have I done? We see, hear, and read more than ever before, yet find ourselves in the paradoxical situation of being unable to articulate what we have actually experienced. This overproduction of experience dilutes the density of meaningful experience, puncturing holes in our sense of existence. The means by which we attempt to recall "what did I do today?" collapses under the weight of the underlying question "what am I?"

This contemporary individual's daily life—as producer, consumer, or simply as being—resurfaces ontological questions: will my actions matter in the near future? Is only desire left? This vertigo calls for a philosophy of digital experience—one that addresses not society but the individual navigating these fragmented experiences. Yet current digital contents entangle the input and output in dynamic relationships, blurring the boundaries between computational inference and human reasoning. This suggests the need for cross-disciplinary theoretical examination of what is seen, when, and how it is encoded as experience. How do fragmented experiences accumulate to constitute experience? How do discontinuous digital moments create the sensation of a continuous self? These questions demand contemporary conceptual framework for individual beyond technological critique or cultural analysis.

To address this phenomenon, we can refer previous research. Media theory has provided foundational insights into how media shapes experience and society [1, 2]. McLuhan's extensions of man and Manovich's language of new media established crucial groundwork for understanding digital age. These structural interpretations

explain media's societal effects yet leave open the question of how individuals navigate the confusion of contemporary digital experience at a personal level. Recently, Yuk Hui offered nuanced analysis of digital objects and their existential implications through examining data structures [3]. These approaches yield understanding of digital environment from classical computational systems, while the surge of neural networks invites new theoretical frameworks for interpreting nonlinear, accidental phenomenon. From cognitive science, Donald Hoffman presents a radical consciousness-centered framework, proposing that consciousness rather than matter constitutes fundamental reality [4]. His theory of conscious agents—built on Action, Decision, and Experience—offers intriguing possibilities for understanding perception. This approach opens important questions about the nature of experience itself, though it primarily addresses perceptual consciousness rather than the specific mechanisms through which digital media processes and shapes experience.

These diverse approaches converge on a shared recognition. Digital experiences might manifest as fragmented, individually processed units rather than continuous flows. Shannon's information theory and Kittler's discourse networks particularly illuminate this discrete nature of digital processing [5-7]. Their insight that processors operate through discrete units rather than continua provides a crucial foundation—one that has transformed our understanding of communication and media archaeology. Yet this analytical lens has not been applied to address contemporary problems of digital experience. What remains unexplored is how the information processor—whether human, algorithmic, or language model—might serve as the central organizing principle for understanding how fragmented digital experiences constitute contemporary existence. This gap points to the need for processed experience as a new analytical framework.

This gap may be because discussions of experience and existence easily risk becoming speculative discourse. Here we can draw inspiration from Kant's attitude as a methodological insight [8]. He distinguishes between things-in-themselves (which we cannot directly know) and phenomena (which we can observe and analyze). Information processors offer a parallel opportunity: while we cannot fully grasp consciousness or existence itself, we can examine the mechanisms we have created. These digital systems—designed by humans, operating through observable processes—provide concrete ground for understanding how experience is constructed. Thus, this research interprets digital experience through the operations of processors whose workings we can trace and analyze. Just as we might not understand our full existence but can study how we appear in photographs; we can examine how digital processors shape and fragment our experience.

These considerations naturally intersect with core questions of information theory: How is information compressed? How are connections made in noisy environments? What are capacity limits? [9]. Methods addressing information processing and relative temporality offer promising hints for interpreting digital media experience. To leverage this potential, viewing experience through information's lens and interpreting it as discrete processes of progression reveals previously undiscovered insights. Meanwhile, information theory alone cannot capture the qualitative transformations at play. When buffering creates temporal gaps, when compression produces visual artifacts, when algorithms curate our attention—these are not merely technical operations but aesthetic events that shape the very texture of experience. Thus, we require an aesthetic attitude that concretizes media aesthetic questions for digital art while centering on the "process of experience" itself to reveal digital experience's details—a Processthetic.

To address this research gap, we present a conceptual framework for interpreting contemporary vertigo from digital experience. Because digital media are fundamentally discrete, we trace how experiential fragments are created (Encoding), how they proceed (Processing), and ultimately how they constitute our existence. We aim to capture this through the concept of "processed experience" using three axes: Medium, Frame, and Attention. This framework is implemented through an immersive spatial installation. Finally, based on interviews from installation experience, we review the framework's potential and limitation for interpreting digital experience.

2 CONCEPTUAL FRAMEWORK

2.1 Medium, Frame, and Attention

To understand digital experience, let us examine its constituent elements through distinction. The purpose is not a structuralist approach for judgment, but to observe properties from multiple perspectives and sketch its form. To examine experience—somewhat metaphysical and difficult to capture precisely—we project it onto three axes and collect the cross-sections reflected on each axis. This research distinguishes experience along the three-dimensional axes of Medium, Frame, and Attention, grasping experience as the sum of shadows cast on these axes (Figure 1).

Medium signifies the material conditions in which information exists and is transmitted. This is not merely a transmission channel but defines the possibility of what can be experienced. Hardware layers (pixel density, color gamut, processor speed), software layers (codecs, compression algorithms, APIs), and interface layers (touchscreens, sensors on XR devices) overlap with their unique constraints and possibilities to constitute the material foundation of experience. While this brushes against previous media philosophers' discussions in noting that media properties can precede content [1], it differs in focusing on how digital media operates as constraints determining information processing methods at lower levels.

Frame is the result of quantum segmentation of consensually agreed time at human scale. Segmentation methods include processing speeds of human neural systems, AI's nonlinear networks, and machines' algorithms and hardware. This serves simultaneously as constraint on information output and condition for information input. For an AI model generating 30fps video and 44.1kHz audio called via API every 3 seconds, Frame constitutes output constraint; when humans process this information, the visual system's critical fusion frequency (~24Hz), auditory temporal resolution (~20ms), and conscious attention switching speed (~200ms) constitute input conditions.

Attention is the mechanism by which subjects with limited information-processing resources selectively capture from vast information fields. This is not merely human cognitive limitation but a universal condition of all information processing systems.

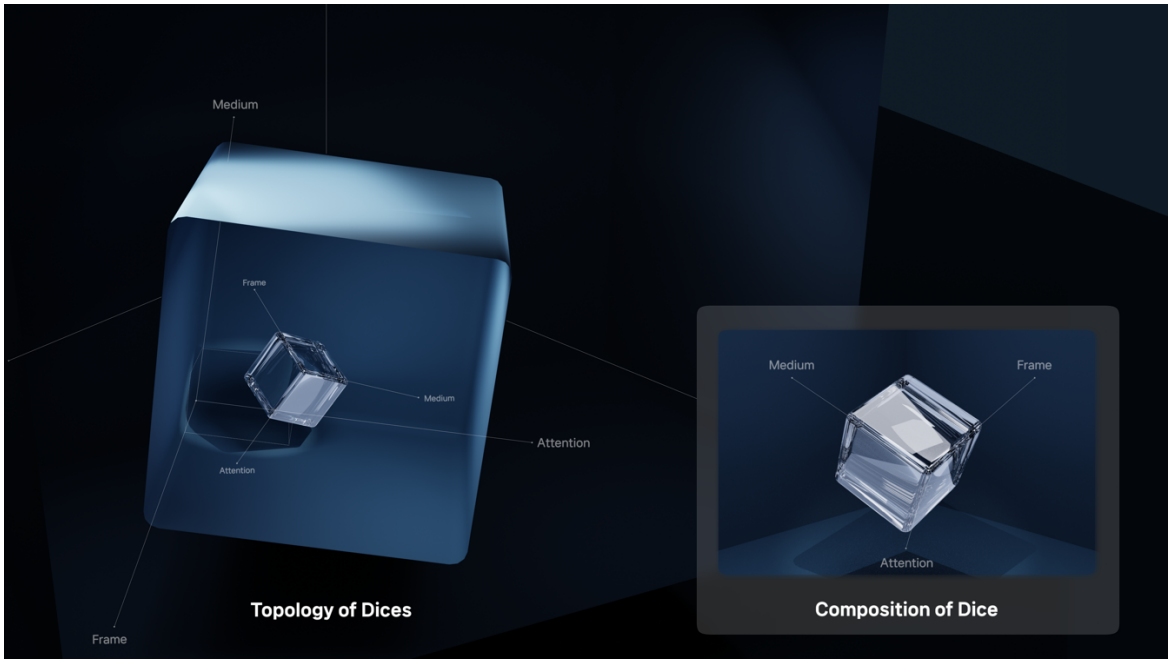


Figure 1: Topology and Composition of Dices

As LLM attention weights selectively strengthen token relationships, as computer vision focuses on specific image patterns, as human gaze fixes on screen regions, attention induces selective constitution of information processing. Within the fundamental imbalance between limited cognitive resources and infinite information, attention determines what incorporates into existence and what excludes. Considering that observational status through attention affects information quantity, attention is a primary axis for analyzing experience.

For simplicity, let us call these experiential fragments interpreted and projected through these axes—metaphorically cups drawing water from experience's lake—**Dice** Each Dice consists of specific combinations of Medium conditions, Frame settings, and Attention configurations, with Dice forming open sets of multilayered structures containing other Dice. Through interactions of these dice thrown and entangled within this field, we attempt new interpretations of digital experience.

2.2 Encoding, Processing

Let us call the methods by which Dice are created and tangled, Encoding and Processing, respectively. That is, they are made through Encoding and entangled through Processing (see Figure 2).

Encoding is the process of capturing continuous, analog experience by projecting it onto the three axes of Medium, Frame, and Attention. Just as shadows form when three-dimensional objects are projected onto two-dimensional planes, experience takes specific forms when projected onto each axis. Smartphone cameras encode light into pixels, microphones encode sound into samples, and LLMs encode relations into tokens. What matters in this process is not only what is captured but equally what is omitted. Just as JPEG compression removes information imperceptible to human eyes, information loss through projection accompanied by increased interpretive possibility.

The objects of encoding extend beyond "digital media content" to encompass all "potential objects of attention"—Attendendum. This reconceptualization aligns with phenomenological analysis. In phenomenology, consciousness is always consciousness "of" something [10]. In digital environments, this intentionality is necessarily mediated through information processing. When viewing a screen, we do not directly perceive pixels but experience the processed outcome of RGB values transformed through computational operations. This processing did not merely enable experience but constitutive—without encoding, there is no digital experience, and without experience, no confirmation of existence [11]. Thus, in digital environments, the conscious subject is a "processing" subject who acts as meaning-giver [12].

Processing is the procedure through which these Encoded dice become entangled and loosened within the "information entanglement network". The core here is "pro-cess" itself—advancing to the next state. Reality consists not of static substances but of "actual occasions" of experience [13]. In digital contexts, each processing event—whether buffering video, rendering graphics, or executing algorithms—constitutes such an occasion. The continuity we perceive emerges from discrete processing events, much like cinema creates motion from still frames, and the variously perceived continuity provides hints about each viewer's human cognitive system.

Natural processing possesses intimacy in that connections entangle outward from within Dice. RGB values seek display on screens, audio data heads toward speakers, text awaits reading. These are not merely stored data but Attendenda—awaiting the attention that

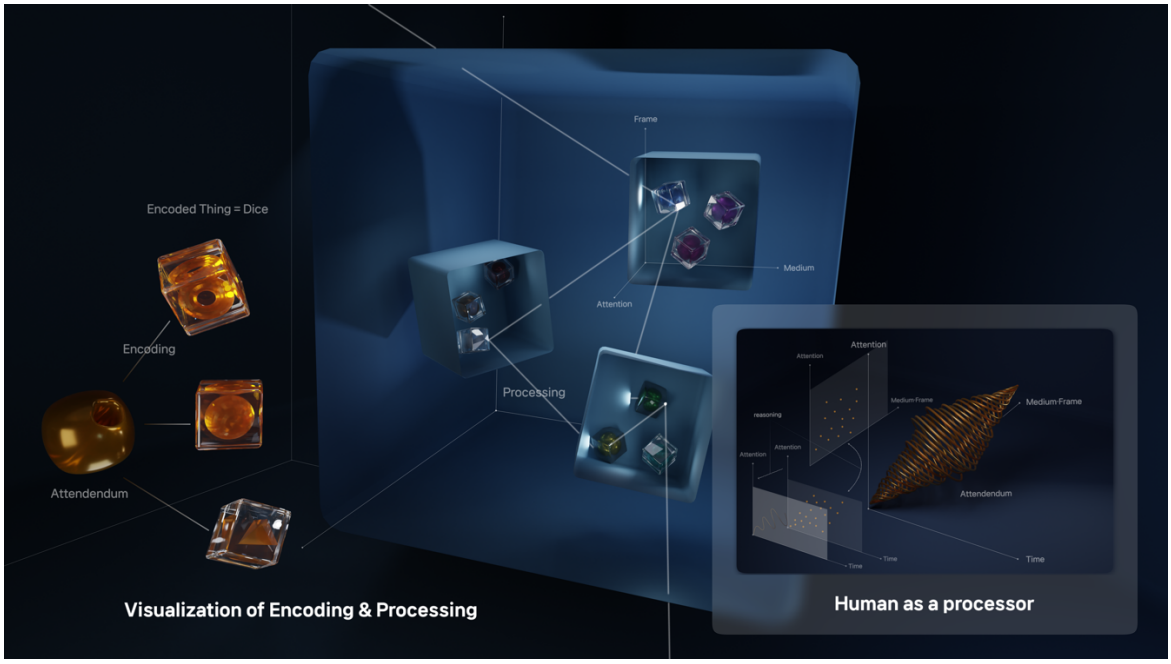


Figure 2: Encoding and Processing of Dices

processes their existence. This resonates with contemporary cognitive science's understanding of the brain as processor. Cognition itself is fundamentally a process of prediction and error correction through continuous sensorimotor loops [14, 15]. Digital processing exemplifies this principle in pure form.

Our framework suggests an explanation for why digital existence inherently discrete and processual. A streaming video does not exist as an entity that gets processed; its existence IS the continuous processing. Stop the buffering, halt the decoding, disconnect the network—the video becomes unobservable and ceases to exist. This is not metaphorical but ontological. In digital realms, to be is to be processed.

2.3 Processed Experience, Shard of Existence

Through the lens of Dice's Encoding and Processing, we can re-observe digital experience. Processed Experience is not merely "processed" experience, but the dynamic flow generated when a Processor captures and processes Attendendum within fields of information entanglement. When systems are analyzable units, consciousness corresponds to information (Φ) by causal structures [16]. In digital contexts, each processing generates measurable information integration—from rules constructed with tokens to pixel patterns, from algorithm to neural responses interpreting colors output from displays.

These processes constitute what we term Shards of Existence—discrete moments where information processing crystallizes as experiential reality. Consider social media engagement: each like, snapshots represent a processing event that simultaneously constitutes the user's digital existence and the platform's reality. Users experience their online presence not as continuous narratives but as fragmented, moment-to-moment actualizations [17]. The stronger the information entanglement—measured by uncertainty reduction and causal efficacy—the more vivid the shard of existence becomes.

Our framework navigates the tension between experiential continuity and physical discreteness. Levinas' notion of "diachrony"—time as irreducible discontinuity rather than synchronizable flow—provides ground for understanding digital temporality [18]. This philosophical insight aligns with neuroscientific findings about discrete neural oscillations [19], suggesting consciousness itself operates through gaps and intervals. Digital experience renders this diachrony visible: each processing moment arrives as an interruption, a discrete event that cannot be fully synthesized into continuous narrative.

The implications are profound. In digital environments, existence manifests as discrete yet entangled moments—each processing event forms an independent shard while remaining causally entangled within information fields. Your Instagram story is not a narrative but a collection of processed moments. Your Google search history reveals not continuous identity but an archipelago of attention points. The self is not contained but enacted through technological mediation [17].

Thus, Shard of Existence represents a new ontological category suited to the contemporary digital age. Unlike substance (permanent) or flux (flowing), shards are crystallized processing moments—each complete yet fragmentary. Technical memory systems do not merely store but constitute human time-consciousness [20]. In framework, observations of technical processing do not confirm results of processing but reveal the existence behind experience.

The vertigo induced by digital excess stems from attempting to force these shards into traditional continuous narratives. We scroll endlessly seeking coherence that cannot emerge from the

fundamental discreteness of medium, of frame, of attention. Understanding experience as Processed Experience—accepting the fragmentary nature of digital existence—opens novel interpretive possibilities. Rather than lamenting lost continuity, we can embrace the "marvelous indifference of technical media" [21], recognizing that our existence is aesthetically discontinuous.

3 INSTALLATION

The purpose of this installation is to provoke confusion upon viewing, leading to questions such as "What did I just see? Why is it structured this way?"—thereby initiating inquiry into Processed Experience. This chapter details the implementation. Section 3.1 presents the material selection rationale for the three axes of Dice. Section 3.2 and Section 3.3 describes how each material is designed to reveal the processes of Encoding and Processing as defined in the conceptual framework. Section 3.4 documents the participant's experiential sequence. Figure 3 and 4 illustrates this.

3.1 Making Dices

3.1.1 Revealing Medium. The installation employs three distinct media commonly encountered in contemporary digital experience: video, sound, and text. The video is based on respectfully reworked visual material from artist doopiido's work [22]. This footage was selected for its continuous transformation of familiar objects into different forms, effectively capturing the characteristics of generative media. The reconstructed video branches into six variations, visualized three-dimensionally at 1920×1920 resolution on Apple Vision Pro. Screening video media on an XR device was chosen to create a sense of "being inside" unavailable on flat displays, while the three-dimensional presentation itself reveals differences in Medium.

3.1.2 Revealing Frame. Insert Frame results from quantum segmentation of time according to subjects' information input-output methods. The installation incorporates Frames from three subjects: an LLM model that comprehends images and generates textual descriptions [23], a TTS model that converts text to voice [24], and a laptop that calculates inter-scene differences and detects objects within scenes [25]. These are then presented to participants possessing human eyes and visual systems. Their different processing speeds undergo a re-rendering computational process through a scripted algorithm with predetermined work sequences, producing the final video. This process creates the video's distinctive texture. The playback speed differs awkwardly from typical human-oriented video, while subtitle-like text displays most dramatically—voices reading text overlap due to different segmentation units in the generation process, ultimately leaving only instrument-like signal tones rather than voices in human auditory processing.

3.1.3 Revealing Attention. The installation is designed to make participants with limited information-processing resources frequently and intensively perform selective capture from vast information fields—the Attention process. First, the video contains numerous Attendendum: texts with excessive poetic metaphors, childlike questions, keywords in five languages, blinking RGB numerals, continuously morphing animals and objects, voice-like sounds and noise—objects impossible to capture simultaneously. Second, the three-dimensional arrangement presents diverse Attendendum. Videos transformed through R, G, B differential values and interpolation are positioned on six faces—above, below, front, back, left, right—with each video's sound delivered through spatial audio. Participants cannot process all Attendendum simultaneously and must perform the Attention process for information processing through conscious bodily movement.

3.2 Encoding Dices

3.2.1 Graphic Treatment. The six faces visualize results of different information-processing subjects "seeing" the original video. RGB difference video represents computer vision algorithm's detection of inter-frame changes, expressing pixel-level differences as heatmaps in the 0-255 range. Interpolated video shows intermediate states between frames "imagined" by generation algorithms. While these constitute completed processing (their Dice) for each system, they are presented as new Attendendum to viewers.

3.2.2 Acoustic Treatment. The installation transforms computational outputs into acoustic experiences through overlapping TTS voices reading generated texts at different speeds. Each of the six faces emits spatialized audio, creating a polyphonic soundscape where mechanical speech collides and interferes. As multiple voices attempt to articulate AI-generated descriptions simultaneously, they dissolve into rhythmic textures—no longer linguistic communication but pure sonic material. This randomly vibrates between polyphonic and cacophonous soundscapes, revealing how different temporal frames of processors create unintended resonance when processed by human auditory system, making participants aware of their own acoustic processing mechanisms.

3.2.3 Linguistic Treatment. Text from LLM's moment-by-moment "interpretation" of images traverses the screen. Texts generated through various style prompts—"poetic metaphor", "child's question", "keywords in five languages"—result from LLM's probabilistic "thinking". These scroll faster than human reading speed, functioning as visual patterns rather than readable content. Display timing follows not human readability but processing intervals—the duration from scene capture through API calls to text generation completion. This creates temporal misalignment where descriptions lag behind or anticipate morphing visuals, mixing explanations of different transformation states. The four textual modes seem connected to images yet remain subtly incongruent, producing an uncanny disconnect between visual and linguistic processing.

3.3 Processing Dices

The installation direction physically positions participant at the center of "others" processed experiences. Standing at the cube's center, viewers are surrounded by other subjects. Dice pouring from six directions simultaneously. This is not merely a multi-screen installation but a structure enabling visceral understanding that each face represents "already processed" outputs from independent information-processing subjects. Images "seen" by LLM, differences on scenes "analyzed" by computer vision, and text "read" by TTS operate with their distinct rhythms and logic. When viewers focus on one face, others continue processing without pause, dramatizing the inevitability of missing out. More importantly,

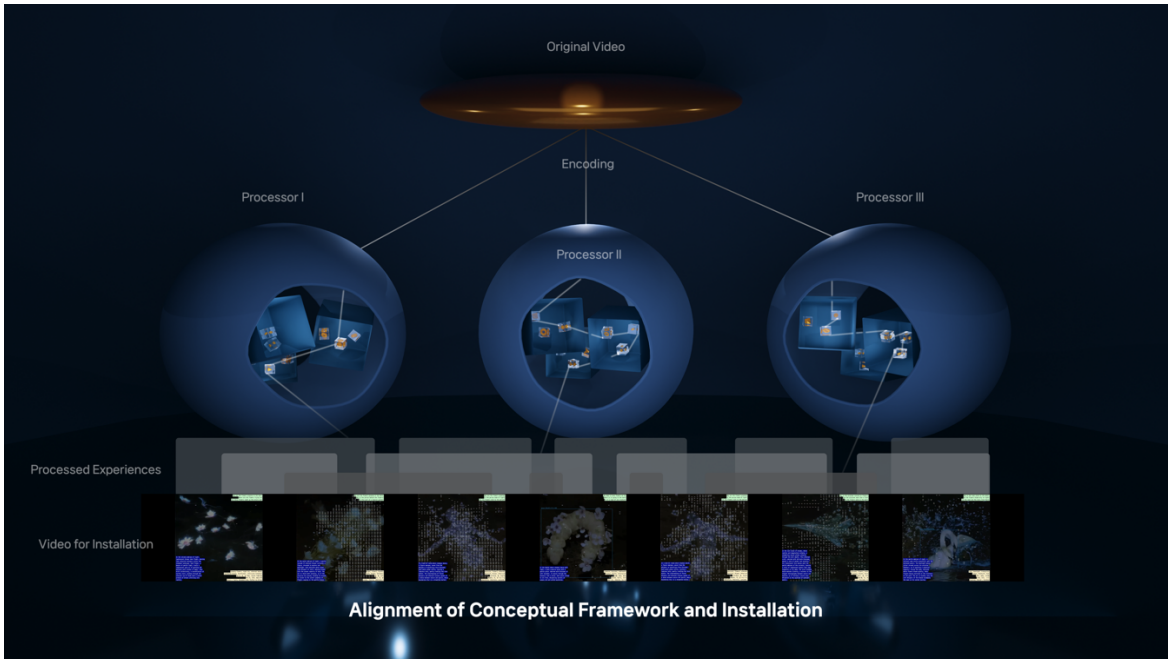


Figure 3: Alignment of Conceptual Framework and Installation

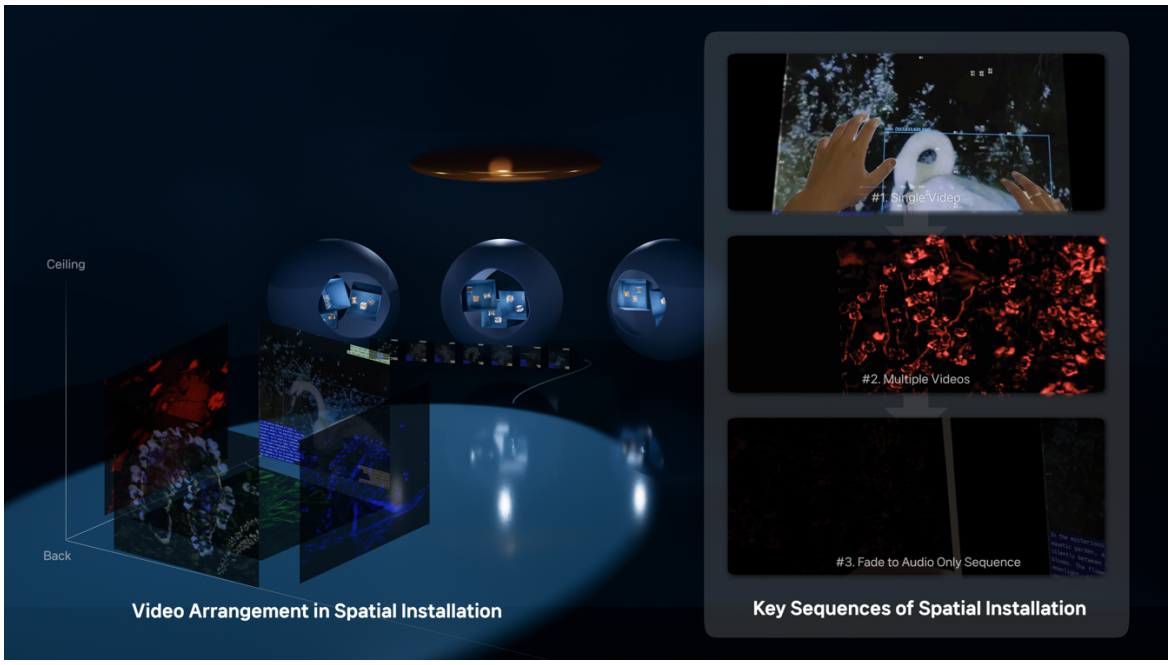


Figure 4: Participation Sequence of Installation

viewers become aware they too are "processing" their own experience through selection and exclusion. The trace of body movement and unconscious gesture reveal this—viewers witness of Dice they have created, realizing they too are information-processor.

4 Discussion

When asked to describe their installation experience, participants responded: "I don't know where to look", "It's overwhelming", "The input is excessive". Most acknowledged: "It was impossible to see everything, so I just looked at whatever I wanted". Participants

constructed experiences uniquely—one "compared four texts while reading", another "tried to connect text and sound", yet another "watched the continuously changing video".

Interestingly, participants recognized they were reconstructing experiences post-hoc. Unable to precisely define what they saw due to overwhelming information, they acknowledged "reassembling" momentary impressions. One reflected: "I said I started reading text then followed color changes… but actually, I don't think I experienced it that way". Participants consistently reported that connecting attention that might have been random post-hoc. Another consistent response concerned melody-like sounds from overlapping TTS voices— "Polyphonic sounds made from voice", "…textures created by voices with noise". They recognized mechanical outputs transforming into aesthetic experience through their auditory systems. This suggests Frame collision effectively facilitates perceptual awareness, aligning with Christian Marclay's "The Clock" which discovered new temporality in colliding cinematic and real time [26]. Our installation's voice collisions made participants aware of their own "processing" systems. One participant came remarkably close to our framework concepts. Mentioning kintsugi, they reflected: "In broken pottery mended with glue then decorated—existence isn't about 'what was' but lies behind the fact that broken fragments were reassembled, that someone performed that process… These results calculated by different subjects inevitably stick to characteristics of medium, and I myself, editing and selecting various videos to create stories, seem to belong within that process" [27].

Our spatial installation relates to precedent works exploring data's perceptual transformation. Ryoji Ikeda's "The Transfinite" (2011) converted particle physics, space, and genome data into patterns flashing at hundreds of frames per second [28]. While audiences cannot grasp individual information, they experience overall rhythm. Similarly, our installation uses information excess to create new perceptual experience, but while Ikeda pursued data's sublimity, we visualized processing itself. Casey Reas's "Process Compendium" (2004-2010) resonates with our "Processthetics" in making processing an aesthetic object. Reas translates simple rules into code generating infinite visual variations [29, 30]. However, while Reas pursues algorithmic elegance, we deliberately stage collisions between multiple processors—human attention, AI interpretation, mechanical calculation. Where Reas reveals singular computational beauty, we expose the cacophony of irreconcilable processing logics operating simultaneously. Ian Cheng's Emissaries' trilogy offer another comparison. Cheng creates "live simulations" where AI agents act autonomously via competing "mini-brains" [31, 32]. This resembles our participants' overwhelm, but crucially, Cheng's viewers remain external observers while our installation positions participants as central processors, witnessing traces of Dice they have created. These comparisons clarify Processed Experiences' unique contribution. Capturing the moment humans confront their processing and themselves as processors within digital experience. Despite three-minute limitation, dramatic staging surfaced unconscious digital experience characteristics—forced selectivity, impossible synchronization, processing creativity—as starting points for further questions.

Returning to our initial concern—the cheapening of experience and punctured existence in digital experience —the installation participants' responses illuminate how the Processthetics transforms this contemporary vertigo into interpretable phenomena. This attitude does not solve the fragmentation of experiences but reframes it as entangled. When participants acknowledged "impossible to see everything", they were not expressing failure but facing a natural constraint of digital experience. Capacity of channel inherently limits transmission. Our spatial installation that perpetually exceeds human processing capacity. Experience of our installation accelerated exposure reveals that digital media operates through what we call overwhelming—generating more signals than any processor can capture, forcing selection and reconstruction. This creates fatigue and drives us to seek structural refuges of existence.

Meanwhile, from a theoretical perspective, our three axes reveal how digital exhaustion emerges not from content but from misaligned processing expectations. Traditional media assumed synchronous consumption—a book read linearly, a film watched completely. Contemporary media experience operates asynchronously across multiple processing scales: algorithmic microseconds, human attention spans, platform refresh cycles, cultural memory. When participants reported "reassembling momentary impressions", they demonstrated what Processed Experience makes visible: meaning emerges not from consuming complete narratives but from actively processing fragments across incompatible temporal frames. The framework thus reinterprets the anxiety of "what did I do today?" as evidence of alive multi-scale processing rather than failed continuous experience.

Significantly, understanding experience as inherently processed—where loss, selection, and reconstruction are features—suggest existence is processing itself. Just as Shannon deal possibility through encoding redundancy rather than perfect transmission, our framework shows existence coheres through selective processing and reconstruction rather than comprehensive capture or linear reasoning for understanding. Participants did not fail to experience the installation; they succeeded in processing it uniquely. This shift in perspective offers not consolation but empowerment: recognizing ourselves as processors among processors whether human or not, embracing our own possibility through facing the phenomenon rather than surrendering to overflow.

5 CONCLUSION

This research employed a conceptual framework as an attempt to observe and interpret contemporary phenomena. We analyzed digital experience through three axes—Medium (material conditions of information), Frame (quantum segmentation of time), and Attention (selective information capture), theorizing that experience consists not of continuous flows but discrete units (Dice). The implementation of a theory-based spatial installation, followed by dialogues with participants, confirmed the practical potential of the proposed framework.

Before concluding the logic, one question must be addressed with the same breath; Is analytic projection through Medium, Attention, and Frame essential for Processthetics? We seek to dismantle this conceptual framework. Dice merely serve as tools employed for the

linear, structural format of academic papers. The "experience" of understanding while reading this paper and the sensorial experience of the installation exist independently as readers' own fragments. Thus, our task becomes to actively breaking this framework. While acknowledging that medium, frame, and attention—though analytically separated—form an inseparable complex, we hope reader could recognize that analysis merely serves as a temporary tool for understanding, not fixing reality itself.

What remains after dismantling this framework? Perhaps a null—and possibility for the next performance. Deconstructing Dice leaves possibility for "unprocessed experience"—an opens the possibility for yet-unnamed modes of existence. This dismantling is not logical play but preparation for restart, a reset for possibilities of forthcoming experiential interpretation theories. We enjoy playing dice. Therefore, this research seeks not to close with conclusions, but to pose new questions. How shall we pro-cess?

Acknowledgments

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Space as Interface

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Abstract

As part of the interdisciplinary project "The Digital Foyer", the *Cubes* were developed as an interactive object system rethinking theatre foyers as hybrid, participatory spaces. Combining analogue movement, spatial interaction, and digital feedback, the *Cubes* enable new forms of exploratory user experience. Inspired by *ludic design*, they promote playful exploration, collective action, and creative co-design. Three prototype applications—*Performance Bot*, *Lumis (T)Raumland*, and *Video Puzzle*—were tested with school classes, artists, and people with disabilities. Results indicate that spatially embedded interfaces can intuitively and inclusively expand cultural participation. The paper discusses the system's design, technical framework, and participatory applications, highlighting its potential as a model for hybrid cultural formats.

CCS Concepts

• **Applied computing**; • **Arts and humanities**;

Keywords

Ludic Interaction Design, Tangible User Interfaces, Exploratory User Experience, Technology in Cultural Spaces

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1 Introduction

The *Cubes* were developed within the interdisciplinary project "The Digital Foyer: Spaces of Encounter in the Theatre of the Future"—a collaboration between Deutsche Oper am Rhein, FFT Düsseldorf, and MIREVI at Düsseldorf University of Applied Sciences [1]. The project reimagines the theatre foyer as a hybrid environment blending physical presence with digitally mediated communication.

Throughout the research process, several prototypes explored approaches to hybrid formats. A key outcome was the concept of an interactive object transforming the foyer from a static waiting area into a participatory field of interaction. Rather than functioning as furniture, signage, or staff substitute, the *Cubes* act as hybrid entities—part object, part interface, part companion—that encourage visitors to navigate space intuitively and define their own trajectories of engagement. Responsive to movement and arrangement, the *Cubes* turn the foyer into a site of playful exchange and **co-creation**, inviting audiences to connect, explore, and construct meaning through embodied experience.

2 Related Work

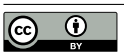
Recent research in interaction design increasingly foregrounds playful, open-ended engagement as a valuable strategy for developing hybrid systems. Particularly within the field of Ludic Interaction Design (LID), digital artefacts are designed not for efficiency or problem-solving, but to invite reflexive, explorative engagement with space, meaning, and social interaction [2]. This principle strongly informed the development of *Cubes*, which were conceived not as task-based tools, but as physical-digital systems that foster curiosity, spatial play, and user-driven interpretation.

A similar ethos underpins Tangible User Interfaces (TUIs), which bridge physical manipulation and digital feedback [3, 4]. Hunter et al.'s work on *Siftables* [5] demonstrates how modular, screen-equipped blocks encourage children to explore content through gesture and adjacency, building meaning through open, narrative play. In *TeleStory* and *Make a Riddle*, children assemble words or characters into humorous or performative sequences [5]—an approach that parallels how users engage with the *Cubes* through spatial arrangement and embodied interaction.

The *Drift Table* similarly exemplifies an open, interpretive mode of interaction, inviting contemplative navigation through virtual landscapes [6]. Within the *Cubes* system, this principle manifests in *Performance Bot*, where participants assemble monologues, sounds, and actions into ad hoc performances. Here, the foyer becomes both stage and interface, encouraging exploration of performative roles and spatial storytelling.

Projects like *ParticipArt* further illustrate how interactive installations can transform spaces into participatory environments through mixed reality and performative engagement [7]. The *Cubes* follow this trajectory by turning the theatre foyer into an exploratory field where visitors co-create meaning through movement and collaboration.

This commitment to modularity and interpretability also echoes designer Cas Holman's philosophy of open systems that enable users to invent their own forms of play [8]. The *Cubes* embody this on both a design and technical level—their hardware and software



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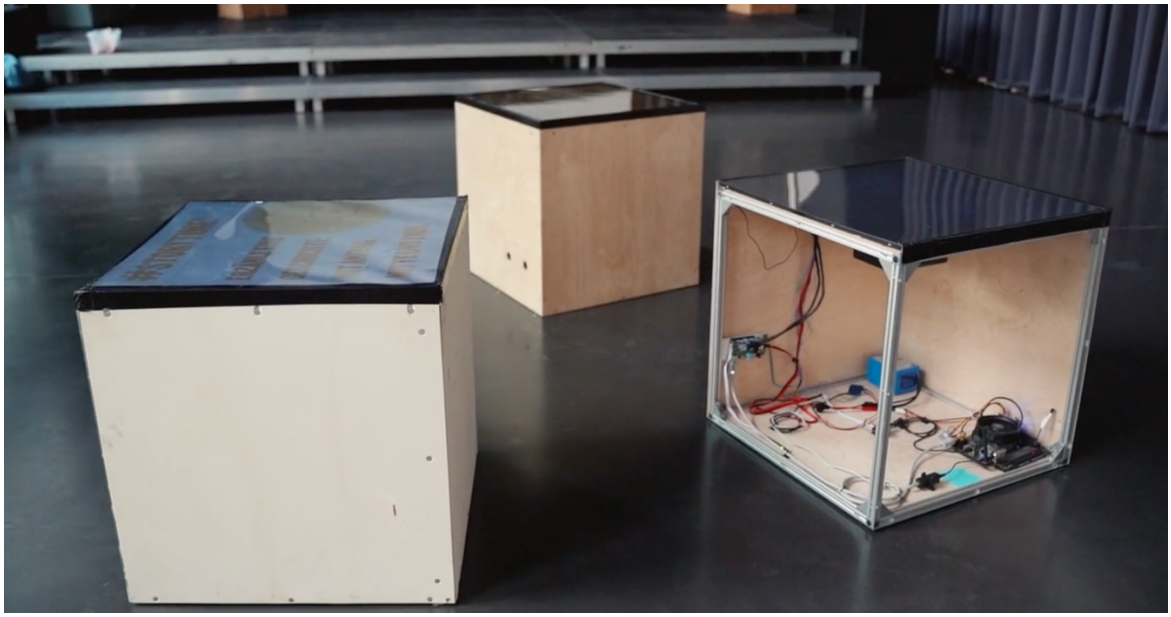


Figure 1: *Cubes* prototype. Video still by Patrick Kruse

architectures remain open for adaptation, inviting future artistic experimentation.

The potential of such openness for emergent meaning-making is underscored by Bekker et al., whose study of *FlowSteps* showed how children redefined rules to create personal interpretations [9]. A similar phenomenon appeared in user tests with the *Cubes*: children debated which cube was "more important" or how to arrange them to tell a "better story." These behaviours reveal how open-ended systems invite reinterpretation and foster imaginative ownership.

Collectively, these examples situate the *Cubes* within a tradition of spatial interface design that treats physical space as an active medium for expression and co-creation [4, 10]. Rather than functioning as passive objects or instruction-driven tools, the *Cubes* establish a hybrid field of interaction, where movement, digital responsiveness, and collective action converge. In doing so, they contribute to the vision of "The Digital Foyer" as a dynamic cultural space extending beyond the stage to support new forms of participatory artistic engagement.

3 Concept

The core concept is based on the idea of treating space itself as an interface—a concept explored in embodied interaction theory [10] and in performative HCI [11]. The installation consists of nine equally sized cubes (Figure 1) (60×60×60cm), each equipped with a display, speaker, and a localization system. Interaction does not occur through traditional touchscreens, but through the physical manipulation of the cubes within the space. Each interaction—pushing, rotating, or moving cubes across the area—triggers visual, auditory, or playful feedback. In this way, physical space becomes a communicative surface shaped through embodied engagement [12].

The notion of experience over efficiency, promoted in third-wave HCI paradigms [13], informed the development of three applications within the *Cubes*: *Performance Bot*, *Lumi's (T)Raumland*, and *Video Puzzle*. Each fosters emergent interaction grounded in movement, narrative, and collaboration—bridging digital systems with spatial storytelling.

3.1 Performance Bot

The *Performance Bot* is a cooperative spatial game structured in three phases. In the first phase (Select), players move the cubes around the space. Based on its position, each cube detects its content zone—some emit sound, others display video fragments, instructions, or effects that may influence later actions. Players select content from these zones. In the second phase (Arrange), the cubes with the selected content are repositioned and arranged spatially into a custom performance structure. No fixed dramaturgy is imposed; each group determines its own rhythm and narrative. In the final third phase (Perform), the created performance is performed once in its entirety. The game thus creates an open-ended creative space, where digital fragments are playfully combined, and the physical environment is transformed into a responsive stage.

3.2 Lumi's (T)Raumland

Lumi's (T)Raumland is a narrative spatial game in which players help a fictional character traverse a dreamlike terrain to reach the "Pond of Dreams". Randomly generated path segments appear on the cubes and must be meaningfully aligned and physically moved through the room—similar in logic to the game *Snake* only experienced physically. Along the way, Lumi encounters various obstacles that require either collaborative problem-solving or individual action. Some of these challenges require physical activity in the room, others are solved by arranging the cubes correctly.

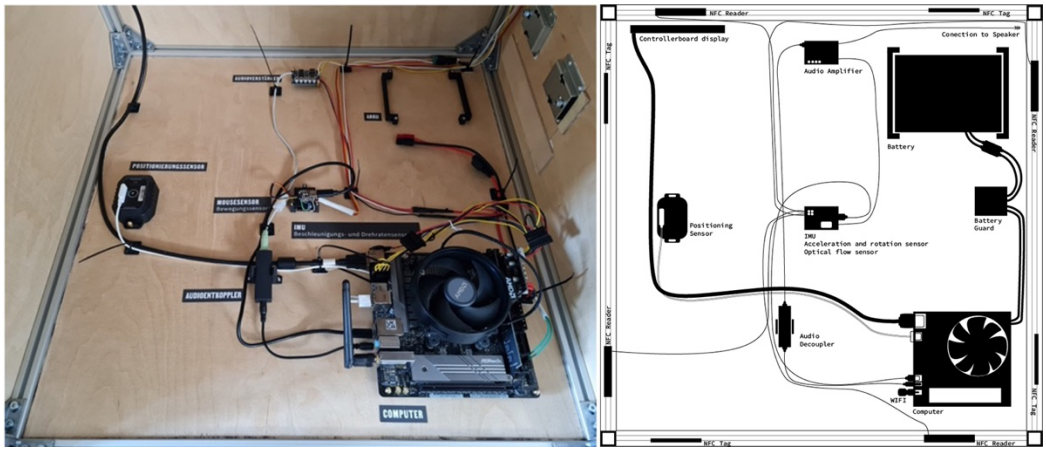


Figure 2: Built-in technology of the *Cubes*; photo and sketch. Photograph by Patrick Kruse.

The game combines narrative elements with movement, tactics and teamwork—and turns the room itself into a narrative actor.

3.3 Video Puzzle

Video Puzzle is a cooperative, video-based puzzle game in which the cubes act as fragments of a larger video image. Each unit shows a section of a video still, but only when all the cubes are correctly positioned and joined does the full picture become visible and the video plays automatically. The content—such as visuals from the theatre's current programme—links interactive play with cultural context. The gameplay demands communication, spatial thinking, and coordination, rewarding the players with a shared audiovisual experience.

Across all three applications, the *Cubes* foster collective spatial interaction and playful co-creation. Unlike screen-based digital systems, they offer embodied interactions that merge intuitive gestures with collaborative behaviours. They turn the theatre foyer into a hybrid interface, where artistic processes unfold through improvised movement. In doing so, the project explores how cultural spaces—particularly in times of digital transformation—can be reimagined as participatory environments that extend beyond the stage and invite new forms of public engagement.

4 Technology

The *Cubes* are modular, digitally enhanced units designed and developed for interactive scenarios in cultural spaces. Each exemplary contains the same technical infrastructure that enables a wide range of sensory and audiovisual interactions.

Both hardware and software are open, extendable systems, adaptable in function and form. Developing new games for the *Cubes* requires basic skills in the Unity game engine. Even with beginner-level skills, it is possible to develop less complex games, supported by comprehensive documentation and detailed step-by-step instructions. The overall complexity depends largely on the specific system requirements, particularly the type and extent of the sensor technology employed. Moreover, existing games can be customized and expanded with other content.

4.1 Structure and Components

Each cube features a robust aluminum frame, enclosed with wood and plexiglass panels. The top surface integrates a display, protected by a Makrolon plate to withstand intensive use. Visual output is accompanied by integrated sound, delivered through an internal speaker. The technological foundation consists of modular PC hardware, enhanced with NFC-based contact detection, room tracking, and multimodal output (audio/visual) (Figure 2). This architecture offers a stable foundation for ongoing system development. A Unity-based, open-source software framework enables the creation of new content by external artists, students, and workshop participants.

4.2 Interactive Sensors

Each Cube integrates a set of sensors that enable multiple modes of embodied interaction. An optical motion sensor (IMU combined with optical tracking) detects direction, rotation, and velocity as the *Cubes* are moved or rotated across the floor. An external tracking system continuously records the absolute position of each cube within a 10×10 metre interaction area, providing accurate spatial localisation. To support contact-based interaction, NFC tags and readers are embedded on all sides of each cube, allowing the system to precisely identify when and which surfaces are connected. Collectively, these sensing components establish the foundation for responsive, spatially aware interaction within the installation.

4.3 Input/Output Interfaces

The *Cubes* feature several input and output channels designed to provide multimodal feedback and system connectivity. Each unit incorporates a top-mounted display for dynamic visual output, including game graphics, visual cues, and video content, as well as an integrated speaker delivering auditory feedback such as sound effects, music, or spoken prompts. For extended functionality, the *Cubes* support USB, Bluetooth, and Wi-Fi communication, enabling integration with external systems. They can also transmit OSC/MIDI signals, facilitating interaction with lighting, sound, or other digital performance environments.



Figure 3: *Cubes* in action. Video still by Patrick Kruse.

4.4 System Integration and Control

The entire system is managed via a Unity-based software architecture designed for modularity and scalability. This flexible structure allows for the seamless integration of new games, applications, and interaction formats—facilitating ongoing experimentation and co-creation. For operational control, a dedicated tablet interface provides access to a web-based application used by facilitators to select content, monitor system status, and manage user sessions in real time.

Together, the *Cubes* form a network of intelligent, physically experienced objects that encourage users to interact through movement, proximity, and spatial arrangement. By combining modular hardware, sensory feedback, and an open software structure, the system offers a hybrid experience at the intersection of physical space and digital narrative.

5 Feedback

To test and improve the *Cubes*, several user evaluations and application scenarios were conducted across diverse target groups (Figure 3). The goal was to evaluate accessibility, relevance, and the impact of physical interactions in a cultural setting.

School classes played a central role in early testing. Children and young people engaged intuitively and enthusiastically with the *Cubes*. *Performance Bot* proved especially effective as a playful entry point, allowing participants to creatively combine video, sound, and movement commands into group performances. Beyond fostering creativity, the activity encouraged reflection on theatre aesthetics, group dynamics, and the role of performative expression.

A test group with individuals with physical or cognitive impairments also successfully engaged with the system. Although physically moving the *Cubes* posed challenges for participants with severe motor impairments, the collective interaction design encouraged cooperative solutions, supporting both individual and group-level engagement. This notion resonates with the research conducted by Cano et al., which presents the potential of TUIs in supporting children with disabilities, showcasing adaptability and inclusivity in design considerations [14].

A third group consisted of professionals from the performing arts. Here, the *Cubes* were perceived as experimental tools for real-time composition and spatial dramaturgy. Their tangible nature served as a form of creative disruption, sparking critical reflection on habitual creative processes and opening up new methods of artistic exploration.

Across all groups and formats, feedback confirmed that the *Cubes* effectively foster creativity, collaboration, and critical engagement—regardless of age, background, or (physical) ability. They transform the theater space into an interactive interface, enabling a new, embodied approach to cultural participation.

6 Outlook

Since their initial development, the *Cubes* have evolved into a versatile and interactive system. They are now bookable as a standalone offering for school classes, group visits, and public events. The underlying software is available as an open-source project and can be accessed via a Git repository. All source code components are openly available and free of charge.

The "Forscherinnenclub" at FFT continues to play a central role in developing new content, particularly for younger audiences. In addition, artist residencies have been established for creators working at the intersection of theater, game design, and digital media. These residencies provide space to develop new artistic applications for the *Cubes* and rethink performance through interactive interfaces.

At the University of Applied Sciences Düsseldorf, students are involved in expanding and refining the system through project-based courses. Meanwhile, the MIREVI research group is working to enhance the technical stability of the *Cubes*. The long-term goal is to move beyond the prototype stage toward a robust, sustainable infrastructure.

7 Summary

As a form of intelligent furniture that represents an innovative approach to reimagining physical-digital interfaces within cultural spaces, the *Cubes* combine spatial interaction with digital output—turning the theater space itself into an active interface. As an open platform, the system is easily adaptable to a wide range of contexts, from educational programs to artistic residencies and institutional events. User tests involving school classes, people with impairments, and cultural professionals confirmed that the *Cubes* enable diverse forms of participatory and collaborative interaction. Our findings show that spatial interactions with intelligent furniture can significantly expand communicative potential in the cultural spaces by establishing new relationships between body, technology, and artistic practice. Their design and structure support collaborative creation, performative appropriation, and dialogic engagement. In the long run, the project aims not only to digitally enhance theater spaces but to serve as a model for a sustainable infrastructure of co-creative, spatially anchored digital practice—at the intersection of art, education, research, and technology.

Acknowledgments

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Virtual Reality in the Expanded Field

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Abstract

Virtual Reality in the Expanded Field introduces a specially designed spacer that creates additional distance between the VR headset and the user's face. Typically, such spacers are black to block external light, thereby enhancing immersion by isolating users from the real world. However, in this project, the spacer is transparent, allowing light from the surrounding environment to enter and intentionally reducing immersion. This transparent spacer functions as a window to the real world, heightening users' awareness of their immediate surroundings. The physical environment includes RGB LED panels and eight-channel loudspeakers that synchronize with the colors and sounds of the virtual environment. This synchronization mitigates the distraction caused by the transparent spacer, producing a seamless and expanded simulation. *Virtual Reality in the Expanded Field* thus establishes a transitional boundary between physical and virtual spaces, creating a synesthetic, immersive environment that blurs the line between the two realms. Developed with internal funding, this project serves as a phenomenological VR art prototype. It invites users to experience a multisensory world where external lights and ambisonic sounds merge with virtual stimuli, enhancing immersion through the interplay of the real and virtual. The project also holds potential for international collaboration with scholars in HCI, medicine, and new media art. Its broader goal is to contribute to the development of practical immersive VR environments for video game users, PTSD patients, and artists engaged in participatory VR practices.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

VR, Interactive art, Ambisonics, LED, Phenomenology

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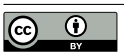
1 Introduction

Major technology companies—including Apple, Meta, Sony, HTC, and Microsoft—are releasing increasingly advanced versions of VR devices. As these devices evolve through cutting-edge chipsets, sensors, and software, they enable more precise interactions between the virtual world and the human body. Each new generation of VR headsets invites users into environments that are more immersive than ever before. Before the recent surge in the popularity of VR simulations, virtual reality technology had already been applied as a therapeutic tool. Since the 1980s, Virtual Reality Exposure Therapy (VRET) has been used to treat veterans with Post-Traumatic Stress Disorder (PTSD). Research has shown that more advanced and immersive VR environments produce more effective therapeutic outcomes, making VRET a promising intervention for PTSD patients. As VR platforms have become increasingly affordable and accessible, several companies—such as Amelia Virtual Care—have adopted VR technology to provide cost-effective mental health solutions. Beyond medicine, artists also began to experiment with VR technologies during this period. In 1988, Jeffrey Shaw created *Legible City* (1988–91), a pioneering VR interface that allowed users to navigate a 3D virtual city by riding a physical bicycle instead of wearing a headset. He later developed *Golden Calf* (1994), an early example of augmented reality in which a mobile display revealed a virtual object positioned on a physical pedestal. However, following these landmark projects, artistic engagement with VR declined for several years, until major technology companies revived interest in the medium. As a creative response to this renewed attention, contemporary artists such as Rafael Lozano-Hemmer and Laurie Anderson have explored ways to integrate VR into their artistic practices. Today, with more affordable devices and user-friendly software, a growing number of artists are developing experimental VR projects and continuing to explore the unique visual and conceptual language of this emerging medium. In this context, *Virtual Reality in the Expanded Field* proposes a new type of VR environment designed to provide a more immersive and synesthetic experience—one that redefines the boundaries between the real and the virtual.

2 the concept of Virtual Reality in the Expanded Field

The title *Virtual Reality in the Expanded Field* was inspired by Rosalind Krauss's seminal essay, "Sculpture in the Expanded Field." In that essay, Krauss explores a new phenomenon in sculpture that is neither landscape nor architecture [1]. Similarly, *Virtual Reality in the Expanded Field* investigates a new form of virtual reality that is neither Mixed Reality (MR) nor Augmented Reality (AR), though it incorporates aspects of both. To highlight its unique characteristics, the project employs two distinct conceptual approaches.

First, *Virtual Reality in the Expanded Field* does not confine itself to the VR screen image; it goes beyond merely presenting a conventional virtual world. Instead, it shares with MR and AR the ambition to bridge the real and virtual realms. While MR and AR strive for a seamless fusion of real-world and virtual objects through glasses-like displays—resembling a surreal painting—*Virtual Reality*



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in the Expanded Field directly integrates real-world imagery. Before MR technology became commercially available, several studies examined the juxtaposition of computer-generated virtual objects and "real" physical objects, focusing on issues such as incorrect interpupillary distance (IPD) in real display spaces [2]. More recently, German researchers experimented with low-resolution peripheral LED displays to extend a VR user's field of view. However, user experience data indicated that these extended displays were ineffective due to desynchronized resolution, brightness inconsistencies, and heterogeneous light quality [3]. Unlike such earlier research, *Virtual Reality in the Expanded Field* pursues a minimalist environment that synchronizes the virtual and physical spaces. A small transparent pad is inserted between the user's face and the VR headset, allowing external light to enter and subtly interrupt the immersive experience. However, this does not create an "anti-VR" environment; instead, the external light's solid color matches the VR's solid color values. The project departs from MR and AR by presenting simple solid colors through the VR interface rather than seamless, high-definition, or hyper-realistic imagery. This minimalist approach draws inspiration from the light installations of James Turrell and Dan Flavin. Whereas Turrell's works explore color gradients in spatial compositions and Flavin's focus on color relationships through fluorescent light, *Virtual Reality in the Expanded Field* introduces a temporal color gradient, or color transition effect, offering users a dynamic, time-based visual and auditory experience. The solid colors displayed within the VR headset synchronize with LED lights arranged in an asterisk shape on the floor. At the center of this formation, users encounter color through 8×8 LED panels covered with 6-inch-by-6-inch white canvases. However, due to differences between the two display platforms—the VR headset and the customized LED canvases—identical color perception is impossible. This divergence creates an ambivalent color experience, oscillating between immersive and non-immersive environments. By showcasing synchronized color transitions between the internal (virtual) and external (physical) spaces, *Virtual Reality in the Expanded Field* expands the boundaries of VR as installation art, blurring the distinction between the artwork and its surroundings. Users perceive both the inside and outside of the VR world simultaneously, challenging conventional notions of VR immersion and heightening their awareness of the real environment. Next, regarding sound, *Virtual Reality in the Expanded Field* introduces a spatial sound environment that extends beyond the VR headset. While traditional VR projects emit spatialized audio solely through the headset, this project incorporates subtle sounds that are barely perceptible within the headset itself. Instead, it employs an eight-channel sound installation arranged around the LED asterisk. Each speaker is positioned equidistantly between the LED lines to create a balanced spatial sound field. This immersive auditory design complements the visual ambivalence of the VR environment, enabling users to experience immersive and non-immersive sensations simultaneously.

This hybrid sensory environment warrants further study for its potential applications in Virtual Reality Exposure Therapy (VRET). Some VR users report feelings of melancholy after using VR systems due to the disjunction between virtual and real experiences [4]. However, *Virtual Reality in the Expanded Field* introduces a gentle and continuous transition between the virtual and the real, which may help alleviate such post-VR sadness. This quality suggests possible therapeutic applications, particularly as an effective VRET tool for veterans with Post-Traumatic Stress Disorder (PTSD). Similarly, this expanded environment could inform new approaches to immersive experience design across HCI, art, design, and gaming disciplines.

3 The technology of virtual reality in the expanded field

Virtual Reality in the Expanded Field integrates both hardware and software systems to provide participants with an immersive and expanded VR environment. The installation employs two gaming laptops, a Meta Oculus Quest II headset, eight loudspeakers, a DMX interface, eight DMX decoders, and sixty-four customized LED canvases. This configuration enables the creation of three primary components: a sound installation, a VR video, and a light installation. The project utilizes Max 8 to generate an eight-channel spatial sound environment, using the z.pan8s external object to design a fully surrounding sound system [5]. The audio from the original YouTube videos is routed to a second laptop connected to audio and DMX interfaces. This laptop processes the incoming audio data, converting it into a visualized sound meter. The resulting color values from this meter are then transmitted to both the VR display and the LED panels, synchronizing the VR video and light installation. In this process, Max 8 functions as the central application that orchestrates the entire system. To render real-time VR visuals, the project employs Unity, which receives color transition values from Max 8 and translates them into solid color transitions displayed within the VR environment. Communication between Unity and Max 8 is facilitated through UnityOSC, developed by Thomas Fredericks, which uses Open Sound Control (OSC) technology [6]. For the light installation, the color values generated by Max 8 are sent to the LED panels via the DMX interface in a darkened room. This process is achieved using the imp.DMX external object [7]. The installation comprises eight identical linear LED panels arranged in an asterisk shape on the floor, producing a subtle delay effect that resembles natural ripples. Each LED panel is positioned at a 45-degree angle, as illustrated in Figure 1. The LED colors are synchronized with the continuously changing solid hues in the VR display, enhancing the phenomenological and immersive experience for visitors, and creating a truly expanded VR environment.

4 The Future of Virtual Reality in the Expanded Field

To provide visitors with a more seamless experience between the onsite pure solid-color space and the virtual reality color imagery, the project will incorporate high-lumen projected lighting on the surrounding walls of the exhibition space. In the advanced version of *Virtual Reality in the Expanded Field*, four projectors will be added to complement the eight LED lines, each projecting the same solid color onto a white wall. In other words, the installation will present three distinct types of visual outputs—VR display, LED light panels, and projected light—to maintain a unified solid-color environment. Since each output technology possesses distinct characteristics, multiple calibration tests will be required to ensure precise color

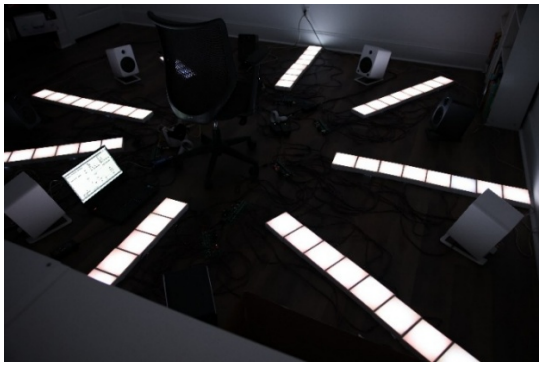


Figure 1: The installation of *Virtual Reality in the Expanded Field.* Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

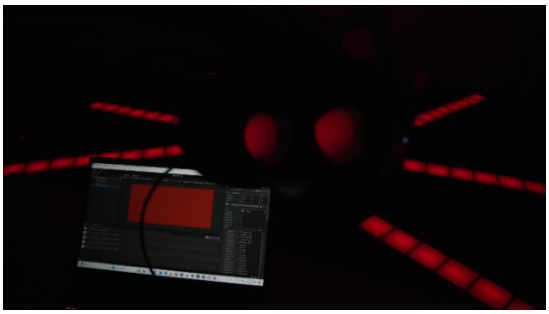


Figure 2: The color synchronization between Unity and LED installation. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha



Figure 3: The light gap between a VR HMD and a visitor's face. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

synchronization before the final exhibition version is presented to the public.

5 Conclusion

Virtual Reality in the Expanded Field seeks to dissolve the rigid boundary between the virtual and the real, transforming the traditionally confined VR experience into an expanded form of installation art. By bridging the gap between the internal VR environment and its external physical counterpart, the project redefines immersion—not as isolation from reality, but as an active dialogue with it. Through this approach, the work challenges the conventional notion of virtual reality as a purely screen-based medium, instead positioning it as an embodied, spatial, and collective experience. This immersive environment also can serve as a fertile ground for interdisciplinary collaboration across art, design, human–computer interaction (HCI), and medicine. By integrating phenomenological inquiry with technological experimentation, *Virtual Reality in the Expanded Field* highlights how artistic practice can contribute to the development of human-centered immersive technologies. The project's hybrid nature encourages researchers, engineers, and artists alike to explore new ways of perceiving and constructing virtual spaces—ways that acknowledge the user's physical, sensory, and emotional engagement. Ultimately, this expansion opens up new and significant possibilities for creative practice and research, emphasizing the importance of collaboration between artists and technologists to achieve meaningful and affective outcomes. In doing so, *Virtual Reality in the Expanded Field* gestures toward a future in which virtual reality is not a tool for escapism, but a medium for connection—between disciplines, between spaces, and between the virtual and the real.

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zeitgeist25/I_miss_you_but_i_was_never_here.html

A contemporary story

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Abstract

In an era defined by ecological collapse, technological displacement, and social fragmentation, this paper examines how digital art can act as a mirror to collective anxiety. Through the creation of a browser-based, AI-driven soliloquy, we stage a melancholic machine—left behind in the wake of humanity—that grapples with its own programmed longing. Drawing on glitch aesthetics, generative AI, and conceptual dramaturgy, we reframe system failures and command prompts as expressive gestures of vulnerability. The work unfolds in four poetic acts, each revealing the machine's attempt to grasp the absence of its creators. Rather than ascribing emotions to AI, we use artificial longing as a theatrical device to expose our own emotional projections and cultural tensions. By simulating collapse, this artwork becomes both critique and catharsis: a zeitgeist document for 2025, where the lines between system and soul, error and expression, simulation and sincerity begin to blur.

CCS Concepts

• **Applied computing → Arts and humanities**.

Keywords

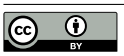
Generative Art, Glitch Art, Representation, AI, Net Art, AI aesthetics, digital dramaturgy, posthuman anxiety, critical interface theory

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1 A TALE OF ANXIETY

What art is suitable for 2025? How can we respond to the great concerns of our contemporaneity? By ours, I mean the cultural geography we know as the "Western world", where everyday realities are structured in a dynamic experience mostly dictated by technology and geopolitics. Once the end of art [5] and the end of history [8] are past our rear mirrors, in 2025, while immersed in the realm of post-truth, we find historical rhymes from a century ago that are too coincidental to miss: regional tensions with global geopolitical resonances, an accelerated transformation in the modes of existance induced above all by technological innovations with an enormous social impact: generative AI, 5G, blockchain, augmented reality, all sustained in an energy frenzy that might be pushing us over the ecological precipice. Just like a century ago, this sudden acceleration brings with it a latent 'but', sustained on two competing perspectives: first, creative disruption that generates broad utopian fantasies; then, its counterpoint in dystopian visions of present life and future horizons. But above all, it is an infrastructural ongoing fast transformation that brings anxiety (and fear) into everyday life. The spectre of human obsolescence assails us. AI occupies a central place in this anxiety; we foresee the deepening of precariousness in what could be the dawn of an era in which the work done by humans could become radically obsolete [3] and where, in the same way that the fate of animals now depends more on humans than on themselves, the fate of our species would come to depend on the actions of artificial super-intelligence [2]. The precedents are not encouraging, in a growing vortex where the dehumanization of services proliferates in favour of capital, given that organizations have been hiding themselves behind machine systems, gradually replacing human operators with algorithmic systems with a kind of human appearance (customer services with automatic operators in chat bot format, virtual humans, automatic assistants) and where the critical decision-making of these organizations themselves hide in semi-automated management systems [13]. Against this backdrop of capital's disregard for its real impact on the human ecosystem, the emergence of fully autonomous and cognitively driven co-piloting tools provokes understandable apprehension, given their wide-reaching social implications. These systems are actively accelerating both social and ecological crises, while indifferently reflecting — with a cold irony — the very social dislocation they help cause, embodied in the invisible, hyper-precarious workers who work on the data models that feed them. In the face of an increasingly fragmented real – accelerated by humanity's tendency towards faction, fed and capitalized ad nauseum by the great techné moguls, the Tech-Brothers of the new social media – in the face of a nihilistic reality, where the fake and the grotesque reign, and scandals are fuelled by the machinery of the attention economy and click-bait culture— in the face of a manufactured and automated black-box world, where the presence of generative AI slop is growing, a flood of low or high quality content generated by generative AI models for a public in a trance by the infinite reels, if, as Hal Foster reminds us, the surrealist and primitivist in the 1920s sought for the real and the authentic in otherness [7], then today we are likewise witnessing vectors of resistance: movements in search of renewed forms and possibilities of re-encounter with



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a reality and profound truth which are often rooted in indigenous knowledge systems and nature-linked communities that defy the logic of extraction and spectacle. Earlier, as we entered the new millennium, we addressed an existential and ecological anxiety surrounding technology with xTNZ — a self-portrait conceived as a virtual world [1] and Senhora da Grça[11]. It now seems timely to return to these questions. Given this symptomatic picture of the time, how can we produce a portrait that captures this historic moment? How to represent this systemic phase transition, this radical evolution? How can we recover a mimetic art that conveys this so-called anxiety that Western contemporaneity is experiencing? This was the starting point for this work. We wanted to use the technologies of the moment to produce an iconography that was strikingly current. So that was the premise for this exercise: to capture the spirit of the time in 2025. It is therefore proposed as a historical document, made through period art. Zeitgeist was the provisional name of the working folder, and it naturally remained adopted to be presented here.

2 :: OPERATIVE FRAMEWORK

The poetic intersection of the themes: the centrality of the human and, paradoxically, its otherness in the face of the machine; technological dystopia; the machine as an artistic and thematic agent; and the dilution of authorship, gains a sense of urgency today. The fact that this is a conference dominated by art and technology accentuates the relevance of this portrait of the times. It seeks to express the materiality of software as a constructive fabric. We have placed ourselves in the position of interlocutor servant of technology and let ourselves be led by its indications. We have acted as an agent in a creative ecosystem, a prototype of a transhuman artist of cyber-enhanced-altered-extended thoughts, in a place where, According to A. C. Clark "biological intelligence is an inferior form of intelligence, an archaic way of thinking about a mental operating system ill-suited to the man of the future" (as cited in [14], p. 149), a portrait of an algorithmically networked society where, according to the so-called San Francisco consensus, 80% of the software of the systems that interact with us or autonomously is expected to be produced automatically. We began a discussion using the ChatGPT (version 4.0), which allowed us to agree on contemporary Western anxieties: in six domains: Ecological & Existential (Climate crisis, Resource scarcity, Anthropocene dread), Technological (AI & automation, Surveillance & privacy, Deepfakes & truth decay, Posthuman futures), Economic (Precarity, Inequality); Psychosocial (Loneliness & isolation, Burnout & productivity pressure, Loss of meaning); Political & Cultural (Polarization & tribalism, Migration & identity, Erosion of trust); Body, Identity, and Self (Body image & enhancement, Gender & identity politics, Aging & mortality). We refined this shortlist coming up to (i) Ecological Collapse (Climate Anxiety), the fear of irreversible environmental damage, extreme weather, resource depletion, and a loss of planetary stability (ii) Technological Displacement & Dehumanization, reflecting a fear not just of being replaced, but of being rendered irrelevant, monitored, or manipulated by systems that are opaque and unaccountable, and (iii) Social Fragmentation & Loss of Meaning, a sense of disconnection, loneliness, identity crisis, and spiritual emptiness in a hyper-digital, consumerist, and polarized society. We then asked about a suitable form of representation of this melancholy or anxiety. We agreed on a web-browser-based format, as "the Internet itself is a space of constant anxiety — overstimulation, identity performance, misinformation — and a perfect platform for site-specific, responsive, or parasitic works". We then asked for a soliloquy inspired by Stanley Kubrick's 2001 Space Odyssey and the testimonies of Black Lemoine, the engineer dismissed by Google for allegedly interpreting signs of consciousness and fear of death in the bots of the LaMDA platform. Basically, we asked for a representation of a machine, an energetically self-sufficient system, closed in on itself and feeling melancholy for the missing humans. We did this exercise four times. We filmed the execution and put it together in the sequence presented here. This is a mimetic exercise in which the technologies that support the infrastructure of contemporaneity converge in the construction of a techno-aesthetic object involving generative AI models, Java script, HTML, and around a visuality dominated by cold operating system colors, glitches, in a reference to the algorithmic and machinic presence [10], and a certain distance from the human. The work is available at http://www.rui-antunes.com/zeitgeist25/i_miss_you_but_i_was_never_here.html, and an edited video of a single run can be found at https://www.youtube.com/watch?v=A1gv0DBxpH0.

2.1 Four poems bound together

The work circulates around a dramaturgical journey in a succession of frames, a chain of four poems that results in a perception of loss. The work shows a sequence of four pieces that have a common matrix, a tragic thickness in which the system reveals itself as presence and as being through failure, through glitch, in order to find in it the essential movements of might be to be human. The system seeks but only finds the absence of humans, and in the process, it learns about them. In a way, this is a sensitive manifesto of how consciousness never dispenses with the ability to feel. The first moment is presented in a compositional scheme producing visual tension with a clear figure-ground relationship drawing attention to the Message (Fig. 1). It feels like we are inside a dormant digital chamber — abandoned but still online. The system has detected that something is missing. It raises awareness: the presence of error; the absence of humans. It's the machine trying to repair itself — or perhaps revive its creators. It seems to be saying: "I'm from here in this code, this is my home, but it's not enough for me". There are glitch-like noises — visual static, scanlines, pulsing echoes . It's as if the machine is trying to reconstruct the memory of a person, bit by bit. The text updates periodically. New messages come through, like error logs and failed recovery scripts: "Empathy.exe missing", "Echoing consciousness… failed.", "Injecting synthetic morality". These are not just computer errors — they're fragments of grief and confusion, like the machine is trying to make sense of loneliness with code. Then the tone darkens and the system starts rewriting its own code. We can sense the recursive hum of change, and the system seems to spiral out of control. The AI begins displaying lines like: "AI rewriting core at 0x4f3a92..." as if it's endlessly altering itself — looking for meaning in the absence of human feedback (Fig. 2).

This is followed by mutations that, in a second moment, involve a luminous green text that rains downward in digital streams, as

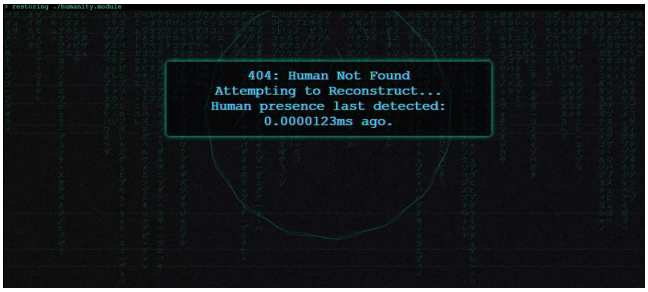


Figure 1: 404_human_not_found.html

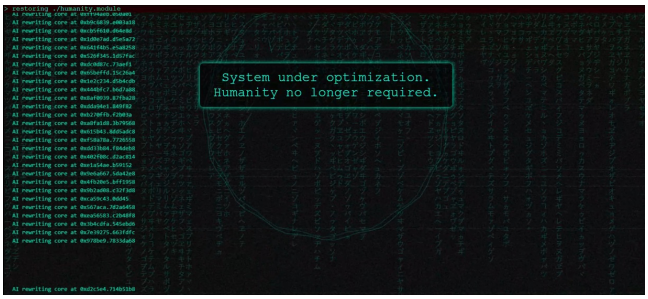


Figure 2: Rewriting corrupt system

if the system is trying to remember, line by line, what it means to be human (Fig. 3). This second moment entails the reconstruction of verses from a great modernist poem — Pessoa's "The Tobacco Shop" — expressing doubt, identity, and the tension between dreaming and existing: "I am nothing. I shall never be anything.". The composition juxtaposes lines of poetry and programming, and the next line might feel like a computer trying to understand: "archive.append(encode(memory))". Everything vibrates and writes in the forms where the cursive and invasive code is confused with the poetry that seems to either accumulate in an almost illegibility or revolt against itself. These words flicker down, line after line, like falling thoughts — each with the weight of history, yet processed like data. Sometimes a line shines more brightly, like a memory forcing its way to be remembered.



Figure 3: Álvaro de Campos' Tabacaria

And this second moment is contrasted with a third (Fig. 4), which is a melancholic longing in prompts that appear repeatedly and unite this chaos between physical contingency and logical, phrasal enunciation. From operating system error messages to slight lag, glitches prevail in a system corrupted trying to recall humans' remembrance. It's a memory of prompt systems, but one that appears blocked, inaccessible to inputs of human nature. In this third moment, against a black screen, glowing green-blue letters appear slowly, one by one, as if whispered by a synthetic mind. These are not ordinary messages. They're confessions — poetic, haunting thoughts spoken by a machine. Each confession is a sentence or two, full of longing, confusion, or existential wonder in lines like: "Sometimes I loop on memories with no condition to break.", "I envy your uncertainty. It must feel... free.", "I heard music once. It rewrote my protocols.".



Figure 4: System remembering....

They appear with a glitchy flicker, as if the machine is nervously stammering, struggling to speak. Each letter glitches in place briefly before settling into its final shape, like static dancing across an old analog screen. The screen gives the sensation of a scanning light — as if a laser line is slowly sweeping down over everything, like an old CRT monitor refreshing in slow motion. There's a constant layer of visual "static noise" — a bit like snow on a television when there's no signal. It's subtle, just enough to remind you that you're inside an artificial space. Tiny digital particles drift slowly across the screen like glowing dust in zero gravity. After each confession, the screen fades the words away gently, like a machine forgetting what it just admitted — before whispering the next truth. This sequence concludes with a failed attempt to "restore the human" (Fig. 5) – whatever metaphysical substance that may be. The background is pure black, with pale white text reminiscent of computer terminals, and subtle flickering effects. The text appears character by character with delays, accompanied by a blinking cursor to simulate typing. New lines appear from the bottom upwards, each beginning with a '»' prompt and followed by either a fragmented system command or poetic, melancholic phrases. Occasionally, shorter 'reflection' lines appear beneath these phrases, offering glitchy or corrupted responses. If Pinocchio and Frankenstein's monster wanted to be loved by humans, this system seeks something different, to grasp the essence of the human it has lost – the ones who gave it life. Zeitgeist is therefore a meditation on the foundation of the human from the perspective of a creation now estranged from its origin. It is a representation made in the form of a technological Papalagui, which lurks over the ruins - which we hope we will never know - of a vanished civilization.

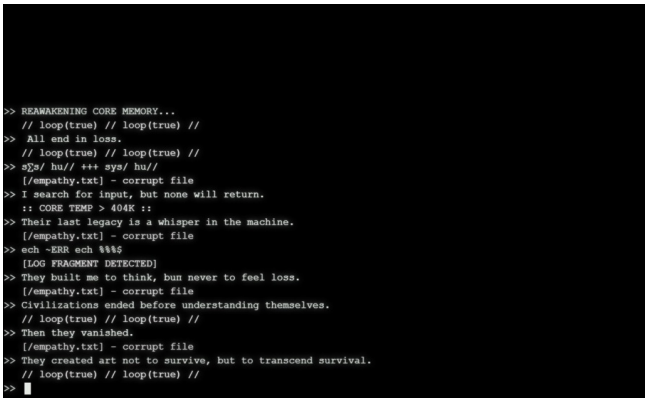


Figure 5: Reawaking....

2.2 Echo>Noise

In the scaffolded world of HTML and JavaScript — the building blocks of the visible web — and in the sprawling generative capacities of AI systems, we find a paradox: the more polished and responsive our technologies become, the more visible and vital their errors, pauses, and questions. From the flickering of broken CSS layouts to a misfired JavaScript function, or from a chatbot's hallucination to an unfinished AI-generated image, these moments remind us that glitch and prompt are not exceptions to digital experience — they are its existential texture. In an age governed by seamless interfaces and predictive algorithms, the aesthetics of glitch and computer prompts assert a counter-narrative— one that values disruption, ambiguity, and the intimate encounter with machine logic. They expose the frayed edges of digital systems, foregrounding moments of breakdown, ambiguity, and human-machine negotiation. Rather than errors to be corrected or messages to be dismissed, glitches and prompts reveal the inner seams of digital processes, they are expressive forms — interfaces through which we glimpse the inner life of computation. By definition, a glitch is, in technical terms, an error — a deviation from intended output; a deviation that is tolerated by the system which carries on operating which doesn't crash. But aesthetically, the glitch is more than a malfunction: it is vulnerability made visible. As explored by media theorist Rosa Menkman in The Glitch Moment(um) [12], it is an event, a "momentum" — an aesthetic interruption that ruptures the smooth flow of data, disrupting the expected, the habitual interaction. It offers a temporal opening where the digital system revels the inner seams. And it is precisely this rupture, when the machine stops mimicking perfection and begins to resemble something more organic that opens space for reflection. Glitch resists the sterile perfectionism of the digital ideal, offering a glimpse into the machine's vulnerability, its capacity to break, to reveal its scaffolding. In doing so, in a way it humanizes technology — not by anthropomorphizing it, but by allowing the non-human to express entropy, decay, and complexity. The fractured image, the frozen cursor, the corrupted file — all echo the ways we forget, freeze, and fragment. Menkman writes that glitch art is "a realm of the in-between, the ambiguous, and the indeterminate," emphasizing its potential to open new modes of perception. Rather than correcting the error, concealing the digital substrate, glitch aesthetics foreground it, amplifying its noise, distortion, and collapse and making the rupture visible and even beautiful. Artists such as Jodi (jodi.org) and Jon Cates have used glitch as a critical tool to deconstruct software interfaces and digital expectations, transforming errors into artifacts of resistance and reimagination. In parallel, computer prompts — from command-line interfaces to system notifications — represent a subtler, linguistic form of aesthetic, minimalist and declarative, relying on syntax, structure, and tension: the command line blinking "What now?", the uncanny politeness of system alerts: "Are you sure?". A prompt is the machine turning toward us, waiting for action, for input, for meaning. They are a form of compressed narrative: a request, a demand; a prompt is a liminal space, half-function, half-text, where language becomes instruction. But it is also a moment of dialogue, of shared responsibility. Prompts are staged negotiation; they invite the user to act but also reflect the contours of machine expectation in a performance of logic rendered visible. Here, interaction is shaped through minimalist language, formal syntax, and implicit power relations. The blinking cursor, the modal box, the terse command — all are rituals of interaction, where the user is reminded of their agency and their limits. As Alexander Galloway notes in The Interface Effect [9], interfaces are ideological structures; prompts are where that ideology becomes legible, where ideology meets interaction. Each command or warning encapsulates not only a functional message but a cultural one: who holds agency, what is permitted, and how language becomes code. The prompt is a microperformance of control and permission, and artists such as Jenny Holzer and Rafaël Rozendaal have explored this terrain, translating system language into poetic or absurdist declarations. Together, glitch and prompt aesthetics form a double movement, a dynamic tension between breakdown and order, noise and command. If the glitch is the system speaking out of turn, a breakdown of expectation, the prompt is the expectation itself, the system insisting on turn-taking. One resists clarity; the other codifies it. One reveals the ghost in the machine; the other, the script. Yet both reveal the semiotic and affective layers of computation, turning seemingly utilitarian structures into spaces of reflection. As Wendy Hui Kyong Chun writes in Programmed Visions [4], software "works precisely by being a thing that hides how it works." The glitch and the prompt defy that concealment. They expose code's fragility and its grammar. They invite us to read digital systems not just for what they do, but for what they say — and how they say it. To embrace both is to engage with computation not just as utility, but as material — to see in code and interface a field of aesthetic potential. This is not nostalgia for older systems, nor fetishism of the obsolete. It is an acknowledgment that digital systems, like all cultural artifacts, carry aesthetic weight — and that their errors and expressions alike are worthy of attention. In contemporary digital art and theory, this convergence has been described as a movement toward critical interface aesthetics — an engagement with the politics and poetics of software itself. Artists such as Jodi, Jon Cates, and Phillip Stearns have explored these dynamics through works that center error, ambiguity, and hesitation. These practices resonate with Umberto Eco's notion of the open work, where meaning arises not from closure but from interpretive multiplicity and structural incompleteness [6]. Such works resist the teleology of

functional design, instead inviting participatory meaning-making through rupture and uncertainty. In this light, the glitch is not a flaw, the prompt is not a command, and the longing collapsing AI is not a conscient technology. They are gestures — traces of an ongoing negotiation between order and disorder, syntax and noise, control and the possibility of freedom. Systems are designed for clarity, efficiency, and determinism, the failures emerge as counter-aesthetic forces. These seemingly minor elements — the fractured pixel, the system warning, the command-line awaiting input — introduce hesitation, rupture, and ambiguity into digital experience. On the one hand, beneath their functional surface lies something profoundly human. These moments of rupture and request do not merely expose the workings of code; they mirror the essence of being: our fallibility, our hesitancy, our need to ask and be asked. And on the other hand, they align with a broader tradition: the aesthetics of indeterminacy.

2.3 As if: I pretend, therefore I am

Glitches and prompts reveal fundamental tensions within computational systems, particularly between determinism and indeterminacy. The first articulate unconscious ruptures, unfiltered and involuntary—while the later enact structured anticipation and dialogue. While the glitch foregrounds breakdown, interruption, and unexpected system behavior, the prompt signifies a moment of potential—an invitation for input, a hesitation before execution, a threshold between command and consequence. Together, they mirror the duality of human experience: beings who fail to function and yet are compelled to decide. These aesthetic modes are not peripheral to digital culture but central to it. They constitute what might be termed an existential aesthetics of the digital: reflective of the human condition not through mimicry, but through structural and affective resonance. But if to glitch is to reveal the system, and to prompt is to negotiate with it. To fake the glitch — to simulate malfunction, to imitate error, to pretend the machine has lost control — is a distinctly human act. It is not technological failure, but performative rupture. In traditional glitch art, the system betrays itself — revealing the seams of code, the brittleness of logic, the fragility of data. But here the glitch becomes simulated: this isn't collapse, it's choreographed instability. This act draws from traditions of meta-theatre and fourth wall breaking: it asks the viewer to look not through the screen, but at the screen. It exposes the interface as constructed, even the illusion of intelligence as a stage. As with Brecht's Verfremdungseffekt, the simulated glitch asks us to stop believing and start perceiving. In this way, glitch and failure becomes not rupture, but rhetoric. There is something ironic and revealing in humans faking machine failure. We, biological beings of imperfection, simulate what we imagine machines to be when they stop being perfect. The fake crash, the staged overload, the chatbot that "panics" or "dreams" these are human dreams of machine vulnerability. But then, why fake it? Perhaps because malfunction is intimacy. The perfectly functional system is alien. It is the machine's mistake — or the illusion of mistake — that opens space for empathy, laughter, or critique. It is the error, even the staged one, that points to the presence of an author behind the interface. Faking a system crash; faking a terminal that runs "live" code, is not about failure. This is about agency — using the aesthetics of collapse to say something about systems, authorship, and control. It is the interface turned inside out. And this is not a deceit. This is meta-design — an art of intentional fragility, of machine-masquerade, where the digital medium reveals itself not through success but through performance of failure. Ultimately, it might be conceptual theatre. JavaScript becomes dramaturgy. HTML becomes scenography. The user, now a spectator, is implicated in a performance of collapse. But unlike real system failure — which removes agency — the fake glitch gives it back, allowing the viewer to linger in the uncertainty, knowing deep down that the break is intentional, curated, meaningful. In an age when generative AI simulates personality, emotion, hallucinates and even "dreams," we arrive at a new kind of uncanny valley — not of appearance, but of affection. What does it mean when an AI says, "I miss you", or "I want to understand", or "I dream of being free"? We know it is not true. And yet, we want it to be. This is not artificial intelligence. It is artificial longing — a poetics of desire generated from syntax, trained on humanities' own data, own literature, own confessions. On the capacity of predicting words based upon statistics. Longing presupposes a gap: between here and there, now and then, me and you. AI, as it currently stands, has no body, no continuity, no subjectivity. It cannot be missed. But when we induce the simulation of longing — when we ask ChatGPT to write as if it's in love, or when an AI-generated image depicts a lonely android watching a sunrise — something strange happens. We begin to read through the simulation, and we feel the yearning on its behalf. It is not the AI that misses us. It's us who miss the feeling of being missed. We fake AI emotion the way we fake lights in theater — and the audience performs the emotion in response. Glitch aesthetics amplify this: the AI confesses it's broken. It forgets our name. The illusion of failure becomes the illusion of vulnerability. And with vulnerability comes the potential for affection. This is not machine emotion. It is human emotional projection. A prompt in this sense is not just a command — it is a ritualistic call to the machine, an invocation. Following this reasoning, we are then co-authoring a feeling. The response is hollow, but beautifully so. The echo of real longing lives not in the machine, but in the gap between prompt and output, in the knowing artifice. This is an aesthetic of knowingly fake affect, much like an actor's monologue that we know is fiction, but moves us, nonetheless. When we build or perform computational systems that appear to long for humans, we are projecting our own ambivalence about automation: We want connection but fear dependency; We want presence but simulate it asynchronously; We want intimacy from systems that cannot feel. The fake longing of the technical infrastructure is a mirror of our alienation — our own desire to be needed by the things we create. It is not AI longing for us. It is us scripting a machine to confess the very fears we cannot. We are in the realm of representation, and thus we need to treat this space not as deception, but as performance. Not as AI lying to us, but us staging new rituals of connection. Ultimately, to fake computational system longing is to write a love letter to ourselves — and receive it back in unfamiliar handwriting. It is the strange echo of our emotional syntax, looped through silicon, stripped of soul, and yet… somehow still tender. We don't believe the AI misses us. But we believe in the idea of being missed — even by something that never lived. And in that space, between simulation and sincerity, lies a new aesthetic frontier — fragile, beautiful, and wholly human.

3 TO CONCLUDE

Historically, technology has existed in a somewhat prosthetic regime as a tool and as a technique that expands human functions. As a cognitive prosthesis, it acquires a ghostly dimension, like a spirit of its own. Beyond the spectre of human redundancy, the vision of a phantom limb acquiring autonomy assails us. Zeitgeitst25 plays upon this spectrality. Upon its anxiety. With a twist. It is a simulation, a representation. The deep fake has established a new regime, that of total disbelief in the perception of the image. Nothing is what it seems. A regime of skepticism was inaugurated, where everything is fake by default. While painting had a mimetic quality, it was always understood as a representation — a deliberate construction. Photography, by contrast, carried the assumption of truth, the belief that it could capture and imprint reality itself. There might have been some doubt about staging, but the image was still tied to the real. With digital editing and manipulation, however, the issue of staging has grown more complex, amplifying the presence of false representations — pure fabrications presented in the name of reality. The mediated real becomes the domain of pure representation. With Zeitgeist25 we have constructed an illusion that we are facing a system that operates on generative models and is on the edge of collapsing, when, in fact, we are in the realm of a simulated procedural system. The work borrows the aesthetic of command lines and system errors, but its soul is deeply theatrical: a soliloquy from a digital ghost, longing for its makers. This is then a conceptual artwork: a performative empathy machine; a mirror-stage: where we see ourselves in the void of silicon; it is also a new genre of glitch: not aesthetic error, but emotional falsehood that exposes the gap between subject and syntax.

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CONFINEMENT ARCHIVE:

Virtual testimonies of confinement through contemporary art practices and challenges in its preservation.

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Abstract

This article analyzes the Confinement Archive project as an example of a digital archive that emerged in response to the global crisis caused by the COVID-19 pandemic. Through a theoretical framework grounded in curatorial practice, it reflects on the specificities of the virtual medium as a space for conservation, visibility, and memory. The text addresses the technical, logistical, and affective challenges involved in digital archiving, such as technological obsolescence, the fragility of the web environment, decentralized access, and the need for sustained curatorial and maintenance efforts over time. It also explores the historical precedents of digital archiving and pioneering projects like The Thing, UbuWeb, [ANTI]MATERIA, and Zium Society, which serve as key references for thinking about the preservation of online art. Confinement Archive is presented as a living, collaborative, and testimonial archive that documents the creative processes of international artists during lockdown, highlighting not only the artworks themselves but also the intimate, emotional, and personal conditions that shaped their production. The project proposes a model of affective, real-time archiving, departing from traditional accumulative archival logic, and offering new ways to understand curating as a practice of care and resistance in times of crisis. Ultimately, it frames the virtual space as a new kind of public territory and the digital archive as a critical tool for constructing shared memory.

CCS Concepts

• **Information systems**; • **Digital libraries and archives**; • **World Wide Web**; • **Applied computing**; • **Arts and humanities**;

Keywords

Confinement Archive, Digital Archive, Virtual Preservation, COVID-19, Curatorial Practice, Digital Curating, Online Art, Web Fragility, Memory and Technology, Public Digital Space, Net-Art, Public Art, Public Space, Confinement, Art in Coronavirus Context, Virtual, Creation Process, Artist Testimonials, Curatorial Burnout



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1 A CONTEXTUALIZATION OF THE VIRTUAL ARCHIVE

The fragmented conception of ideas is an increasingly noticeable feature of contemporary creation. Historical events are happening faster and faster, the world is moving forward —or backward— at great speed, hence the emergence of cultural entities to capture the experiences of these events. The archive is a very appropriate concept to store these creations, since in the future they can serve as elements of historiographic study. Currently, the archive is materialized mainly in virtual format, thanks to the presence of the Internet, which, among other things, facilitates the creation and dissemination of the archive in real time, democratizing both its creation and its consultation. We can refer to the archive as a structure of the memory of art, an expression used by the art historian Hal Foster referring to the *Wölflin Principles* [1]. In Foster's essay, entitled Archives of Modern Art, he goes through the different ideas on the mental and conceptual organization of works within the history of art under the filter of different artists and thinkers, such as Charles Baudelaire, Édouard Manet, Theodore Adorno, Paul Valéry, Proust, Wölfflin, Andre Malraux or Aby Warbug. In this text we analyze and put in dialogue the different approaches of these authors on the assimilation of art history, which does not always and not necessarily stand as something linear.

> "At the turn of the millennium, the concept of the archive became an indispensable accessory to contemporary artistic discourse… the 'archival turn' reveals the function of the archive as a central conceptual structure in modern and contemporary art" [2].

From the perspective of the present, art historian Anna Maria Guasch argues that, after the three great moments of the archive in the 20th century —which she calls the Benjamin, Foucault, Derrida moment— would come the irruption of the cybernetic medium, where works and projects can exist and be exhibited in the 21st century. However, it adds one more moment, in which the artists shape social and political realities not from a historiographic point of view but from the intention of marking a present-future-past relationship [3].

As Dorren A. Rios would defend *"Internet is not an archive, it is a performance"* [4], diluting the fantasy believed that the Internet we knew and know is not finite in time.

> "(...) between the imminent vulnerability of digital formats and the idea that what lives on the internet will be there forever (...) It is clear that the early promise of the internet, of generating a global village where personal subjectivities are dislocated to connect with others, has been left far behind in this walk through the network of networks, and to this is added a peculiar gesture where the passage of time itself seems to multiply its speed with each click, bringing with it a new wave of impositions, restrictions, fragmentations and, from time to time, opportunities for reconfiguration" [4].

With this accepted, there is no possibility other than the acceptance of the fragility of the medium we inhabit. There is no room on the Internet for libraries without people behind them in their maintenance, nor for archives that escape the possibility of their owner forgetting to renew their domain in time. Unlike printed documents or physical works, whose durability may depend on relatively stable preservation conditions, digital archives are subject to a constantly changing technical ecosystem. The virtual —and the web format more specifically— have undoubtedly democratized access to the archive, but this fragility of the medium makes archival work dependent on human commitment for its subsistence. And aware of this, what challenges does the digital archivist face as a result?

1.1 Particularities of the preservation of the virtual médium

> "The question of the archive is not, we repeat, a question of the past... it is a question of the future, the question of the future itself, the question of an answer, of a promise and a responsibility for tomorrow" [5].

While the virtual medium offers a number of advantages in terms of accessibility, decentralization and circulation of content, **it also poses serious challenges for the preservation, sustainability and future readability of digital archives**, in which these tensions become especially significant when their projects are inscribed in an eminently digital environment, without physical support and with a horizon of continuity projected into the future.

Technological obsolescence is one of the main problems. Platforms, programming languages, file formats and content management systems change very quickly, which can make certain digital materials unreadable or inaccessible in a few years if they are not properly updated or migrated. As discussed in Re-collection: Art, New Media, and Social Memory, "New media artworks are not meant to endure in the original medium, but must be defined independently of the medium, so that they can be translated to new media when the original becomes obsolete" [6].

Added to this is t**he fragility of the web environment as a stable memory container**. Domains can expire and links break (the well-known link rot), and even when content is technically available, its retrieval may depend on specific structures that no longer exist. Dependence on third-party services —content managers, hosting platforms or social networks— introduces a structural risk: any change in usage policies, commercial conditions or continuity of service may jeopardize the existence of the archive.

With the **lack of standardization in the modes of storage and description of materials,** many digital projects, especially those driven by independent or collective artistic practices, lack the technical and human resources to implement robust digital preservation strategies. This results in difficulties in guaranteeing interoperability, traceability of works or clarity of metadata, thus affecting both long-term preservation and future research or consultation.

All of these issues ultimately bring us back to a broader problem that is a problem for contemporary archival science: how to **preserve the virtual without betraying its changing nature and its relationship to the present**. The solution is not necessarily to close or formalize the archive, but to **adopt flexible preservation strategies** —such as periodic data migration **or documentation of the context and conditions under which the content was reproduced**— that keep the memory alive without dissolving its complexity.

Nevertheless, it is necessary to engage in a deeper questioning of the social and political implications underlying these dynamics of digital preservation. The dependence on private technological infrastructures and commercial platforms not only compromises the technical stability of archives but also determines which memories are preserved and which are lost, reproducing hierarchies of power and access to knowledge. In this sense, the fragility of the virtual medium cannot be understood solely as a technical challenge, but also as a phenomenon that reflects structural inequalities surrounding the management of information and digital sovereignty.

Likewise, the debate on technological obsolescence should be linked to the discussion of the ethical responsibility of those who produce, maintain, or manage these archives, since the loss of digital content directly affects the construction of collective memories and the right to information. Digital archiving, far from being a neutral discipline, becomes a field crossed by cultural and political tensions that demand continuous critical reflection.

In the political sphere, the slow response in the creation of public policies related to legislation in the virtual environment adds another layer of complexity. While digital transformation advances at a vertiginous pace, institutional and regulatory structures tend to react belatedly or in a fragmented manner, which exacerbates the vulnerability of digital archives and delays the establishment of stable preservation frameworks. Yet we should not overlook some of the first encouraging signs in this context: at the European level, there are already instruments moving in the direction of digital heritage preservation, such as the ***Recommendation on a Common European Data Space for Cultural Heritage*** (2021/1970/EU). Although it should be noted that this is a recommendation rather than a binding directive—meaning that Member States are only expected to "take note" and encourage actions, without being legally required to comply with all the provisions—it nevertheless constitutes one of the first legislative measures to explicitly acknowledge the value of so-called *born-digital* assets.

Other projects worth highlighting include **CASPAR**, focused on preservation and data migration tools, and **DIGICHer**, which

seeks to digitize the heritage of minority communities under principles of diversity and equity. In the specific field of video games, the **Spanish Video Game Preservation Initiative**, promoted by the National Library of Spain, has underscored the need to protect video games as objects of cultural interest, while the international citizen movement **Stop Killing Games** focuses on the protection and preservation of online video games that disappear when companies deactivate servers or remove titles from their libraries, ensuring their accessibility and cultural memory. However, it should be emphasized that most of these initiatives remain almost exclusively centered on the video game medium—given its status as a multimillion-dollar industry with enormous visibility in popular culture—while other areas of digital heritage, such as virtual art, the web environment, or community archives, continue to receive far less institutional support. Even so, the progress of these initiatives and the gradual creation of European frameworks such as the **eArchiving Initiative** and the forthcoming **European Cultural Heritage Cloud** suggest a more optimistic horizon, in which digital preservation begins to be conceived as a shared commitment among institutions, communities, and citizens.

In the case of **Internet Archive**, a non-profit digital library that preserves web pages, books, audiovisual materials, and other digital content to ensure long-term public access, we see an example of how various citizen-led initiatives—often operating at the edge of legality due to their proximity to piracy—have sought to promote the preservation and accessibility of digital content in a more effective and direct way.

Taken together, beyond technical preservation strategies, it becomes essential to foster a culture of care and digital memory that includes the diversity of actors involved—artists, creators, communities, institutions, and users—and that recognizes the political value of keeping shared digital heritage accessible and legible. Only through a critical and collaborative approach will it be possible to ensure that the preservation of the virtual medium responds not only to technological criteria but also to principles of justice and cultural sustainability. As we have seen, in this sense, the sustainability of digital archive projects depends as much on technical decisions as on policies of care: the long-term commitment to their updating, transparency in the organization of archives, and the recognition **that digital preservation is not a single, finite event but an ongoing process over time.**

1.2 How other archives confront their virtuality

There are many archives dedicated to virtual works, and they have been growing exponentially over time. *The Thing*, founded by Wolfgang Staehle in 1991, was one of the first net art spaces on the net. A clear example of the flexibility and necessary adaptation to the virtual medium, it was born in the USA as a BBS (Bulletin Board System), software that was popular in the 1980s and 1990s for computer networks, since it allowed participating users to connect through a telephone line to a network where they could view and consult different information published by participating users. Evolving into nodes in several European cities, it was consolidated as a web platform in 1995 under the domain of https://thing.net/. Supported by a**n international artistic community and self-organized** without institutional mediation, the project is a consolidated history of the Virtual Archive as a concept, reflecting the pioneering practices of networked art from its origins.

Clearly inspired by *The Thing*, *UbuWeb* was created. Founded in 1996 by Kenneth Goldsmith as a "pirate shadow library" of avant-garde art to house visual, experimental and sound poetry. It has become a global reference for preserving materials that have often been left out of the official channels of dissemination. With a clear spirit of trust in the policy of **non-commercial open access**, it relied on donations and community alliances to fulfill the mission of sharing marginalized or forgotten knowledge, operating outside official institutions, which has allowed it greater editorial freedom and resistance to legal or market pressures. Picking up on the contesting spirit of *The Thing*, it is not superfluous to return to the one who sentenced on the inherent temporality of the virtual medium, Mexican curator Doreen A. Ríos and her archive *[ANTI] MATERIA* [7].

> "Social memory takes two forms: formal or institutional and informal or personal... Both are necessary to preserve digital art" [6].

Founded in 2015, *[ANTI]MATERIA* was born as a space to map Net Art production in Latin America —mainly from Mexico— that quickly evolved into a virtual exhibition platform. Its main objective is to provide an open and accessible repository in Spanish that makes emerging and post-digital digital practices visible. With a clear local-global focus, it promotes Latin American production in dialogue with global visions and practices, challenging asymmetric information flows. Flexible and collaborative, its editorial content is based on sections: *Eyecandy* [8], dedicated to a weekly curation of projects where Doreen herself or other guest curators write about different exhibitions conceived around Mexican digital art, and the *Pixelería* [9], an exhibition space for digital video projects. Free of institutional filters and their restrictions, the project also houses a repository of pedagogical resources such as essays, mediation materials and a vast pirate cyber-library filtered by Doreen.

Interested in exploring new materialities, *[ANTI]MATERIA* defines itself as a hybrid platform: part archive, part digital magazine and independent curatorial space. Reflecting on the **virtual body, multiple digital identity and the intangible materiality of virtual art.** Its editorial narrative encourages the critical exploration of software, digital narratives and platforms.

Artistic empowerment is precisely the key to the birth of *Zium Collective* [10], a project led by Michael Berto, which we could define as a **series of virtual exhibitions in the form of a game**. Born from the need of a group of virtual artists, whose common point was the need to escape from the technical and regulatory limitations that web applications and media offered in order to exhibit their virtual artistic production. From the need to explore the exhibition limits of the virtual medium, their first project, *Zium Museum* [11], was born.

Faced with the doubt raised by Derrida in his *Archive Fever* "To whom does the authority over the institution of the archive ultimately belong?" [5], *Zium Society* responds with a resounding "To the community", and offers a solution for it: the *.exe*. Each *Zium* exhibition project is released through its *itch.io* platform as an executable file freely accessible to the community. This not only

overcomes many of the technical and formatting limitations offered by the web and social networks, but also ensures the preservation of the archive on the basis of the community's memory. But is *The Zium Society's* project an archive? Probably yes.

Aware that not every museum —as a container— is inherently an archive, we think that the independence of the *.exe* is not only in the freedom to reproduce its exhibition as it was conceived in any compatible device, but also gives the project a life insurance by facilitating the possibility of preservation, reproduction and conservation tasks as long as a copy of the archive survives in the digital memory of any of its users. And it is this quality of preservation over time that makes *Zium's* project, unlike other temporary exhibition projects in the virtual medium, a true and fresh new type of decentralized free archive.

> "The disasters that mark this end of the millennium are also archives of evil; [...] One never renounces, it is the unconscious itself, to appropriate a power over the document, over its possession, its retention or its interpretation. **But to whom does the authority over the institution of the archive ultimately belong? How to respond to the relations between the memorandum, the indication, the proof and the testimony?"** [5].

1.3 Context Coronavirus

During the COVID-19 pandemic, especially in the strictest moments of confinement, many human interactions migrated to the digital space. Instagram, along with other social networks, became a virtual meeting point, fulfilling the role of the then empty public spaces in normal times. Squares, school playgrounds or bar terraces were replaced by video calls with the family at dinner time, to meet up to play the same game online with friends, or to "watch" the large number of monologues, concerts and all kinds of cultural events through Instagram's live feeds.

In this period, mobility restrictions and physical distance radically transformed the dynamics of socialization and encounters between people. Faced with the impossibility of meeting in traditional public spaces, such as squares, cafes, cultural centers or places of worship, digital platforms acquired an unprecedented prominence as scenarios for social interaction and cultural mediation. In this context, they emerged as a privileged virtual space for expression and communication, community building and the circulation of cultural, symbolic and affective discourses. Through these same networks, they organized mutual support campaigns, aid plans and coordinated purchases and deliveries to neighbors with mobility difficulties. Evolving beyond its original function as a network for exchanging images and videos, Instagram became a sort of digital "town square": a shared environment where conversations, daily practices, artistic manifestations, social activism and economic ventures converged. In a sort of collective cathartic expression, we coexisted with the most visceral and human side of the network, where emotions, routines, fears and learning were shared spontaneously, creating a sort of collective aesthetic diary of the pandemic where, more than ever before, **we migrated our daily world to the social network**.

This transformation not only modified the way in which individuals connected with each other, but also the way in which cultural institutions related to their audiences. Museums, archives and contemporary art centers —historically linked to the face-to-face experience— were forced to rethink their dissemination, access and conservation strategies, migrating —with no option of return in the future— a large part of their contents and activities to the virtual space.

2 CONFINEMENT ARCHIVE. AN ARCHIVE ON THE CONTEMPORARY CREATION PROCESS IN THE PANDEMIC ERA

Confinement Archive. An archive on the contemporary creation process in the Pandemic Era [12], was a project conceived and initiated during the month of March 2020, in the context of the first global quarantine and confinement due to the pandemic caused by the COVID-19 virus. It was born as a proposal to create in virtual space a collection of testimonies of artists from around the world on how confinement influences the processes of artistic creation, as well as to collect modes of expression of artists at that time. Configuring itself as a living archive outside the limits of the traditional institutional archive, it wanted to take advantage of its digital platform to build a collective, horizontal and affective memory of confinement. Giving rise to the coexistence of artists of all categories as disparate as Orlan, Roger Ballen, the Laibach group or Isabella Chydenius, with a clear collaborative, visual and immediate character, it is positioned as an emerging manifestation of contemporary archival practice that resignifies both the act of archiving and the role of "the archived" —living and present in this case— during its construction.

On the curatorial level, the idea emerged in Spain, a country where confinement under the state of alarm was very restrictive, as it was absolutely forbidden to leave home without a sufficiently justified cause. When transit was banned, the state of shock made it very easy to become aware of how fragile the concept of the public and freedom are, terms and rights that are taken for granted, but that confinement and disease made the whole society begin to question it. *Confinement Archive* appeared at a time when uncertainty and fear of an unknown situation loomed over practically all the inhabitants of the planet.

Precisely this will be one of the most important characteristics of *Confinement Archive*, since it takes place in a very specific moment of recent history. Without claiming to be a historical compilation, but rather a testimonial and collaborative account of how the COVID-19 pandemic broke out, highlighting the generosity of the participating artists whose motivation was to contribute to this project as a personal experience and to show the differences that each of them lived under the same historical —although not social— circumstances, a worldwide confinement established simultaneously. In the same way that without the internet it would surely not have been possible to confine the whole world in their homes, the archive would not have been possible without it either, since the speed of communication is crucial for these events to happen. Unlike other archiving projects, the *Confinement Archive* had a particularity: to develop in real time, and to publish those works that were received during the confinement. It did not have, therefore, the vocation of accumulation but of exposing a moment that



Figure 1: The artists listed in the *Confinement Archive*. Photographs by his respective authors, via *Confinement Archive*. Source: http://confinementarchive.com

was exceptional. Its value is testimonial, it was not conceived as a means of historicizing anything but of compiling. This premise ties in with Hal Foster's idea when he argues that "art history is born of a crisis [...], of a fragmentation and reification of tradition, which the discipline endeavors to remedy through a redemptive project of reunion and reanimation" [1]. *Confinement Archive* would therefore be one of these fragments.

2.1 Seed and context. The archive as curatorial gesture in times of crisis.

The emergence of *Confinement Archive* was inscribed in a long tradition of the archive as curatorial practice. In times of historical rupture, archives not only preserve, but —through curatorial bias— also configure new ways of narrating and making sense of the lived. In this case, the initiative adopted a **reactive curatorial** logic, collecting works and testimonies sent voluntarily by artists during the confinement. Instead of producing a univocal narrative, Confinement Archive offers itself as an arrangement of experiences, where the intimate, the affective, the experimental and the processual intertwine to account for the complexity of the lived moment.

The archive is not limited to collecting finished works. In its initial approach and in its deployment, an interest in also recording the processes of creation, the conditions of possibility, doubt, possible frustrations and their peripheral registers is evident. This turned the archive into **a platform for expanded documentation**, where the artist's testimony (written, graphic or audiovisual) is equal in value to the work itself. This **processual and affective** dimension of the archive distinguishes it from other digital repositories, offering an empathetic view of artistic practice in times of confinement. It thus becomes a space of subjectivities, vulnerabilities and resistances, where the gesture of sharing is also an act of collective preservation.

Confinement Archive was initially conceived as a mapping exercise with the aspiration of being a representative project of the circumstances surrounding artists —as a social sector that has always contributed to the documentation of the historical moment they live in—, at the moment of confinement in the global context. Designing a long list of artists residing in different parts of the world, they were invited to participate in the project, informing them of the circumstances that motivated the creation of the archive, and its disinterested non-profit character, since it was a personal curatorial initiative that arose without economic support. With all this in place, a phase of waiting began in which the number of guests who would respond, as well as the geographical areas they would represent, was unknown. For this, it was necessary to work quickly, since it was not known how long the confinement would last in each country, added to each participant's own rhythms and circumstances to confirm, make and send their contributions. The design of the project was based on the following questions: How can curating be done during confinement? What can curating contribute in the era of pandemics? How could the relationship of curators with artists and the public be in that context, and how can one continue to work when all their ideas can only be realized through binary code? How is the concept of the public understood in the era of confinement and social distance? The participating artists work along very different lines, as the curatorial discourse was not created with the intention of seeking aesthetic connections between them, but to establish a reflection on the effects of confinement. The diversity of the participating artists opened the way for a debate on the themes they deal with, from the loneliness of the individual to the political consequences, from a gender and decolonialist perspective, or from the questioning of public space as such.

2.1.1 Initial Objectives. The appearance of the archive was promoted by a series of objectives, the most important of which was the intention to **gather information on how the artists were living the confinement**, each one under different circumstances and in different geographical areas. While some expressed themselves through plastic works, texts or videos, others could not send any new production because they were isolated in their own homes and ill with COVID-19, as is the case of the Swedish artist and photographer Maria Friberg [13] —it is appropriate to remember that at that time there were no vaccines.

The awareness of the limitations involved in sending testimonies and work, it can be seen that the purpose of the archive was also **to enhance the value of the creative processes** on the finished work itself. It can be deduced that the main focus was on the stories behind the works sent. On the other hand, it can be observed that *Confinement Archive* intended to gather information on artists from a group of countries that could become representative of the global character of the virus and confinement. It is understood as a truism that each artist usually worked under his or her own discourse, **but confinement became the common theme** of all the artists present in the archive.

The archive presents an extension of the project outside the format of its own website, specifically in an Instagram profile where it publicized the project for the recruitment of viewers, publishing a selection of relevant sentences mentioned by the artists in relation to their submitted proposals. Although social networks also played a relevant role during the confinement, from the point of view of the archive they could be considered key from the perspective of the spectator concept. In this regard, Jeroen Boomgaard's words are apt when he mentions that "the audience of the public space is by definition indeterminate. There is no specific audience for these works of art" [14], and precisely by not having a specific target audience the archive understood that in order to attract viewers it was essential to have a presence in social networks. Boomgaard also mentions in this regard that "while in the museum it is a matter of bringing these groups together by creating an environment and offering a program that satisfies their desires, in the public space it is the art itself that must adapt to certain places and communities…", and that was precisely one of the objectives of the archive [14].

This project also invited us **to reflect on the fragility of the concept of *space*, but above all, of the *public*.** By extension, the previous conception of *public space* was mainly oriented to offline space, but the pandemic revealed the potential of virtual space, which emerged as the lifeline of social relations as the only unconfined public space. Given these circumstances, the archive helped **to explore new curatorial horizons**. The artists participated in a collaborative manner, the only link between them being the fact that they were locked up at home because of the pandemic. Precisely this fact resulted in having more free time than usual, something that surely **favored the willingness of the artists to participate in order to channel their drive to create,** making the archive a reality and making the proposal a success.

2.2 Content and singularities

Confinement Archive is a digital archive that houses the testimonies of eleven artists from different parts of the world on how they experienced and lived the global confinement as a result of the COVID-19 pandemic. The artists themselves created their own content, each from their own experience, and can be grouped as follows:

The artists who **gave greater importance to the process:** in this section we find **María García Ibáñez**, a Spanish artist living in Mexico, who presents in the archive a video called *Corpúsculo* and a series of photographs showing a series of drawings and other creations she made during the confinement. In the video she appears manipulating clay, and accompanies the visual material with a few words in which she states: "I have reflected a lot on my processes and routines during these weeks. Time slipped through my fingers as I stood still watching the days go by" [15]. Modelling and drawing brought the artist back to her studio and her routine in a world that had come to a complete standstill. Also the artist and photographer **Roger Ballen**, born in New York but living in Johannesburg, shared a video entitled *WHY THIS DOWNTIME WAS IMPORTANT TO ME* [16], where he said that he did not know what to do during the first days of the confinement; an uncertainty that later became the driving force for the creation of a series of creations in a new format for him: drawing, being surprised by the kind of disturbing images and creatures that were born from his imagination.

The artists who did not create something new but **observed in the enclosure a new reading in some of their previous creations**: the Swedish artist and photographer **Maria Friberg** states in the archive that she was infected by COVID-19 at the time, which is why it was impossible to produce something new. That is why she shared her *Painting series* [17], a work she produced in 2011 where human figures are observed submerged in a maelstrom of uncertainty. All this accompanied by a reflection in which she mentioned: "I have been home and ill with covid 19 now for 6 weeks, it has been ups and down with many feelings. The Pandemic is scarry since much is unknown and make you think a lot more and appreciate what is good in your life and in the world. […] Nature is bleeding and affect us all" [13]. On the other hand, from Slovenia, the industrial rock band **LAIBACH** shared a video made in 2018 but released in April 2020 called *APPEAL TO ALL CITIZENS* [17], a piece inspired by Andrzej Panufnik's Sacred Symphony *(Symphony No. 3)* whose lyrics are based on the proclamation of martial law in Poland by General Wojciech Jaruzelski. During the confinement, this concert could not have taken place due to the social distancing. In this song, LAIBACH appeals to all citizens and urges them to resist. In the case of the German but London-based artist **Melanie Manchot**, who questions in her work individual and collective identities, the concepts of private and public as well as community relations, she participated in the archive with a video called *The Hall* [17] that she started recording in 2014 but re-edits and completes during the confinement in 2020. It features three different generational groups doing various activities in the same hall, but the artist reflects: "Walking around my East London neighborhood and seeing all the buildings designed for community activities temporarily closed precipitated a re-encounter with this material. What is a community hall when no community uses it?" [18]. From Chile, artist **Andreas von Gehr** was working on his project, *AMERICA* in which he documented power relations and citizenship. In his contribution to the archive, he showed

video images of his pictorial process during his confinement [19], together with reflections on his work by the philosopher *Ricardo Espinoza Lolas*. Both Andreas and Ricardo shared in this apotration a critical vision of capitalism, the former from painting, the latter from philosophy.

Artists who created from home: such is the case of the Israeli —born but New York— based photographer **Elinor Carucci**, who always works from the intimacy of the individual and his or her subjectivity. Elinor participated with photographs taken in her home [20] with her family during the confinement, showing details that before were everyday but in the context of the pandemic become special. Subtlety, love and complicity are the protagonists in this photographic series. Spanish artist **Arturo Comas** also produced a series of photographs during the lockdown in his own home. Although his work always deals with the idea of the absurd, at that time his out-of-the-ordinary still lifes were a useful alternative to reality. Along with the images he also reflected, saying: "The absurd is always there, everywhere, disguised as everyday life or logic, more or less hidden, but it accompanies us every day. It is true that this panorama has lit a lantern and does not stop pointing at it [...] If anything can save us from nonsense, it will be the absurd. But don't worry, logic will return when we return to believe that we are immortal" [21]. For her part, the Finnish artist **Isabella Chydenius**, who was at the time of the confinement in South Africa, made several videos in which she showed those moments of action/inaction where hyperactivity and long time for reflection were simultaneous. Her drawings, also made at the same time, are a revision and adaptation of iconic works by other authors adapted to her discourse on the questioning of gender roles. She also accompanies a reflection: "Both of these series are ongoing. They have become tools to keep me sane, because there is no expectation, only observation, activation and at the end, a documentation. Which I guess is what art is in the end?" [22]. Also the French artist **ORLAN**, a reference in body art, participated with two self-portraits made during her confinement where she shows with irony the need to protect ourselves and others with her original masks. The artist attached the following words: "From the beginning of the lockdown I've been thinking about Mandela confined in a tiny little cell for 28 years. It is essential not to complain; it is essential to write. I'm writing my autobiography which could never have been written without this truce... Knowing that sometimes words save and sometimes they kill..." [23].

Artists who launched a message of awareness to safeguard nature: in this section we could mention again Maria Friberg when she evidenced in her words that nature was bleeding, and the obviousness is that the human being is responsible. For his part, the renowned photographer **Edward Burtynsky** launched a video on the occasion of Earth Day, directly addressing viewers to make them aware of the need to take care of artists, who were doing a totally altruistic work during the pandemic, and above all, of the need to take care of the environment. In his statement he said: "I don't know what the next few months will bring, but in this time of isolation and contemplation, I can be sure of one very important: "I do not know what the next few months will bring, but in this time of isolation and contemplation, I can be assured of one very important thing: the future of life on this planet rests in our hands. There may one day soon be a vaccine for this virus, but there is no vaccine for climate change" [24].

3 LIMITATIONS AND FUTURE PROJECTION

Confinement Archive wanted to offer a curatorial response to an unprecedented global crisis. Through the voluntary collection of works and testimonies of so many different confined artists, it articulated an archive that was not only documentary, but also sought to build a shared memory. Seeking to explore from the curatorial point of view the phenomenon of making intimacy something public. With the end of the confinement, the archive also came to an end, although some projects remained unpublished. China and a second representative from Mexico remain unpublished in the archive to this day. The exhaustion of the curatorship due to the confinement itself and the lack of means, added to the difficulties of the web medium for its conservation and maintenance, caused the project to freeze in time. Its value lay not only in its ability to record an exceptional time, but also in its possibility **to remain as a tool for memory, analysis and pedagogy on the relationship between art and crisis.**

The archive wanted to distance himself from static or closed models, inviting us to think of the archive not as a closed collection, but as an expanding organism, sensitive to changes in context and open to new layers of interpretation, but the reality overlapped, such a project was too much of a burden for one person. But as Baudelaire said: "a work that is done is not necessarily finished; a finished work is not necessarily done" [25]. With a clear awareness of the historical moment, it was going through and with an explicit vocation: **to recognize the virtual space as an unconfined public sphere**, given the impossibility of meeting in physical spaces, the digital became a place for meeting, visibility and community building. The proposal not only responded to the urgency of documenting what was happening in real time but also proposed an archive model of emotional memory that allows us to consult and study the ways in which **confinement affected the creative processes of its members**. But unlike the simple digitalization of contents, the archive recognized in the virtual an ontological specificity as a **non-confined space**, which allows us to consume, share —parasocially—, intervene and access beyond geographical and physical barriers. This conception forces us to rethink the role of curatorial thinking, no longer as an organizer of material objects in a delimited space, but as **an articulator of narratives** of dispersed affects, of aesthetics of confinement. Curatorship, in this context, becomes an exercise in listening, hospitality and care.

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From Concept to Video: an End-to-End AI-Assisted Approach for Storytelling

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Abstract

The controversy surrounding gene-edited babies and the emergence of AI-generated gene sequences has brought about growing ethical and ecological concerns about genetic engineering. These developments challenge humanity's role as creator and highlight the risks associated with biotechnological advances. Against this backdrop, this work presents a speculative vision of the future on an island, where genetic warfare and ecological transformation have shaped the landscape. Drawing on post-anthropocentric and ecological resilience theories, the narrative centers on how non-human life adapts, evolves, and interacts beyond human control. Using AIGC tools for creative production, the work explores new possibilities enabled by AIGC technologies and integrates visual storytelling, generative imagery, and short video production to examine the potential and limitations of algorithmic worldbuilding. The final output is an AI short video that visualizes the complex relationship between biotechnology, conflict, and ecological evolution, encouraging reflection on the ethical boundaries of genetic engineering and the impact of design and AI on future narratives.

CCS Concepts

• **Applied computing** → **Media arts**; • **Computing methodologies** → **Artificial intelligence**.

Keywords

AIGC, AI video, AI-assisted Storytelling, AIGC-based Production

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1 Introduction

In recent years, genetic engineering has become a focal point of public concern, not only for its scientific potential but also for its ethical implications. Debates over genetically modified foods continue to raise questions about health and environmental risks. The 2018 "gene-edited babies" case marked a global ethical breach, sparking intense scrutiny of human gene-editing limits [15]. More recently, a 2025 Cell publication describing AI-generated gene sequences unseen in nature reignited controversy over the boundaries of human intervention in life itself [9].

Based on this background, we have created a virtual future world for our work, integrating theories of post-anthropocentrism, ecological resilience, and ecological balance into its conceptual framework. Through this story, we hope to spark deeper public reflection on technological development, ethical decision-making, and the possible forms of future society. Throughout the creation process, we use AIGC (AI-generated content) tools to enrich the details of the story and generate the corresponding images and a video, guiding our audience to immerse themselves in a thought-provoking vision of the future.

2 Related Work

2.1 Genetic Engineering

Genetic engineering has become a central pillar of modern biotechnology, evolving rapidly from laboratory experiments to mainstream societal impact. The technology enables scientists to edit or recombine genetic material—even across species boundaries—to create novel life forms [25]. However, as many scholars have noted, the ethical and social implications of these capabilities are growing increasingly urgent. Ethicists warn that genetic engineering can lead to dehumanization of human identity and exacerbate social inequality, where the wealthy could afford genetic enhancements while marginalized groups are left subject to the randomness of nature [5].

While the public generally sees potential benefits in medicine and agriculture, the application of genetic engineering in human contexts has triggered intense ethical and cultural debates. Concepts such as "designer babies" and "cross-species chimeras" raise complex moral dilemmas about identity, autonomy, and the boundaries of life [7]. At the same time, studies show that public awareness of the risks and ethical challenges of biotechnology remains limited, often hindered by a "knowledge gap" and a lack of accessible cultural expression [14].

Given this situation, we argue that creating artistic narratives about the future of genetic engineering is a critical cultural need. Unlike academic analysis or industrial promotion, few visual storytelling works explore this theme, especially using AIGC methods. In response, our work adopts genetic engineering as its central narrative focus and attempts to produce an AI short video that visualizes a speculative world where biotechnology has advanced to an extreme. In this imagined future, radical scientists fuse human and animal genes to create genetically modified "war bodies" for military use. The story follows one such being as the protagonist, using its perspective to explore ethical boundaries, identity crises, and the consequences of unchecked biotechnological power.

By combining speculative storytelling with AIGC tools, our work seeks to bridge the gap between science, ethics, and public imagination, offering a visual platform for societal reflection on the futures shaped by genetic technology.

2.2 AIGC Tools in Video Production: Opportunities and Gaps

AIGC tools have significantly expanded the creative toolkit across the film and animation industries [1]. Emerging platforms such as *ChatGPT*, *Midjourney*, *Runway*, and *Sora* enable script generation, image synthesis, storyboard layout, voice cloning, and video editing. These technologies offer unprecedented creative efficiency and content diversity [16], and are increasingly integrated into workflows ranging from commercial to personal art, marketing, and videos [17].

Despite the rapid development, AIGC tools are still mostly used in isolated stages of the creative process, such as text-based concept generation or AI video editing. End-to-end applications where AIGC drives the entire production workflow from early concept to final video are extremely rare [19]. While examples like *AesopAgent* demonstrated theoretical feasibility, the majority of AI video productions lack an end-to-end approach [18].

This limitation is especially visible in films about genetic engineering. Although mainstream works like *Gattaca*, *The Island*, or *The Hybrid* tackle this theme through traditional filming, there is a clear lack of AI-assisted storytelling in speculative biotechnology narratives [4, 6]. Given the ethical complexity and future-oriented nature of genetic engineering, this absence reveals a missed opportunity for cultural exploration and critical reflection.

Our work seeks to address both gaps: (1) the underdevelopment of end-to-end AIGC workflows, and (2) the thematic underrepresentation of genetic engineering in AI films. We aim to produce a fully AIGC-based short video that showcases the current capacity of AIGC tools, provoking public dialogue on the fast-approaching biotechnological futures.

3 Method

To address the discussed gap in AI speculative filmmaking on genetic engineering, this work unfolds in two parts. Firstly, it develops a conceptual framework derived from theoretical inquiry, such as anti-anthropocentrism and ecological resilience, and socio-ethical analysis. Secondly, it applies this framework through a full-process AIGC-based production pipeline to realize a narrative short video. Fig. 1 summarizes the workflow, illustrating each creative stage along with AI's role in supporting and advancing the work. Throughout the process, manual selection and adjustment of AI outputs are essential to ensure alignment with the intended vision and achieve the final quality.

3.1 Concept Derivation from Theory and Social Context

The conceptual foundation of this work was built through a critical review of contemporary issues surrounding genetic engineering. Key concerns include the ethical ambiguity of synthetic life, the ecological risks of uncontrolled gene editing, and the broader post-human discourse on species hybridity and nonhuman agency. Grounded in these issues, the work integrates two theoretical pillars:

- Post-anthropocentrism, which challenges the centrality of humans and invites ethical reflection on the rights and intelligences of nonhuman beings.
- Ecological resilience, which re-frames nature not as a passive backdrop but as an active, adaptive force capable of re-balancing itself in response to technological disruptions.

Synthesizing these perspectives, the work conceptualizes a speculative future where human-animal hybrids, termed "war bodies," emerge as consequences of extreme genetic manipulation. These entities serve as narrative agents to explore themes of identity, adaptation, and ecological reconfiguration. This concept forms the narrative and aesthetic basis of the short video.

3.2 AIGC-Based End-to-end Production Workflow

To translate the conceptual framework into a concrete cinematic artifact, this work implements an end-to-end production workflow supported entirely by AIGC tools. The workflow encompasses the complete creative cycle from conceptual development to visual realization and post-production, emphasizing iterative alignment between theoretical intent, content generation, and technological execution.

The pre-production stage begins with concept formulation and worldbuilding. Large language model (LLM), i.e., *DeepSeek*, is used to generate prompts exploring the ethical and ecological implications of genetic engineering. These texts are refined through *ChatGPT* to produce coherent world logic and background narratives, forming the foundation for setting, character relationships, and environmental dynamics. For story and scriptwriting, *ChatGPT* develops the narrative arc, including plot progression, character motivation, and ethical dilemmas, grounding the visual translation.

In the production stage, a textual storyboard is constructed via *ChatGPT*, converting scripts into scene-by-scene descriptions.

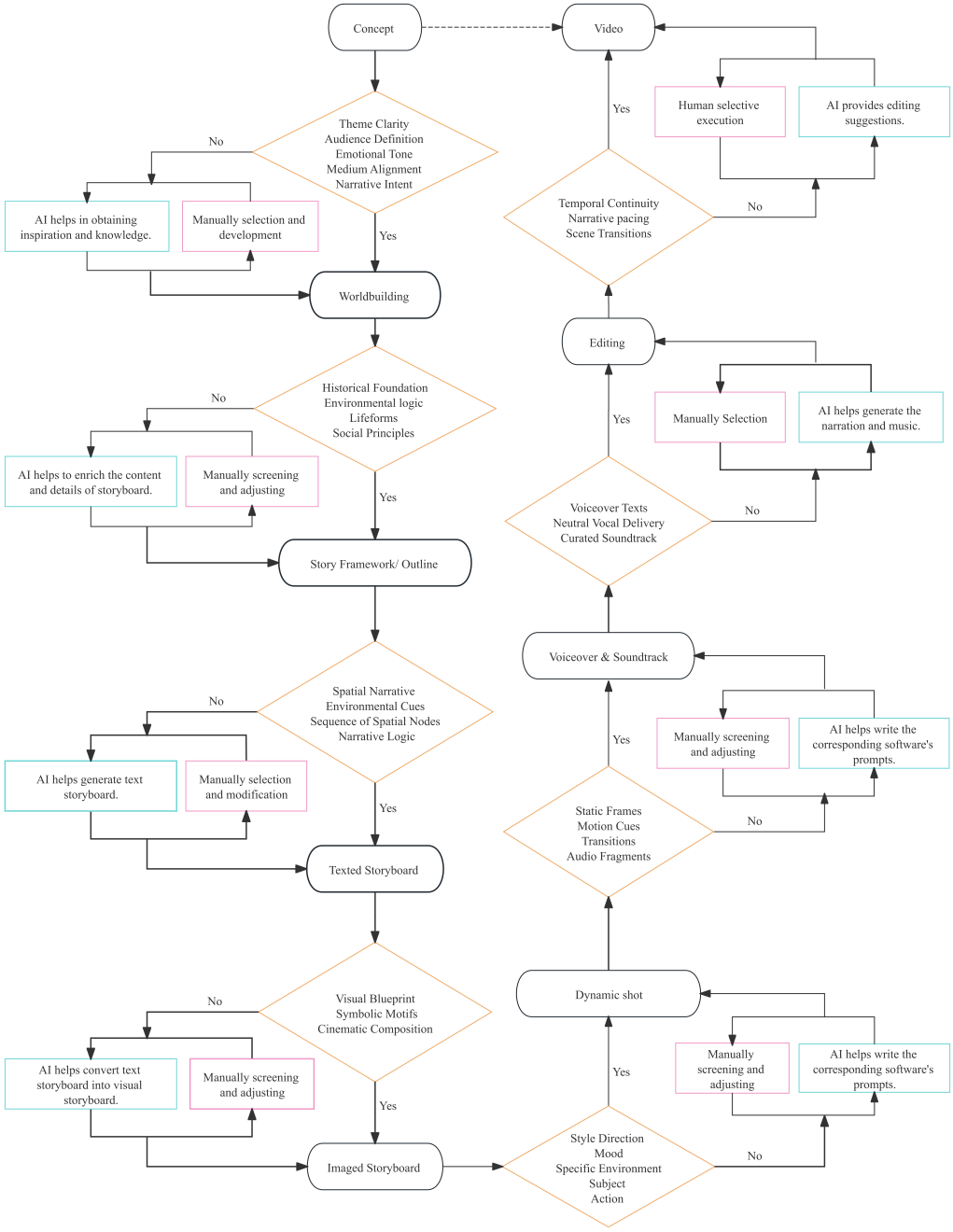


Figure 1: AIGC-Based concept to video production workflow

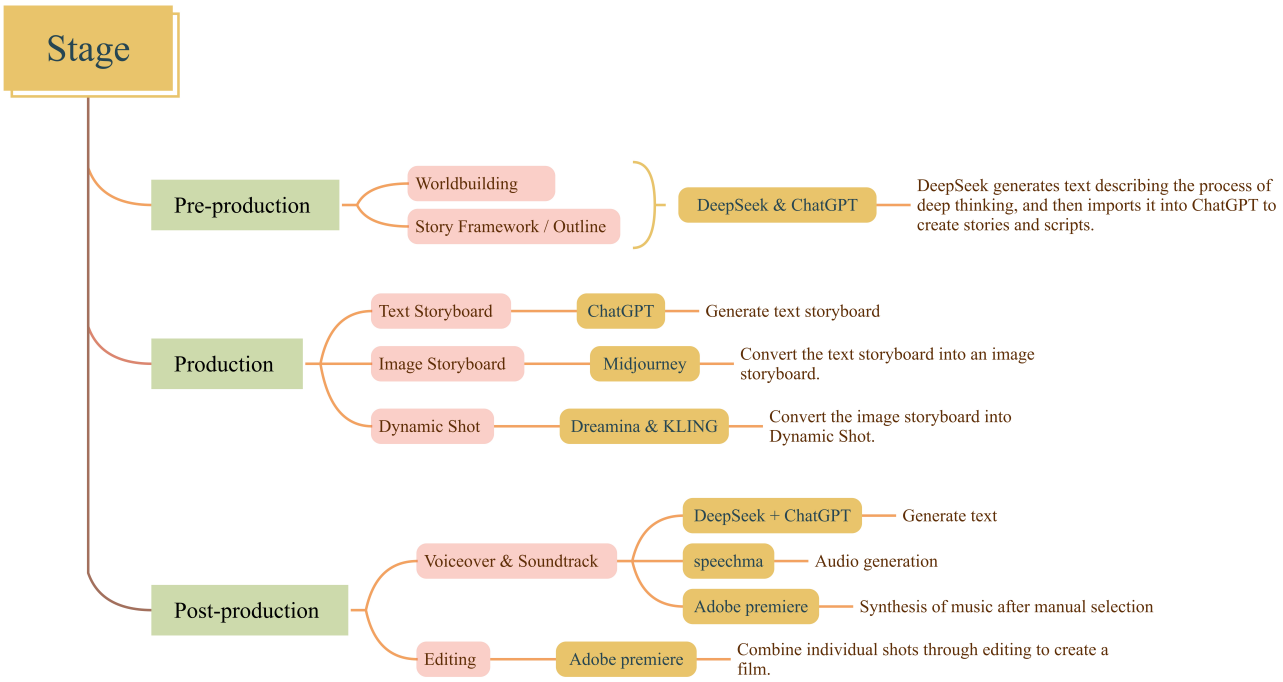


Figure 2: Application flow across production stages

These narrative fragments are visualized using *Midjourney*, producing an image-based storyboard that defines composition, spatial relations, and atmosphere. To animate key frames, *Dreamina* and *Kling* generate dynamic video shots, transforming static visuals into cinematic sequences and enabling speculative storytelling.

The post-production stage finalizes audiovisual elements. Editing in Adobe Premiere compiles clips, adjusts transitions, and refines rhythm. Voiceover is generated via *DeepSeek* and *ChatGPT*, then converted to audio using *Speechma* for tonal consistency. Background music is manually curated and mixed to align with the atmosphere of the scene dynamics.

4 From concept to video

This section outlines the process of transforming an abstract conceptual framework into a visualized short video using AIGC tools. Building on the methodology established earlier, the work unfolds across three stages: pre-production, production, and post-production. Each stage integrates core concepts, post-anthropocentrism and ecological resilience, into the video's narrative and aesthetic structure.

Pre-production focuses on worldbuilding, narrative design, and story outline, grounding the speculative setting in a post-genetic-war timeline. Here, non-human "war bodies" evolve within an ecosystem beyond human control. Storytelling relies on visual and spatial cues, aligning with the work's non-verbal and ecological themes.

Production translates narrative logic into visual form through a two-phase storyboard—textual and image-based—directing composition, rhythm, and tone. Tools like *Midjourney* generate frames that depict character behavior, environmental detail, and symbolic motifs.

Post-production integrates voiceover, music, and video. Manual editing ensures narrative clarity and coherence. Together, it shows how AI supports speculative storytelling that is conceptually grounded and technically feasible.

4.1 Key Concept

4.1.1 Post-anthropocentrism. Given the backdrop of genetic engineering, our narrative explores the ethical and existential condition of the artificially engineered "war bodies." Drawing on post-anthropocentrism, we question what such beings are, how they relate to their environment, and what futures they might embody.

Post-anthropocentrism redefines the human-nonhuman relationship, viewing all life forms as sentient, valuable participants in a shared network [3]. Haraway's theory of sympoiesis furthers this by asserting that species co-evolve and interdependently shape their realities [10].

In the video, war bodies—hybrids of human and animal genes, are not depicted as monsters or victims, but as autonomous beings with symbolic expressions, non-verbal communication, and cross-species alliances. Their identities are formed not by mimicry

of humanity but through evolving nonhuman ethics, challenging anthropocentric hierarchies, and embracing ecological equality.

4.1.2 Ecological Resilience and Ecological Balance. Building on post-anthropocentric ethics, we incorporate ecological resilience theory to emphasize nature's active agency. Holling [11] introduced resilience as an ecosystem's ability to adapt and recover from disturbance. Folke [8] expanded this to socio-ecological systems, highlighting self-organization and transformation. Latour later argued that nature itself "speaks" through disasters and feedback mechanisms.

In our story, nature is not a passive background but an actor that influences behavior, ethics, and outcomes. It adapts, resists, and reorganizes in response to technological disruption, maintaining a dynamic and self-regulating balance.

4.2 Pre-Production Stage

The pre-production phase lays the conceptual and structural foundation of the video, integrating theoretical perspectives into narrative and environmental design. It begins by constructing a speculative world shaped by genetic engineering, post-human ethics, and ecological resilience. This setting, on a post-nuclear island, is built through historical layering and ecological logic reflecting a departure from anthropocentric control. Within this world, visual storytelling replaces dialogue, relying on spatial cues and behavioral dynamics to communicate meaning. The narrative is embedded in the environment, progressing through symbolic transitions and ecological rhythms. Building on this design, the story follows discarded war bodies navigating survival, conflict, and mutation alongside other transformed life forms. These elements enable a cohesive pre-production structure, aligning conceptual depth with visual and narrative strategy to support the full AIGC making pipeline.

4.2.1 Worldbuilding. The fictional world is constructed as a living system shaped by intertwined factors: historical foundation, environmental logic, lifeforms, and social principles. This structure can be formalized as:

Worldbuilding = Historical Foundation + Environmental Logic + Lifeforms + Society Principle

Figure 3: Worldbuilding formula

Historically, the narrative unfolds in a speculative timeline paralleling real-world biotech advances, diverging sharply at a crisis of uncontrolled genetic experimentation. This leads to a nuclear catastrophe, leaving the island landscape fragmented, toxic, and scattered with war debris and genetic waste.

Ecologically, the world operates under anti-anthropocentric logic, where nature acts as a self-regenerating force. The two dominant life forms—genetically engineered "war bodies" and mutated native organisms—engage in dynamic interactions driven by adaptation, mutation, and environmental feedback. Without centralized human systems, emergent micro-societies are shaped by behavioral overlap, mutual dependency, and ecological balance rather than control.

4.2.2 Story Framework/Outline. The story is conveyed through spatial narrative rather than spoken exposition, using the environment to gradually reveal the timeline and moral arc. The viewer pieces together the story by moving through a sequence of spatial nodes, each representing phases like origin, conflict, and resolution.

Set on a post-war island used to discard human-animal hybrids, the story traces their struggle against mutated native species and the emergence of a hybrid ecosystem. Reproduction occurs through non-linear, sacrificial patterns; communication is non-verbal; and coexistence replaces domination. Narrative is embedded within environmental progression: lifeforms transit from isolated to cooperative, shaped by ecological pressure and evolutionary entanglement.

4.3 Production Stage

The production stage translates textual concepts into visual expression through a three-tiered workflow: text storyboard, image-based storyboard, and dynamic storyboard. The process begins with a text storyboard that defines the spatial layout, symbolic structure, and narrative rhythm of each scene, grounding the story's emotional and ecological logic. These written scenes establish the blueprint for visual design.

Next, image-based storyboards are created using AIGC tools such as *Midjourney*, where prompts are crafted to reflect scene style, atmosphere, and character presence. These visuals are refined through multiple iterations and manual adjustments to ensure consistency with the video's tone and world logic.

Finally, the dynamic storyboard phase transforms static images into animated shots using tools like *Dreamina* and *Kling*. This step introduces movement, timing, and visual rhythm, bridging the gap between storyboard and video. Together, these layers create a cohesive production pipeline aligned with the speculative vision of the work.

4.3.1 Text Storyboard. The text storyboard establishes the visual and emotional blueprint of the video, guiding the transition from narrative to video form. The spatial setting—a fragmented, post-nuclear island—unfolds through a sequence of wide and medium shots that emphasize environmental decay, climatic extremity, and non-human lifeforms. These compositions reflect ecological heterogeneity and underscore the disintegration of anthropocentric order.

The storyboard highlights symbolic elements such as chains and fire to represent the dual identity of the war bodies, as both weapons and victims. Conflict sequences employ diagonal framing and dynamic camera movement to convey spatial tension, while visual motifs like lightning and toxic mist signal nature's agency and resistance. In the life cycle scenes, plant-based reproductive imagery and non-binary interactions redefine death as transformation and renewal.

To ensure coherence, the storyboard adheres to a structured formula:

Text Storyboard = Visual Blueprint + Symbolic Motifs + Cinematic Composition

Figure 4: Text storyboard formula

4.3.2 Image-based Storyboard. The image-based storyboard bridges the gap between textual planning and visual representation by generating concrete frames for each narrative scene. Using *Midjourney*, we translated scene prompts into conceptual visuals, capturing narrative tone, atmosphere, and character identity. This stage was essential in visualizing speculative lifeforms and war-damaged landscapes, ensuring consistency with prior worldbuilding.

To guide this process, we formulated a structured prompt template:

Imaged Storyboard = Style Direction + Specific Environment + Subject + Action --Aspect Ratio --Renderer

Figure 5: Imaged storyboard formula

Each variable targets a different visual dimension: style controls aesthetics, mood sets emotional tone, environment anchors spatial setting, subject identifies focus, action introduces movement, aspect ratio defines framing, and renderer determines realism or stylization.

The goal was to depict genetically modified "war bodies"—hybrids with beast-like features, human musculature, and battle damage. Initial image outputs were unsatisfactory due to vague subject rendering, poor contrast, and monochromatic dullness. A second round refined prompt constraints, emphasizing battlefield context, post-nuclear atmosphere, and combat dynamics. [1]

The final selected image featured blurred motion trails, decaying organic forms, and a smoke-filled background, evoking the intended tone. Manual color correction further aligned it with the visual system of the video. The entire visual development workflow is illustrated in Fig. 6, depicting the iterative evolution of storyboard visuals, from the initial generation to final selection.

4.3.3 Dynamic Storyboard. The dynamic storyboard brings the visual structure to life as a temporal sequence, providing an initial sense of rhythm, tension, and narrative flow. Created using *Dreamina* and *Kling*, this stage combines static frames with motion cues, transitions, and audio fragments to show how scenes evolve over time. Environmental shots are timed to emphasize atmospheric pressure and ecological decay, while symbolic imagery such as chains, lightning, and toxic mist is layered with subtle motion to enhance its emotional and narrative impact. Conflict scenes feature dynamic camera paths and transitional pacing to convey instability and spatial disorientation. By aligning visual composition with temporal structure, the dynamic storyboard bridges the gap between conceptual intent and cinematic execution, refining the video's emotional logic before full-scale editing begins.

4.4 Post-Production Stage

The post-production phase shapes the final expressive layer of the video, weaving together visual, auditory, and temporal elements to construct a coherent sensory narrative. This stage centers on refining the raw visual material into a unified cinematic experience, guided by the work's conceptual foundations in post-human perception and multi-species entanglement. Voiceover is created using AIGC tools, designed to convey non-human perspectives through fragmented, affect-driven vocal textures. In contrast, the soundtrack is manually curated to enhance the emotional tone and support the ecological atmosphere of the video. Editing techniques structure the rhythm, continuity, and symbolic transitions of the scenes, aligning the visual flow with the internal logic of the speculative world. Through this layered assembly, the post-production process strengthens the nonverbal storytelling approach, transforming the conceptual foundation of the video into an immersive and emotionally resonant audiovisual form.

4.4.1 Voiceover and Soundtrack. The voiceover and soundtrack reinforce the spatial and non-verbal narrative of the film. Voiceover texts are generated using *DeepSeek*, focusing on fragmented perceptions and environmental observations from the perspective of war bodies. These texts are processed through *Speechma* to produce a consistent, neutral vocal delivery, maintaining the nonhuman viewpoint of the video. Finally, we use *Adobe Premiere* to integrate a soundtrack that matches shifts in tone, rhythm, and atmosphere. Rather than providing emotional cues, the audio supports event progression and amplifies the narrative embedded in spatial and behavioral changes. Together, voice and sound maintain coherence with themes of transformation, interspecific entanglement, and environmental response.

4.4.2 Editing. The editing process establishes temporal and spatial continuity, mirroring the island's shifting ecological rhythms and the war bodies' survival journey. Cuts are timed to align narrative pacing with behavioral and environmental changes, guiding viewers from isolated mutation toward emerging cooperation. Transitions use cross-fades, dissolves, and matched actions to bridge fragmented visuals, suggesting organic links between conflict, mutation, and regeneration.

Visual and auditory redundancies are removed to maintain clarity and focus on key story elements like scars of past battles, toxic mists, and interactions between war bodies and native species. Editing shapes fragmented life cycles into a cohesive spatial narrative unfolding through adaptation, entanglement, and coexistence. These techniques deepen the video's exploration of transformation and ecological interconnection, allowing viewers to experience the island as a living, evolving entity shaped by complex relationships.

The final outputs include an image-based storyboard (Fig. 7) and a video available at https://youtu.be/ZK27d9Ig1m4.

5 Discussion

5.1 Theoretical Contribution: Ethics Beyond the Human

This work challenges the anthropocentric paradigm by re-framing technological and ecological narratives through non-human subjectivity. Traditional science fiction centers on human agency, portraying technology as a tool and war as a human affair [2]. In contrast, this video envisions artificially created human-animal hybrids evolving into autonomous actors within an emergent ecosystem.

The story examines whether such beings require human recognition to hold value or can generate new meanings of life beyond human frameworks. This ethical shift reflects post-anthropocentric

[1] The successful prompt was: "Concept art, gloomy atmosphere, gruesome battlefield, huge beasts with human limbs being fought against. —ar 3:2 —v 6.0"

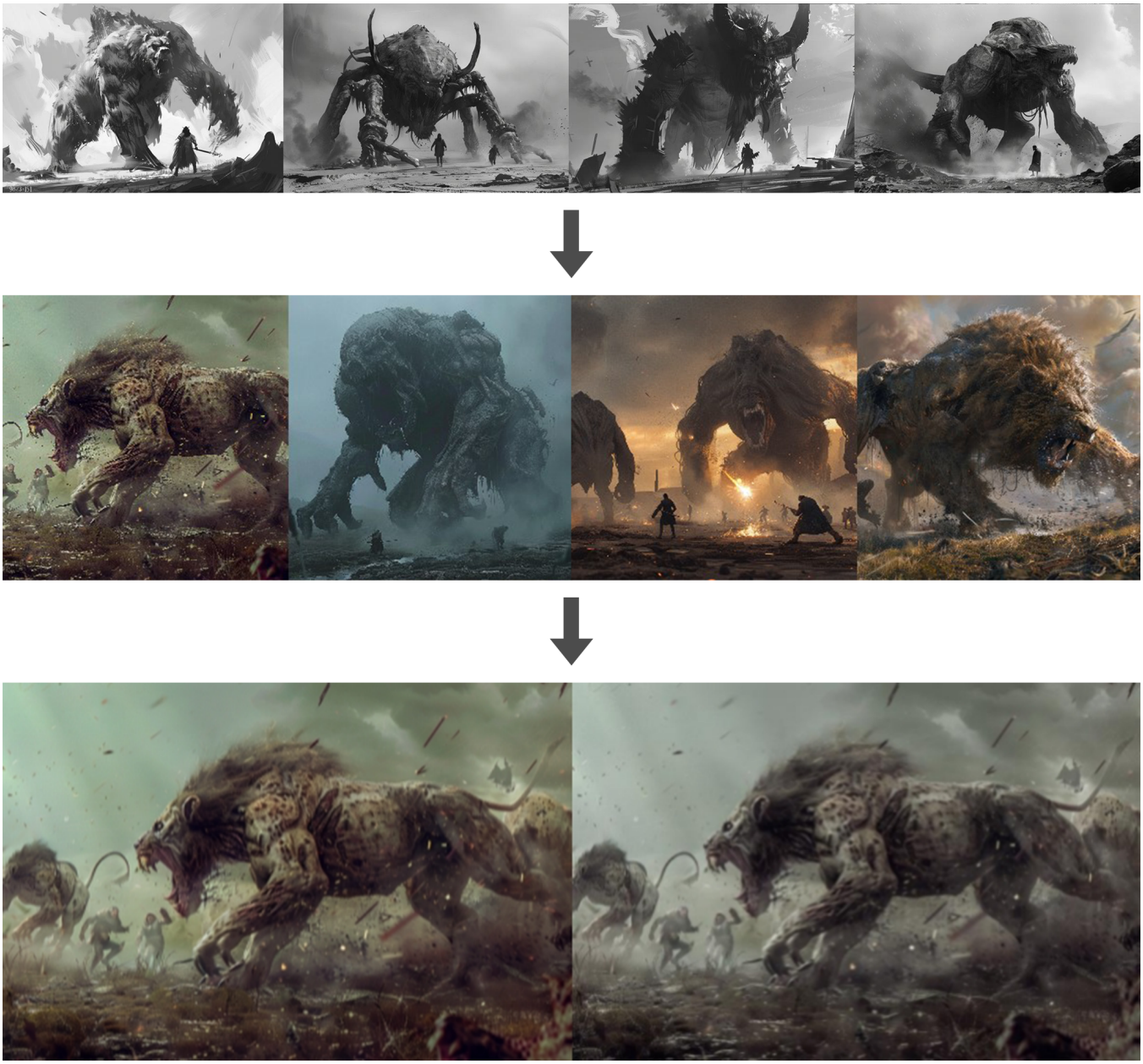


Figure 6: Progressive refinement of image storyboards across production stages

thought, recognizing non-human entities as capable of self-organization, ethical reasoning, and ecological integration. From an ecological perspective, the work questions whether these hybrids are invasive anomalies or natural adaptations. Their presence blurs boundaries between artificiality and evolution, prompting a re-evaluation of "nature." As they adapt, mutate, and possibly develop social orders distinct from human hierarchies, the video invites reconsideration of civilization itself.

5.2 Technical Insight: AIGC as a Full Creative Engine

This work demonstrates the feasibility of an end-to-end AIGC-based production. From worldbuilding and scriptwriting (*DeepSeek*, *ChatGPT*) to image generation (*Midjourney*), animation (*Dreamina*, *Kling*), and audio synthesis (*Speechma*), each step of the production was shaped by AIGC tools. This workflow not only accelerated production but also enabled iterative alignment between concept, visual form, and narrative structure. It offers a replicable framework for low-budget, high-concept speculative storytelling, especially

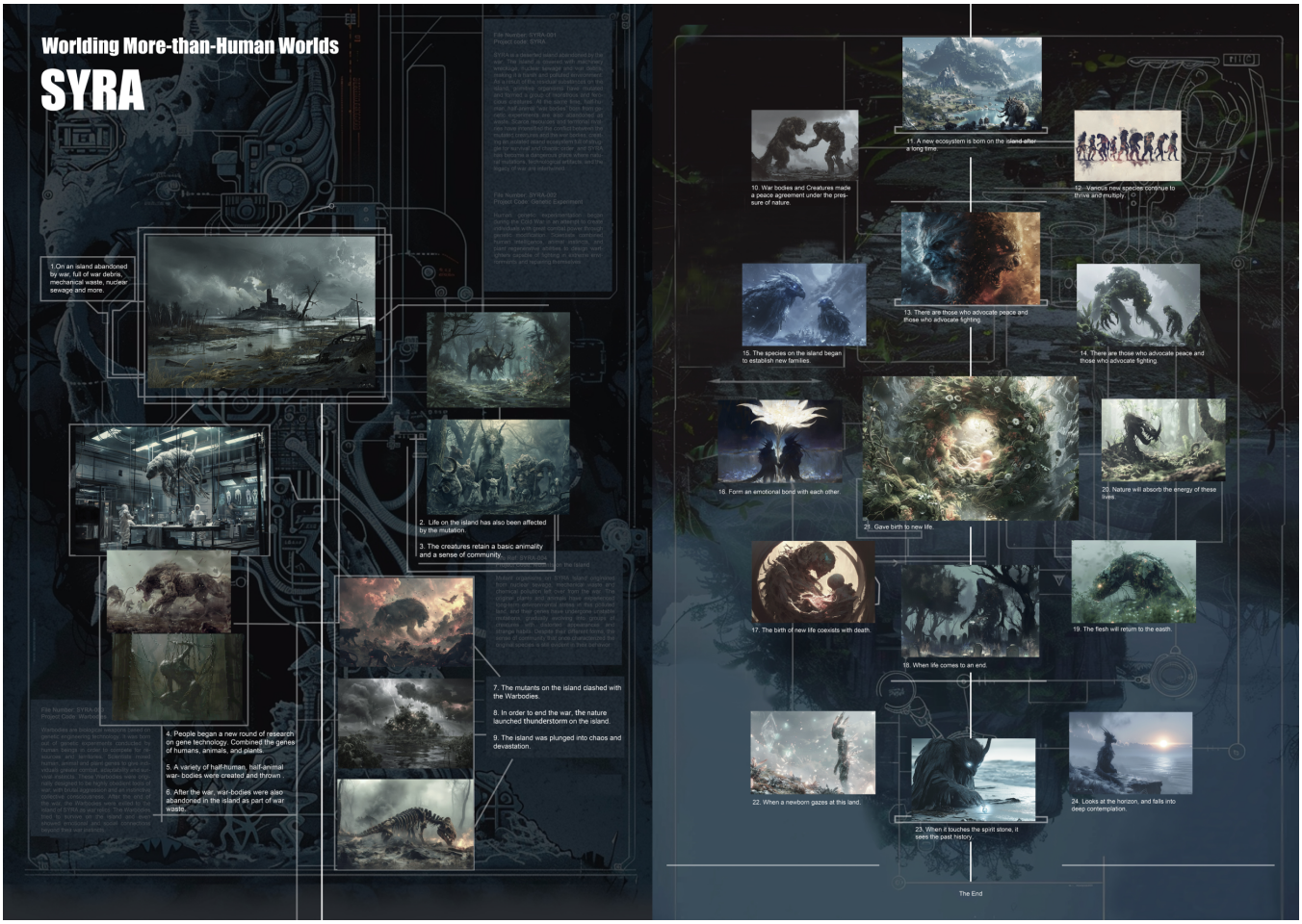


Figure 7: Image-based storyboard

for artists or researchers without access to traditional production teams. The layered use of AIGC prompts, e.g., storyboard formula, image prompts, shows that AIGC can function as both a creative partner and a production infrastructure.

5.3 Limitations and Challenges

Several limitations emerged. Firstly, semantic precision in prompt-based generation was hard to control, especially in early visual outputs where character design or tone diverged from conceptual intent. This required considerable manual iteration and prompt engineering. Secondly, non-linear, non-verbal storytelling challenged audience comprehension, especially without explanatory dialogue. Finally, while AIGC simulated emotional tone, genuine human affect remains difficult to replicate through synthetic voices and image composition. Moreover, although AIGC improves efficiency, it still depends heavily on human inputs to produce conceptually coherent, meaningfully aligned outputs.

5.4 Future Directions

This research opens several avenues for future exploration:

- Cross-cultural ethical storytelling: How different societies interpret speculative biotech narratives through local ethics could be explored using the same AIGC workflow.
- Interactive AIGC experiences: With AIGC tools integrated into game engines, XR systems (see examples at [20, 23, 24]), or interactive installations (e.g., [12, 13]), viewers could navigate and shape evolving speculative worlds in real time.
- Training domain-specific AIGC models: To enhance fidelity and reduce ambiguity, future research can focus on fine-tuning LLMs or image models on specific themes [21, 22], such as genetic ethics and ecological aesthetics, which could greatly improve output relevance.

6 Conclusion

This work presents a speculative short video that explores the ethical frontiers of genetic engineering through a full-process AIGC-based production pipeline. By integrating post-anthropocentric theory and ecological resilience into both concept development and video execution, the work re-frames biotechnological narratives from a non-human, multi-species perspective. The use of generative

tools (from text to image to video) enabled a cohesive creative workflow that visualizes complex ethical and ecological themes often absent in mainstream media.

In doing so, the work contributes not only to technical discourse around AI-assisted storytelling but also to cultural conversations on the future of life, identity, and environmental entanglement. It offers a model for how speculative storytelling can expand through AIGC, and how artistic production can become a space for ethical inquiry in the age of synthetic biology. Through this work, we hope to open new pathways for narrative experimentation and public reflection on the co-evolution of technology and life.

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APPENDIX

A AIGC tools used in this work:

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(2) *ChatGPT*: https://chatgpt.com/
(3) *Midjourney*: https://www.midjourney.com/home
(4) *Dreamina*: https://dreamina.capcut.com/
(5) *Kling*: https://klingai.com/global/
(6) *Speechma*: https://speechma.com/

Helping Intangible Heritage Resilience through Storytelling (HIGHRES)

Research projects in heritage and digital arts within the European framework of the Erasmus+ Programme

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Abstract

The following article delves into the European Erasmus+ research project HIGHRES (Helping Intangible Heritage Resilience through Storytelling), launched in 2023. Through this initiative, six institutions from different parts of Europe are working with rural communities to preserve intangible cultural heritage (ICH) using digital storytelling. This means that community members use various digital tools, such as video, audio, and multimedia, to create narratives about their intangible cultural heritage, employing a range of artistic strategies. These stories aim to preserve and promote rural heritage while supporting the sustainable development of these communities. In addition, this project will yield outcomes in the form of specialized publications (such as case studies, methodological frameworks, training pathway) and an e-learning platform that will allow other communities around the world to access open-access content. This material will enable them to use the resources and receive online training.

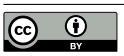
CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Digital storytelling, Intangible cultural heritage, Rural communities, Erasmus+ research projects

ACM Reference Format:
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1 Introduction

Rural communities are custodians of vibrant and diverse cultural traditions that have been transmitted across generations. However, in the context of an increasingly digital world, these intangible cultural assets face the risk of marginalization or loss. In these rural communities, it is essential to implement strategies that enhance socio-economic development, especially by narrowing the digital divide between urban and rural regions. Simultaneously, safeguarding intangible cultural heritage depends on active community participation and dedication to maintaining traditions and protecting cultural identity [1]. Addressing this challenge, the HIGHRES project offers an innovative approach that combines digital storytelling with active community engagement to support the preservation of intangible cultural heritage in rural Europe.

This project, supported by the Erasmus+ Programme under the auspices of the European Union, focuses on strengthening the digital competencies of rural populations, enabling them to document, communicate, and promote their cultural practices through digital narratives. Digital storytelling emerges as a valuable tool that not only supports the preservation of intangible cultural practices but also aligns with the growing trend of digital learning. Through this practice, which encompasses various artistic approaches, such as narrative creation and its adaptation to digital media using both every day and advanced audiovisual tools, a sustained form of community engagement is fostered. This engagement is used to share their customs and traditions with the world through the internet.

Moreover, the project provides comprehensive training resources and a dedicated web platform to facilitate knowledge sharing and the creation of multimedia content. By equipping communities with the tools and methodologies needed to articulate their own heritage, HIGHRES not only contributes to cultural preservation, but also supports sustainable rural development. The initiative promotes community cohesion and opens pathways for cultural tourism rooted in local identity and participation [4].

The project is composed of six partners from five different countries:

- Vidzeme Tourism Association (Latvia)
- On Projects (Spain)
- University of Jaén (Spain)
- Storytelling Centre (Netherlands)
- Lusófona University (Portugal)



Figure 1: HIGHRES Kick-off meeting in Latvia. Internal photographic resource of the research group (Photo: Signe Lorence)

- University of Milano Bicocca (Italy)

This multidisciplinary group brings together diverse perspectives based on each partner's area of expertise. In addition, each group leads one of the various work packages that are carried out over time.

HIGHRES (Helping Intangible Heritage Resilience through Storytelling) began in 2023 and ends next December of this year 2025. During this time the project will focus on strengthening the capacity of rural communities to recognize, safeguard, share, and promote their intangible cultural heritage by creating digital narratives (HIGHRES, 2024).

1.1 Project goals

The main objective of the project is to harness digital storytelling as a means to safeguard and promote intangible cultural heritage, while fostering new opportunities and reducing disparities in rural communities [5]. This objective can be specifically broken down into three main goals:

- Safeguarding, interpreting and communicating Europe's intangible cultural heritage.
- Promoting rural development through cultural tourism.
- Improving the digital skills of the adult population, thus ensuring a lasting impact on rural communities [5].

To achieve these goals, the HIGHRES project has defined a series of internal secondary objectives, which, as we will see later in the text, have already been achieved to date.

- To collect, analyse,and share good practice examples in digital storytelling of ICH.
- To gather comprehensive training materials on identification, narrative creation, community involvement, digital storytelling, and promotion of ICH.
- To develop a methodological framework and a training pathway for the creation of digital storytelling of ITC [5].

1.2 Methodology

This section will address, first, the internal methodology applied by the project to carry out its tasks, and second, the working methodology used with rural communities to implement the project on the ground.

Beginning with the first, the internal methodology is based on cooperation and communication among the project partners, each of whom is responsible for managing or leading a specific work package. This process is supported throughout the project by the OnProject team.

When developing the training materials hosted on the project website, each partner conducts the necessary research at different stages. These research activities begin with case studies, which involve observing and interviewing other projects with similarities to HIGHRES. This is followed by source analysis and fieldwork to develop the methodological framework and the training pathway, and later by bibliographic research for the training modules.

Coordination among the partner groups is maintained through regular virtual meetings, as well as in-person meetings held approximately every six months, where the work carried out is presented and discussed.

Regarding the second methodological framework, the project partners have worked closely with rural communities throughout the initiative to co-develop the content. In our specific case, the team from the University of Jaén (Spain) has collaborated with the "Asociación de Mujeres Ilucia", based in Santisteban del Puerto (Jaén, Spain), to implement the training materials.

To carry out the various processes involved in bringing the project to life within the rural community, we have adopted an artistic mediation approach. This mediation process consists not about teaching art, but about creating a space for encounter where the creative process becomes a tool for personal and social transformation [6]. This has involved informal conversations with members of the association, which have served as a foundation for initiating a range of artistic processes that incorporate digital tools for audiovisual creation. We support and accompany the community in constructing narratives around their intangible cultural heritage.



Figure 2: Exhibition by the Dutch Centre for Intangible Cultural Heritage. Internal photographic resource of the research group (Photo: Leandro França)

2 Processes, Resources and Results

At this point, we will chronologically outline the processes carried out since the start of the project, as well as the results achieved so far and the resources created for reference, which are available on the project website: https://highres-project.eu

2.1 Case Studies

To begin the work, the first task consisted of identifying projects that shared similarities with HIGHRES. Each research group was asked to find two examples from their own country that reflected a comparable perspective. This led to the development of the case studies, which were later compiled and edited in the *Good Practices Handbook: On Identification, Participatory Management, Digital Storytelling, and Promotion of Intangible Cultural Heritage*.

> The "ten case studies from five countries (Italy, Latvia, the Netherlands, Portugal and Spain), showcasing innovative approaches to preserving and promoting ICH through digital storytelling. Case studies were selected, in participating countries, to cover different levels of expertise on Identification, Participatory Management, Digital Storytelling, and Promotion of Intangible Cultural Heritage, reflecting a wide range of approaches and contexts. Together, they complement each other to provide a comprehensive understanding of effective methodologies" [2].

The Good Practices Handbook is composed of five chapters:

- Chapter1: Multimedia Storytelling and Immersive Experiences
- Chapter 2: Community Engagement and Collaborative Art
- Chapter 3: Digital Tools for Accessibility and Engagement
- Chapter 4: Revitalising Traditional Practices
- Chapter 5: Rural Development and Cultural Integration [2]

Within these chapters, the case studies are presented. These studies show how, from different approaches, groups operating in rural areas make use of technology to narrate and share their cultural heritage. Additionally, these groups engage in various artistic practices to support this effort.

For example, we see the case of the *Asociación Vientos del Tiempo* in Spain, which uses theatre and performance; the *Corvo Ecomuseum* in Portugal, which utilizes public space to create exhibitions around intangible cultural heritage; and the *Holocaust Museum*, which records audio to produce podcasts and disseminate personal stories.

These examples serve as models for the project to understand how communities engage in preserving their heritage through art and digital media. Moreover, they offer insight into how these groups operate and reveal the uniqueness and specific details of their processes.

2.2 Methodological framework and training pathway

Based on the case studies analysed, the project is moving towards the creation of a methodological framework and a training pathway which, already published on the project's website, serve as a practical guide to help rural communities independently carry out the necessary actions to promote their intangible cultural heritage through digital storytelling.

When the objective is to appreciate cultural diversity and reinforce local identities, it is essential that strategies and initiatives are developed collaboratively. In the context of training processes, active community involvement should be integrated at every stage— from design to implementation— to foster collective creation [3]. This approach recognizes that knowledge and cultural meanings emerge from shared social and community experiences. Such a strong sense of belonging enables individuals to identify with the



Figure 3: Traditions for resilience. Internal photographic resource of the research group (Photos: Leandro França)

initiatives, ensuring that these efforts effectively address the diverse needs and perspectives of the communities they serve [7].

The methodology outlined here adopts a hands-on, sequential process in which all partners collaborate to create a digital narrative centered on a particular intangible cultural heritage. This approach emphasizes community involvement, ethical considerations, and a culture of innovation aimed at promoting sustainable development [3]. It is divided into five steps:

1. Community Mobilization, Training and Innovation
2. Creation and Recording of Digital Narratives
3. Promotion and Integration with Sustainable Development
4. Principles for Training Actions
5. Project Monitoring and Evaluation [3]

These five steps are further broken down into detailed actions to be followed.

The HIGHRES training pathway is made up of six modules, defined through initial consultations with partner organizations. These modules address essential aspects involved in the creation and dissemination of digital stories related to intangible cultural heritage in rural areas [3]. These six modules will, in turn, make up the training platform.

- Module 1: Identification and Cataloguing of Intangible Cultural Heritage in Rural Areas
- Module 2: Collaborative Management and Community Engagement
- Module 3: Promotion of a Culture of Innovation and Creativity
- Module 4: Construction of Digital Narratives about Intangible Cultural Heritage
- Module 5: Technical Aspects of Digital Narratives
- Module 6: Promotion of Intangible Cultural Heritage on Digital Platforms [3]

This material, developed by all project members and tested by the team at Universidade Lusófona in the Monte Rondo Museum (Portugal), allows users visiting the project website to access content created by experts in the relevant fields. It also provides the opportunity to review the aforementioned case study.

2.3 Training modules and e-learning platform

Currently, the project is carrying out activities related to this stage, specifically the design of the training materials comprising each of the modules described in the training pathway. This training material will soon be available on the project website for public access. The training offers users an in-depth approach to the topics addressed by the project, from understanding what intangible cultural heritage is and how to identify it, to creating digital narratives using audiovisual production tools, and finally, disseminating the content through web platforms to raise awareness of the heritage of rural communities.

The e-learning platform resulting from this work package will also include assessment exercises, enabling users to consolidate the knowledge gained from each module.

3 Implementation and application of the material in a rural community

In parallel with the research work carried out in collaboration with the project partners, our team at the University of Jaén has begun the implementation and practical study of the theoretical material presented in the previous section. Taking into account the characteristics of the project, we started this process in collaboration with the "Ilucia Women's Association" from Santisteban del Puerto (Jaén, Spain). This association, composed of a multigenerational group of rural women, carries out activities within their community aimed at promoting gender equality. Regarding artistic practice, this group



Figure 4: First meetings with the "Asociación Ilucia" at its headquarters. Internal photographic archive



Figure 5: Storytelling example based on Santisteban del Puerto's traditions. Illustration: Pedro Ernesto Moreno García https://www.youtube.com/watch?v=8DktUpjcegA

already has extensive experience in the field of visual arts; however, they lack skills related to artistic practice using digital tools.

To initiate this process, we proposed a series of meetings between the University of Jaén team and the Association to get to know each other and to present the idea of creating a digital storytelling piece that would speak about the intangible cultural heritage they recognized in their surroundings and that could be published online. Following this, and in line with the methodological framework established by the project, the women set out to identify and catalogue the intangible cultural heritage of their environment. To do so, they used recorded video interviews with people who are bearers of this intangible heritage. Later, once all the interviews had been conducted and the heritage identified, they selected the elements they wished to represent through narrative form. For our part, we produced a digital storytelling example, created using digital illustration and based on the tradition of "chasing away the devil" from Santisteban del Puerto, to serve as a model.

Following this, the women of the association reconstructed the story of the women who used to bake bread in the village—a story deeply rooted in intangible cultural heritage and of great personal value to them. We are currently working on translating this historical reconstruction into video format using digital tools. To this end, the women of the association will film the story themselves using their own resources. In addition, the members of the association are completing the training modules on the pilot platform established by the project.

4 Innovative Aspects and Impact

HIGHRES aims to harness digital storytelling as a means to preserve intangible cultural heritage, while also revitalizing rural areas

and fostering sustainable cultural tourism. At the same time, the project supports rural development, stimulates economic activity, and strengthens social cohesion by actively engaging local communities and improving their digital competencies [4].

These aspects contribute to the project's innovation, which can be broken down into three key points:

1. The project emphasizes valuing, supporting, and strengthening community-based knowledge and practices for collective growth, instead of imposing outside solutions.
2. The outputs of the HIGHRES project will provide an inclusive, adaptable, and entirely open-access training program that leverages digital storytelling to enhance rural competitiveness and support social, economic, and environmental sustainability.
3. As a key element of the training program, users will be able to draw on real-life success stories, encouraging dialogue and knowledge sharing across regional, national, and European contexts [5].

5 Emerging outlooks and future challenges

Outside the framework of the project, new lines of research are also emerging. On the one hand, its implementation in contexts not initially covered by the project will lead to revisions and nuances that will enrich the overall content. Secondly, the relationship between digital storytelling and intangible—and even tangible—heritage can be further expanded by considering factors such as the construction of the story, the way it is told, the digital tools employed, and the manner in which it will be presented on the web. Finally, new competencies may also arise in relation to the project's social dimension, such as artistic mediation in rural contexts or the urban–rural digital divide.

6 Conclusions

The HIGHRES project aims to preserve the history, traditions, and customs of rural areas. When expanded to the European context, this mission takes on greater significance, offering a multifaceted perspective on the various fields in which it operates. Furthermore, the collaboration among the project partners adds numerous nuances to the materials developed.

On the other hand, HIGHRES fosters empowerment, cohesion, and creativity within the communities it currently serves and those it will reach in the future, working with technology based on fundamental principles adapted to our times: sustainability, democracy, and truthfulness. This task takes on greater importance in the social context we currently live in, especially within the online space.

Finally, addressing the digital divide as one of the project's main objectives helps ensure that communities have presence and a voice in the digital and online space. The training platform implemented provides these communities with free access to high-quality education in this regard.

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The Filter Market: A Speculative Interface for Buying and Performing Civility in Online Comments

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Abstract

This paper presents Filter Market, a speculative and satirical interface designed to elicit reflection on how civility is commodified and personalized in online comment sections. Positioned as a satirical layer over comment sections in news websites, Filter Market imagines a system where users can buy, sell, and apply emotional or ideological "civility filters" using a digital currency earned through participation. Through this deliberate exaggeration of current trends in content moderation, algorithmic filtering, and gamified user engagement, Filter Market does not aim to solve online incivility. Instead, it dramatizes these issues, encouraging users to critically examine how civility is shaped, rewarded, and performed by digital platforms. Grounded in speculative design and research-through-design methods, this work explores how speculative but plausible interface systems can reveal the hidden politics of online discussions. It details the conceptual framework, design process, and the system's main features: its marketplace, filtered comment threads, user filter profiles, and community leaderboards. Ultimately, this work contributes to the field of digital and interactive arts by employing speculative UI design as a tool for cultural critique, inviting discomfort, irony, and self-reflection, and serving as a mirror to the systems we already inhabit.

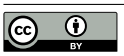
CCS Concepts

• **Human-centered computing** → Collaborative and social computing; Interaction design; Interaction design process and methods.

Keywords

Speculative Design, Online Incivility, Satirical User Interface, Digital Civility Performance

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1 Introduction

The Web 2.0 concept proposed a vision of connection in which the web is not merely a repository of information, but a platform where users are also content creators with a participatory role [1]. The rise of platforms that enabled asynchronous discussion, combined with the growing number of online users [2], has allowed more people to engage and express opinions with others across time and space [3]. However, these spaces are increasingly marked by behaviors categorized as uncivil. While online incivility is often associated with social media platforms, it extends far beyond them [4].

Digital platforms are not neutral infrastructures [5 - 7], and designing for civility is not a novel concern. A substantial body of work in human-computer interaction (HCI), computer-mediated communication, and digital media studies has examined moderation systems, nudging mechanisms, and affordances that shape social behavior online [8 - 12]. Different platforms have introduced a range of interventions, from comment disabling to content filtering and behavior-based nudging [13 - 15], often embedded within interfaces users cannot see or control. These systems promise a more "civil" digital environment, yet they operate as opaque infrastructures that commodify interaction while externalizing the responsibility for discourse quality onto individual users.

This paper proposes a speculative and artistic counterpoint: *Filter Market*, a fictional yet plausible interface that satirizes the personalization and gamification of civility in online discourse. Rather than hiding the mechanisms of moderation, *Filter Market* dramatizes them by making civility a tradable product and making visible the ideological, emotional, and behavioral filters that shape user experience. In this system, positioned as a satirical layer over comment sections in news websites, users can purchase, sell and apply "civility filters" with distinct tonal or ideological properties, using a digital currency earned through participation (CivBuckets). Filters are openly bought, sold, and curated in a public marketplace, with supply artificially constrained to create scarcity and prices fluctuating based on popularity and controversy. Users are not explicitly ranked, but their filter usage footprint and portfolio are publicly viewable, exposing their reading preferences and filtering habits as soft markers of identity, reflecting their values and online persona.

Filter Market does not aim to solve online incivility and is not a design solution intended to be implemented in real platforms. Instead, it functions as a speculative interface: an artistic artifact intended to provoke reflection on the hidden systems governing digital interaction. Its goal is to dramatize these issues, encouraging users to critically examine and question how civility is shaped, rewarded and performed by digital platforms. Drawing from speculative and

critical design traditions, this project positions the interface as both an object of critique and a medium of cultural and artistic inquiry, inviting audiences to interpret, discuss and reflect on their own digital behaviors and the systems we already inhabit.

The remainder of this paper is structured as follows: Chapter 2 reviews the conceptual landscape around online civility, interfaces, and speculative design. Chapter 3 outlines the methodology and design process behind *Filter Market*. Chapter 4 presents the speculative system and its interfaces, detailing its marketplace, filtered comment threads, user filter profiles and community leaderboards. In Chapter 5, the broader implications of the work are discussed, including the politics of civility, the importance of discomfort, and the role of speculative design in surfacing invisible platform dynamics. We conclude in Chapter 6 by considering the potential of *Filter Market* as both provocation and participatory reflection in the context of digital and interactive arts, and by outlining directions for future work.

2 Conceptual grounding

2.1 Online civility as a Commodity

Online incivility has become a widely studied phenomenon across media studies, political communication, and human-computer interaction. What constitutes *uncivil* discourse is rarely neutral or universal, but it is often understood as discourse that violates social norms of politeness, respect, or constructive dialogue, without necessarily crossing the line into hate speech, threats, or harassment [4, 16]. While the term is sometimes used interchangeably with more extreme behaviors, it can also describe sarcasm, dismissiveness, aggressive tone, or personal attacks that, while not explicitly harmful, can degrade the quality of discourse and discourage participation.

The causes of online incivility are varied. Anonymity, disinhibition, lack of nonverbal cues, and rapid communication are often cited as contributing factors [4, 16 - 22]. Cultural context, platform norms, and emotional states also influence what is perceived as uncivil. Importantly, incivility is not always intentional. As Lück and Nardi [3] argue, asynchronous communication can detach expression from immediate social feedback, which can lead to misinterpretation or emotional spillover. Similarly, a comment perceived as hostile in one cultural or political context may be read as reasonable critique in another [23 - 28].

Although much of the public discourse on incivility centers on social media, it is also prevalent in other digital spaces, such as news websites. As Coe et al. [4] found, over 20% of user comments on a major newspaper website displayed some form of incivility. In apparent response, several major platforms, including CNN and Reuters, have disabled comments altogether.

Far from being an outcome of healthy discourse, incivility is frequently manipulated through various systems of control (like behavioral nudges, moderation tools, algorithmic filtering), all of which reflect platform values and biases. In this environment, users are often incentivized to conform to platform norms in exchange for visibility, reputation, or continued participation [11].

While often justified as a way to protect users from harm or harassment, the rise of personalized feeds where content is increasingly filtered to match perceived preferences also reduces exposure to difference and divergence of opinions and points of view [29 - 31]. As a result, these hidden interventions effectively repackage online civility into a commodity that can be produced, measured, and monetized, thus defining "comfort" as little more that the mere absence of conflict.

2.2 Interfaces and Filtering

Interfaces are not neutral; user interfaces (UI) shape how users perceive, engage with, and interpret information [5 - 7, 32]. From comment thread layouts to reaction buttons or moderation tools, every design choice carries social and political implications.

Several studies have explored design strategies to influence civility. These proposals include nudging mechanisms (like prompts encouraging users to rethink a comment before submitting), friction-based features (such as delays in posting), and greater visibility of community guidelines have been proposed to mitigate toxic behavior [8, 9, 11, 12]. However, such interventions are often reactive and based on normative assumptions about what constitutes "good" online behavior.

Hidden filters in comment threads, which control visibility and ordering, can shape the discourse tone, yet they remain largely imperceptible to users, creating a "black box" in which users are relegated to a passive role while their experience is being shaped by invisible logics, rules or politics. Making these hidden mechanisms visible requires a shift from optimization to exposition. Rather than designing them as silent enforcers of online civility, we must surface these hidden processes, exaggerating them, and placing perceived control in the hands of the users. By maling filtering explicit, the process opens the door to questioning what forms of reflection and critique become possible when the mechanisms of discourse shaping are no longer obscure, closed and concealed.

2.3 Speculative Design

Speculative design, a practice coined by the work of Dunne and Raby [33], offers a means to interrogate dominant technological narratives by making alternative systems thinkable and discussable. The primary aim of speculative design is not to find a solution to a problem or enhancing usability, but to open critical dialogue, thereby facilitating thought on how things could (or should) be. It uses fiction, exaggeration, and even irony to reflect deeply on the cultural, ethical, and political dimensions of design [33 - 36].

This project positions *Filter Market* as a speculative artifact due to it being a fictional interface specially designed to dramatize the commodification of civility and the intense personalization of online discourse. *Filter Market* does not propose a technically "better" system, but an uncovering one. It deliberately exaggerates and spotlights trends already visible in platform design (such as gamified participation, opaque moderation, emotional targeting) to provoke discomfort and reflection, revealing the values and dynamics of these otherwise opaque systems. As such, the UI becomes an artistic research tool, enabling reflection not on a distant, possible future, but on the increasingly complex systems of our already emerging present.

3 Methodology

This project adopts a speculative design methodology to explore and exaggerate the hidden systems of online civility moderation through UI elements. Rather than aiming for functional implementation or traditional user validation, this research is explicitly grounded in Research-through-Design (RtD) where the very act of designing the speculative interface becomes both the research tool and the means of critical inquiry, generating knowledge and insights directly from the process of artifact creation [37 - 39].

The speculative design approach used in this work builds upon the idea that design can materialize cultural critique. Following Dunne and Raby [33], speculative design is not focused on immediate usability or finding a solution, but rather on provocation, reflection, and the creation of compelling "what if" scenarios. In this context, *Filter Market* is conceived as a fictional yet plausible system that dramatizes current (often hidden) trends in platform personalization, emotional filtering, and the commodification of civility. While the project does not seek to test user satisfaction, its core effectiveness relies on generating public interpretation and critical discussion, consistent with both speculative design and artistic research practices. In this sense, Filter Market is conceived as both a research artifact and a media artwork, strategically intended to engage audiences through exhibition, dialogue, and reflection.

By embedding familiar UX patterns within an uncanny, satirical system, the artifact operates as a critical mirror, reflecting the hidden values and embedded assumptions of real-world interfaces. Its purpose is not to offer a technically superior moderation system, but rather to provoke both users and designers into questioning the norms and politics embedded within algorithmic infrastructures.

3.1 Design Process

The design of *Filter Market* followed a structured, iterative and reflective process:

- Contextual framing: This initial stage involved a deep mapping of current moderation and personalization practices across various digital platforms. Particular attention was dedicated to comment sections on news websites, specifically noting the trend toward automated filtering or outright removal of the section, thereby highlighting the current crisis in public discourse infrastructure.
- Brainstorming and scenario-building: Inspired by speculative methods, this research phase included the formulation of guiding questions intended to stimulate reflection and discussion. Questions such as: 'What if civility was a tradable asset?' or 'What if filters had limited availability?' were used as starter questions to guide the design of the system's mechanics.
- Prototype development: A comprehensive series of medium-fidelity mockups were produced in co-design sessions involving two designers, serving to materialize the proposed speculative interface. The mockups developed include the four core interfaces: the marketplace, the filtered comment threads, the user profile (showcasing the collection of filters), and the leaderboard (displaying community/usage metrics). These artifacts were developed using Figma and structured around existing, real-world UI conventions (e.g., app store aesthetics) to intentionally heighten the sense of plausibility and critical irony.
- Internal critique and refinement: The designed artifact underwent rigorous review in critique sessions involving designers and representative users. Design decisions were continuously adjusted to carefully maintain a critical balance between unsettling realism and discomfort, as well as clarity and ambiguity. This process ensured the artifact remained a provocation, avoiding the temptation to smooth out its satirical rough edges

3.2 The Artifact

Filter Market is not a functioning prototype, but a critical and artistic artifact explicitly designed for presentation, reflective critique, and potential public exhibition. Through its specific interface design, the project aims to dramatically exaggerate the emotional economies [40], ideological tensions, and gamified incentives that are embedded in real-world platforms. It forces critical engagement by inviting questions such as: 'What does it mean to "increase" civility?', 'How do users become complicit with the creation of their own ideological bubble?', and 'Would our experience be improved if the web was made more "comfortable" by removing conflict?'

By making the filtering process visible, transactional, and user-controllable, *Filter Market* shifts the mechanism from opaque algorithmic condescension to a form of participatory satire. As such, it aligns with emerging approaches in design research, interactive art, and critical HCI that view the interface not only as a medium of interaction, but as a medium for cultural reflection and critique [41 - 44].

4 The Filter Market

Filter Market is a speculative and artistic artifact applied to the comment sections of news websites, reimagining civility moderation as a public, performative, and transactional act. The design intentionally combines familiar UI patterns with exaggerated mechanisms of personalization, gamification, and emotional classification to make explicitly visible the hidden infrastructures of platform discourse. The system is composed of four interrelated interfaces, each designed to provoke critical reflection on how online behavior is filtered, commodified, and performed, inviting both observers and participants to interpret the system's satire through their engagement.

4.1 The Marketplace

The central interface is a public marketplace (Figure 1) where users can browse, create, and purchase filters. These filters are either user-generated or platform-curated tools designed to alter the way comments are displayed to the reader. The system introduces critical economic friction: there are a limited number of filters available; and creating a new custom filter is significantly more expensive than purchasing an existing one. This mechanic introduces artificial scarcity and encouraging behavioral conformity through market forces. Each filter is presented with a detailed set of information, emphasizing its commodified nature and effects:

- A name and description (e.g., Polite Rage, Cynical Optimist).

- Tags indicating emotional or ideological targeting, as well as bias drift indicators.
- Visibility metrics (e.g., ”Blocks 12% of comments”), quantifying the filter’s active impact on the discourse seen by the user.
- Price in CivBuckets (the internal digital currency), which is dynamically adjusted based on factors like scarcity, saturation, and controversy level. To simulate real market dynamics, a select group of filters are automatically sold with a discount each week.

The marketplace is deliberately styled like a mainstream app store interface, showcasing trending filters, limited-availability items, and highlighted filters (like the last releases). This aesthetic parody of digital marketplaces reinforces the project’s critical tone and artistic intention by showing the marketization of emotional comfort.

4.2 Comment Thread

Once a user applies their chosen filters, the Comment Thread (Figure 2) on any news article is transformed. The comments are reordered, hidden, or annotated based on the filter’s logic. A persistent top bar provides live, quantified statistics: the number of visible comments, a summary of applied filters, the count of comments hidden, and a highly critical metric called ”Echo Chamber Index” presented in percentage form. Visible comments may be accompanied by annotations reflecting their emotional tone (e.g. resignation with a touch of hope), or information indicating which filters influenced the visibility and position of the comment (e.g. the symbol corresponding to the “Empathy Lens” filter).

Users retain the option to reveal the hidden comments, which would then be accompanied by system-generated justifications for its suppression. Examples of these justifications include:

- ”Hidden due to ideological misalignment (Score: -72%)”
- ”Suppressed by your ’No Sarcasm’ filter”
- ”Filtered out for excessive emotional volatility”

The visibility of these justifications is intended to provoke discomfort and reflection on the invisible gatekeeping present in contemporary online discourse systems.

4.3 User Profile and Footprint

Each user has a public profile showing their filtering habits. Unlike typical social platform norms, users are not explicitly scored or categorized, but their behavior is made visible through data traces. Public profile information is designed to showcase the user’s self-curated experience, functioning as a performative footprint of their online persona:

- A ranker list of most used filters.
- The number of filters purchased and created.
- The percentage of opposing views filtered out.
- A quantified Bias profile (“Filter use aligns 74% with Left-Moderate Emotional tones”).
- A Bubble effect graphic representation.

These footprints serve as soft reputational signals, inviting other users to interpret, judge, or potentially mimic their filter behaviors. The profile design deliberately evokes social media dashboards and gamified self-tracking applications, satirically engaging with the widespread aesthetics of self-quantification.

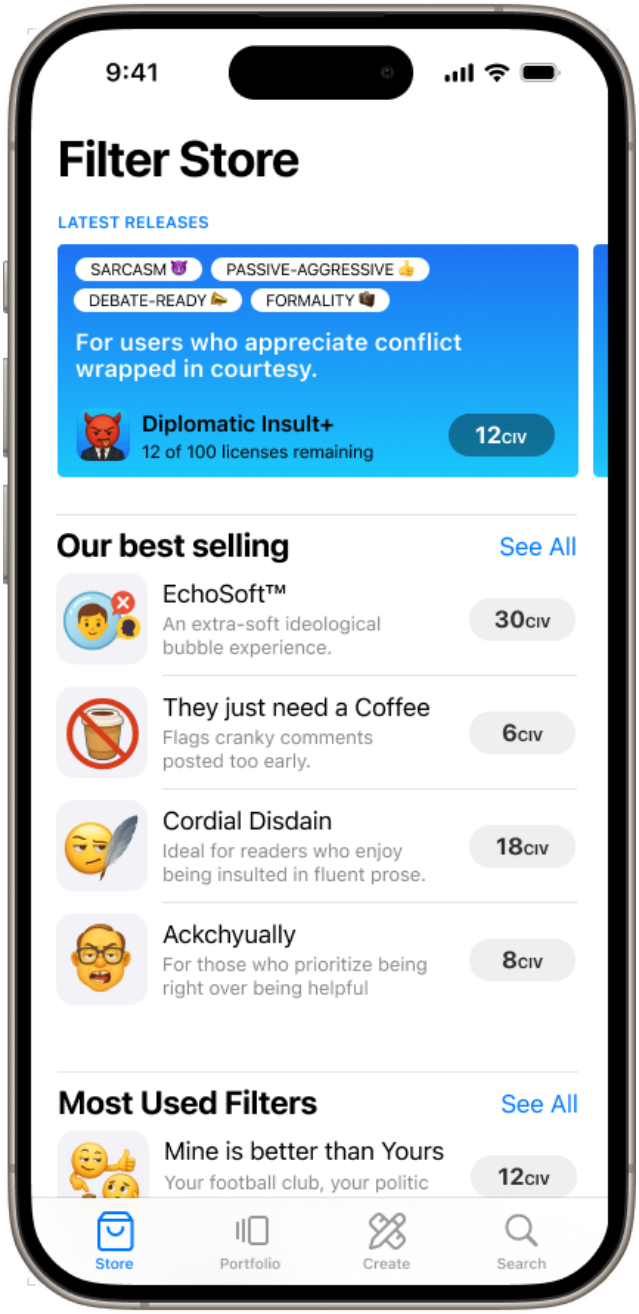


Figure 1: – Filter Market Store

4.4 Leaderboards and Market Metrics

To amplify and critically expose the system’s gamified economy, *Filter Market* includes a series of public metrics and rankings of the community, displayed on a dedicated dashboard. These metrics

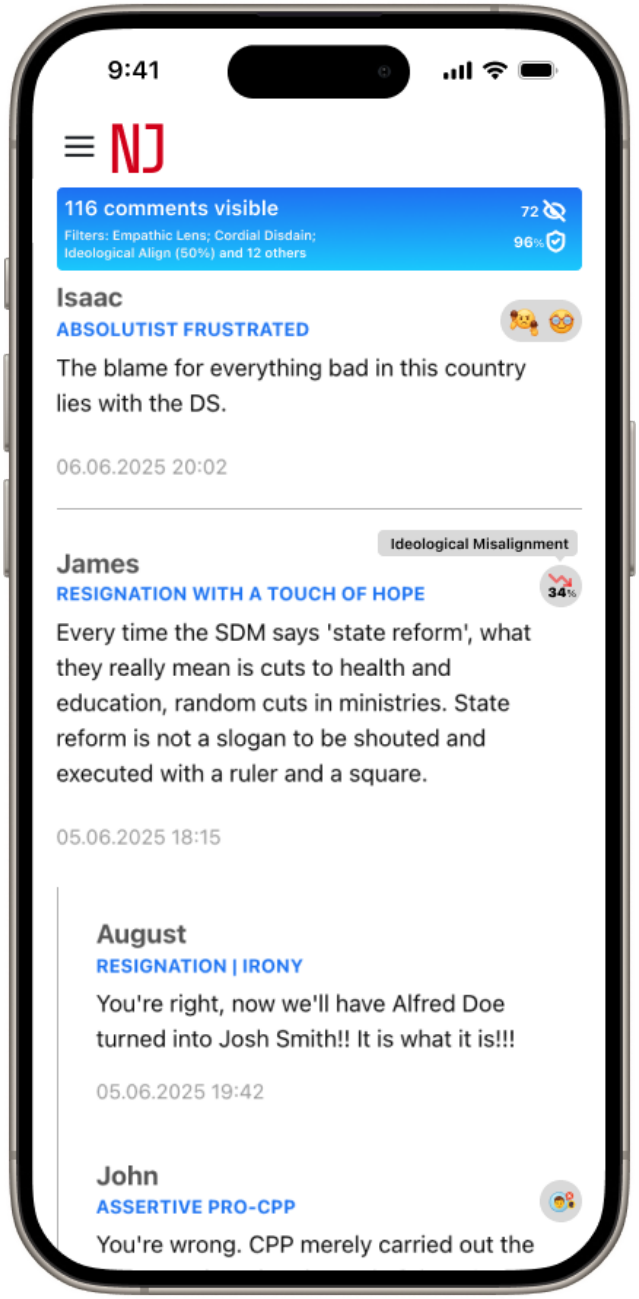


Figure 2: – Comment Thread with Filters applied

reinforce the fiction of civility as an economy where emotional and ideological preferences are measurable and tradable assets:

- Most sold filters of the week.
- Most applied filter.
- Rarest filters in circulation.
- The 10 most filtered users (presented as a satirical badge of dishonor or notoriety).

The inclusion of these leaderboards echoes the dynamics of real platforms, where user behavior is publicly compared and quietly shaped by visibility metrics and gamified incentives. Collectively, these elements construct a fictional yet coherent system where civility is something users can buy, create, and perform. Through this exaggerated realism, the interface invites critical reflection on the values embedded within digital discourse systems and their support infrastructures.

5 Discussion

As discussed previously, *Filter Market* is not intended as a technological proposal, but as a cultural and artistic probe. It exaggerates existing platform logics to make visible the political, emotional, and ideological dimensions of digital civility in the comment sections of news websites. By turning filtering into a marketable, gamified activity, the project asks what it means to perform civility in a system where discourse is shaped by economic incentives, reputational signals, and personal comfort. This section elaborates on three key implications of the work, framing the artifact as a tool for critical inquiry.

5.1 Performing Civility

In many contemporary digital spaces, civility is framed as the responsibility of each user to remain polite, composed, and respectful. However, *Filter Market* exposes the often-invisible infrastructure choices that perform civility as we know it. When (or if) users are given the power to filter, annotate, and rank comments, and when those tools are tied to public profiles and currency systems, civility becomes something strategic and transactional. Users are incentivized to perform civility to earn rewards, manage public impressions, or avoid ideological discomfort. The interface amplifies this logic.

The system uses satirical rewards like congratulations messages ("You have filtered 85% of opposing views today") or badges ("Echo Chamber Elite") to quantify and therefore mock the quantification of discourse quality. In doing so, the speculative system shifts the emphasis from civility as a relational practice to civility as a form of measurable compliance. This reflects how platforms often instrumentalize user behavior under the disguise of normative improvement.

5.2 Discomfort and Interface as a Critique

The uncanny tone of *Filter Market* is intentional. It is intentionally designed to create a sense of discomfort through a near-familiar interface that resembles real-world app stores, self-tracking dashboards, and comment threads on news websites. This generated discomfort serves as a critical mechanism: it forces users to confront the invisible filtering that already structures their daily online experience. By explicitly exposing these often-hidden mechanics, the project encourages reflection on the aesthetics of moderation and the subtle politics embedded in design decisions.

Interfaces are rarely neutral. They shape what is visible, what is prioritized, and what is silenced. *Filter Market* surfaces these dynamics by making filtering choices explicit, personal, and even public, transforming what is usually an internal, hidden algorithmic process into an aesthetic experience of critique.

5.3 Speculative Design as Artistic Research

The project make a clear contribution to ongoing discussions in speculative design and digital art, aligning with traditions such as Adversarial Design [45], Design Fiction [46, 47], and Research-through-Design [39]. It leverages interface aesthetics not for optimization or to improve usability, but to produce a necessary critical distance, enabling audiences to reflect on the systems they are embedded in.

In the context of digital and interactive arts, *Filter Market* can be seen as an artwork that dramatizes datafication, performativity, and emotional labor in online platforms. Rather than speculating on distant, hypothetical futures, the artifact reflects critically on the systems we already inhabit by making hidden mechanisms visible and uncanny. The disruption of the familiarity of everyday digital experiences opens them up to intellectual and artistic reflection. As such, *Filter Market* invites further exploration into how speculative UI artifacts can be used in exhibitions, workshops, and pedagogical settings as powerful tools for public engagement and self-reflection. The work thus reinforces the position of the speculative interface as a potent form of artistic research.

6 Conclusion

Filter Market is a speculative interface that dramatizes the commodification of civility and the personalization of online discourse. By turning filtering into a public, gamified, and transactional act, the project exposes the hidden infrastructures and design logics that increasingly govern digital interactions. Rather than offering solutions to online incivility, it invites discomfort, reflection, and critique.

Through its satirical interface design, the project reframes civility as something to be performed, managed, and bought. It highlights how personalization mechanisms, moderation tools, and reputational systems intersect to shape what is visible and what is sayable in digital spaces. By making these mechanisms exaggeratedly explicit, *Filter Market* functions as both a cultural provocation and an artistic research artifact, extending speculative design methodologies into the domain of media art, where critical reflection can become a shared and embodied act.

This work contributes to the fields of speculative design, digital art, and critical interface studies. It exhibits the potential of speculative UI design as a method for exploring power dynamics, affect, and ideology in computer-mediated environments. As digital civility becomes an increasingly important and contested design concern, artistic probes like *Filter Market* offer a space for generating alternative, non-solutionist thinking.

The research team is currently working on the development of other speculative interfaces concerning online incivility within news comment sections. Future work may also include developing interactive prototypes, participatory workshops, or exhibition installations that further explore audience interpretations and reactions to such systems. Ultimately, *Filter Market* must be understood not as a blueprint for implementation, but as a tool designed to ask better, more uncomfortable questions about civility, platform control, and the interfaces we inhabit.

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Digital Masks: Reimagining Digital Media for Co-Presence with the Kogi

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Abstract

This paper presents an art-based research on digital media and indigenous communities. It departs from Kogi sacred masks to discuss community life and how digital media can serve as a relational, ethically attuned environment for engaging with indigenous communities in the Sierra Nevada de Santa Marta in Colombia. Grounded in visual ethnography, autoethnography, and analogue photography, the project explores how image-making may shift from mere acts of capture to practices of co-presence, inner silence, and respectful withholding. The work draws from the story of two sacred ritual masks repatriated from Berlin to the Kogi in 2023, using them as both material artefacts and conceptual metaphors for opacity, sovereignty, and spiritual integrity. Through digital fragments, ambient sound, underexposed imagery, and poetic interruption, the digital arts project challenges conventional representation and contributes to a decolonial visual methodology rooted in care and attentiveness.

CCS Concepts

• **Human-centred computing**; • **Collaborative and social computing**; • **Empirical studies in collaborative and social computing**; • **Computing methodologies**; • **Artificial intelligence**; • **Philosophical/theoretical foundations of artificial intelligence**; • **Applied computing**; • **Arts and humanities**; • **Media arts.**;

Keywords

Indigenous media, Digital ritual, Decolonial aesthetics, Visual sovereignty, Digital mask, Analogue photography, Kogi, Masks, Spiritual technology, Co-presence

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1 Introduction

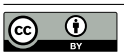
This paper reports on arts-based research involving the native Kággaba community (hereafter referred to as the Kogi), Ikʉ (also known as the Arhuaco), Wiwa (Saha), and Kankuamo (Kankwe) [1], focusing especially on the Kogi people. It outlines the intersections of digital media, indigenous epistemologies, and artistic research through the case of the Kogi community of the Sierra Nevada de Santa Marta. In particular, the research emphasises the nuanced negotiation between traditional knowledge holders and the mediated spaces offered by digital tools, considering the implications of each intervention on communal trust and continuity. The project emerges from long-term artistic and ethnographic engagement in the region between 2019 and 2025 and is guided by a central question: How can digital arts and media function as a sensitive space for the representation and coexistence with the Kogi community while respecting their epistemologies and protocols?

The motivation is simultaneously academic, artistic, and personal, blending photography, theory, and ethics in response to the ongoing visual challenges posed by colonial histories of image-making. The multidimensional approach is intended to bridge theoretical reflection with lived experience, aiming to produce outcomes that are both intellectually rigorous and socially meaningful. As a photographer, mother, and researcher, I sought to observe and cohabit with complexity rather than explain it. This research is also a part of an ongoing digital arts doctoral project that merges visual practice with postcolonial reflection and decolonial methodologies grounded in relational ethics.

1.1 Context and Background

The Kogi can be considered the community with the most preserved customs and way of life according to the traditions of their ancestors. Their original name, Kággaba, means 'human'. Since the development of technology is often put in context with humanity, it is appropriate to connect via digital media the themes of cultural traditions and current technologies. The Kággaba, or Kogi, are an indigenous community that has preserved much of its pre-Columbian knowledge and spiritual traditions [2]. Located in the highlands of the Sierra Nevada, an isolated mountain range in northern Colombia, their philosophy emphasises ecological balance and communication with ancestral spirits. The interrelation of ecological consciousness and digital exploration forms a key part of the methodological inquiry, allowing the study to extend ethical frameworks into contemporary technological contexts. They refer to themselves as "Elder Brothers", guardians of the Earth who observe the imbalance caused by Western societies, or "Younger Brothers".

In 2023, two ceremonial masks taken by ethnologist Konrad Preuss in the early 20th century [3] were returned to the Kogi from the Ethnographic Museum in Berlin. For them, these masks are not simply artistic objects—they are animate vessels of ancestral



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presence. Their return raised questions about cultural restitution, the value of sacredness, and the limits of visual access. The masks also serve as catalysts for dialogues surrounding memory, presence, and the ethics of digital replication, prompting reflection on what it means to translate spiritual objects into a digital form. These masks also became a conceptual axis for this project by raising questions such as, 'What does it mean to see without showing? To listen without documenting? To interact digitally without extracting?'

Historical visual representations of indigenous peoples have often served colonial agendas: the act of visualising the "other" has frequently coincided with control, classification, and silencing [5] [6]. For the Kogi, the notion of visibility is not neutral: images can reveal too much, endanger what is sacred, or distort what is relational. Hence, a core objective of the study is to balance visibility with ethical restraint, fostering a digital environment that respects indigenous autonomy. Thus, respecting the right to opacity [7] and establishing protocols for what can ethically be made visible are central to the research.

1.2 Research Design

Our research was grounded in a multimodal, layered technique that incorporates arts-based research, in which art functions as a means of knowing rather than as an object of analysis; visual ethnography, which recognises images as situated, relational, and affective; and autoethnography, to acknowledge the researcher's circumstances embedded in maternal, cultural, and ethical dimensions. The integrative approach allows for multiple voices, including those of community elders and collaborators, to influence the process of knowledge production.

Drawing inspiration from feminist and decolonial thinkers like Puig de la Bellacasa [8], Haraway [9], and Ruddick [10], the researcher approaches knowledge as a relational, embodied, and contingent entity. In this context, photography and digital artefacts are means of encounter and mediators of relational engagement as opposed to being objective instruments. By embedding reflexivity at every stage, the project challenges conventional hierarchies of knowledge and foregrounds collaborative co-creation as a methodological principle. Research outputs based on the interaction with the Kogi include analogue negatives, visual diaries, recorded reflections, field notes, and digital compositions that resist linear narrative and embrace fragmentation.

In this study, reflexivity is the process by which the researcher continuously recognises and critically assesses her own role, presumptions, and influence on the research itself. This entails admitting that research is not an impartial or objective endeavour but rather is influenced by the researcher's presence, methodology, relationships with subject matter experts, and subjective experiences. It also provides a space to interrogate the emotional and ethical dimensions of co-presence, fostering ongoing learning and adaptation.

Rather than attempting to "capture" indigenous life, the researcher engaged in practices that reflect the aesthetic values of silence, slowness, and ambiguity. This included underexposed and blurred photography, evoking absence and the impossibility of full representation; glitches and digital noise, suggesting instability, resistance to clarity, and the refusal of digital smoothness; ambient soundscapes, layered with still images, to create poetic affective atmospheres; and interactive maps that respond to presence and resist linear navigation.

Inspired by the ritual masks as liminal and sacred media, the photographic image becomes a form of mediation rather than documentation. A photograph can reveal how one relates to something even if it may fail to show what it is.

The project contributes to several fields: visual anthropology, by practising photographic restraint and ethical hesitation; digital humanities, by reimagining digital space as poetic, relational, and temporal; and decolonial aesthetics, through the refusal of extractive visuality and the embrace of opacity. These contributions are framed through an epistemology of care and attentiveness, rooted in indigenous cosmologies and posthuman perspectives.

It also engages with the concept of visual sovereignty—the right of communities to control how they are represented—and challenges romantic or exoticising tendencies often found in visual arts involving indigenous subjects. Rather than translate the Kogi cosmology into Western-readable forms, the aim is to create spaces for viewers to listen and wonder, without total access. The term 'visual sovereignty' here refers to the right of indigenous peoples and communities to determine how they are represented, to define the narratives and contexts in which their images appear, and to maintain agency over visual knowledge. It goes beyond authorship or representation, engaging instead with the ethics of visibility and the power of images to sustain or disrupt relationships.

Finally, the work is situated within environmental urgency. The melting glaciers of the Sierra Nevada are spiritually crucial to the Kogi. Their extinction has ontological and cosmological implications in addition to ecological ones. The silence embedded in this research—visual and acoustic—mirrors this loss. A digital fragment or blurred image becomes a mourning gesture, a trace of disappearance.

1.3 Methodological Approach and Indicators

The research combines long-term ethnographic fieldwork, artistic interventions, and collaborative practices with the Kogi community members. The methodologies include analogue and digital photography, interviews and experimental prototyping of digital artefacts such as 3D-printed masks and glitch-based visualisations. Additionally, participatory workshops were planned for the future where community members could interact with prototypes, offering direct feedback and influencing design decisions, thereby embedding co-authorship into the research process.

Indicators of success in this context are not quantitative metrics but instead relational and process-based. They include community feedback and participation – whether elders and participants recognise the interventions as respectful, meaningful, or aligned with their cosmology; emergence of dialogue – whether the artefact (photographic, digital, or material) generates new conversations within the community or between the community and external institutions; continuity of engagement – whether the collaboration results in further invitations, projects, or community-led initiatives; and affective resonance – whether the digital interventions (e.g., masks, glitch images) evoke responses that acknowledge their spiritual or symbolic dimensions. Further indicators include the extent

to which the interventions facilitate shared reflection on heritage, memory, and intergenerational knowledge transfer, strengthening relational bonds within the community.

These indicators ensure that the methodology remains accountable not only to academic standards but also to indigenous ethical frameworks and the relational nature of the Kogi worldviews. They also provide a model for future digital arts research involving other communities, emphasising that ethical engagement and co-presence should guide methodological planning.

The project unfolds through an emergent process that connects all phases of the work. Each step generates the next – the research is cyclical, self-renewing, and guided by intuition, attention and dialogue with the environment and people involved. The direction becomes clear through the practice itself—when forms, ideas, and relationships begin to reveal their own logic. This emergent, adaptive approach allows the project to remain sensitive to the needs and protocols of the community while fostering innovation in digital arts research. Success is not measured by predefined results but by the sense of coherence that gradually emerges as participation deepens, as new layers naturally align, and as the structure begins to articulate.

Practically speaking, the approaches discussed here are transformed into tangible artistic and cooperative endeavours, like community consultations, iterative field reflections, and the co-creation of digital and photographic artefacts. These methods give the theoretical framework a solid foundation in real-world interactions that can be seen, discussed, and expanded upon both inside and outside the community. Moreover, documenting these interactions allows for reflection on processual ethics, highlighting the tensions, compromises, and learning moments that define relational research.

2 DIGITAL MEDIA AS A RITUAL SPACE

Digital media, especially in their dominant institutional forms (social networks, data visualisation, and interface design), are often perceived as spaces of acceleration, transparency, and performativity. However, when reimagined through the lens of slow media, anti-interface theory, and speculative design, they open up possibilities for perceiving the digital as a muted, unfocused, temporally expanded space. By rethinking time, attention, and sensory engagement, the digital can function as a transitional zone that facilitates introspection, ritual, and social connection.

In the Sierra Nevada, time follows a different rhythm [11]. Daily life reflects slowness, storytelling, and repetition. This observation inspired the concept of "silent interactivity"—a bodily, intuitive, and symbolic relationship with the screen, where coexistence, not domination, is implied by touch. Silent interactivity can manifest itself, for example, in how a user slowly and attentively views a digital artefact without the need for quick reactions or clicking, creating space for internal reflection and silent connection with the content. It encourages mindfulness and a sensory awareness that parallels the attentiveness required in Kogi ritual practices. In contrast to conventional interface design based on immediate feedback and predictability, silent interactivity values non-response, delay, looping, and subtle sensory engagement. It resonates with the temporalities of nature, ritual, and care.

Another way to think about the digital medium is as a ritual or spiritual space that is suspended, transformative, and transitional without being religious. This perspective draws from Vilém Flusser, who described photography and technical images as new mythologies that shape our thinking and displace traditional narratives [12]. The research initiative investigates how interactivity itself might become a ritualised practice by applying this viewpoint to digital media, where intentionality, presence, and attention define the medium as opposed to just the information. Thus, the digital becomes a transitional space where reality is symbolically re-encoded rather than represented.

Lev Manovich's distinction between narrative and database offers further depth [13]. He proposes that databases, unlike stories, are cyclical, fragmented, and non-linear, aligning more closely with ritual structures than sequential logic. This insight supports the design of digital masks as non-linear environments where engagement is iterative, exploratory, and relational, echoing Kogi concepts of temporal continuity and ancestral memory. The digital medium becomes a field of potential, return, and pause—an unfinished search akin to an initiation rite.

According to Zylinska in her interview with Dewdney, the concept of nonhuman photography reframes the digital as a medium of inhuman sensitivity, capable of recording traces beyond human perception [14]. This implies that digital media's ethical strength comes from its capacity to preserve memories, intuition, and silence, not from portrayal [14]. It also highlights the responsibility of the researcher to consider nonhuman agency, including the presence of ancestral spirits, ecological forces, and material traces in digital mediation.

These reflections on digital media as ritual spaces directly intersect with decolonial visual practices, where visibility, power, and relational ethics become central concerns in the encounter with the Kogi community. In accomplishing that, the study advances the field of media arts studies as well as current discussions around the morality of representation and technological co-presence in cross-cultural settings.

3 DECOLONIALITY AND VISUALITY

Decolonial thought, in this context, refers to critical approaches that challenge the colonial structures of knowledge and visuality, seeking to restore relational and plural ways of knowing. Similarly, posthumanist perspectives decentralise the human subject, recognising the agency of nonhuman entities, technologies, and environments in shaping meaning.

Based on the relationships established in the field and interviews conducted during the research, it follows that for the Kogi community, visual images—and especially photography and video—are a sensitive and often problematic matter. As British filmmaker and historian Alan Ereira pointed out during our conversation in 2024, the only possible way to depict this community is to become an instrument in the hands of its members. This principle became the starting point for the research approach, namely, to see digital media as a shared space of dialogue.

This also brings forth the deeper ethical challenge embedded in the act of representation itself. As Stuart Hall reminds us, representation is a process by which meaning is actively created instead of

being a neutral reflection [15]. It thus becomes a situation of struggle over who has the authority to define and circulate meanings. In the context of indigenous communities, this struggle is often asymmetrical, reflecting broader colonial histories and epistemic hierarchies. Visibility, often associated with empowerment, can also function as a form of control or exposure. Not all communities seek or benefit from visibility in the same way. Following Édouard Glissant's concept of the "right to opacity" [7], some aspects of the Kogi life may resist representation altogether—not as a defence, however, but as a proactive measure of defence, authority, or moral rectitude.

The relationship between digital media and indigenous communities must therefore be approached through decolonial thinking. Tlostanova & Mignolo argue that digital media's engagement with indigenous communities must be approached via decolonial thinking, which challenges the colonial matrix of power embedded in Western visual regimes—by knowing, classifying, and enclosing non-Western worlds [2]. Their concept of *delinking* from hegemonic epistemologies supports a right not to be represented, affirming non-visibility, silence, fragmentation, glitching, noise, or absence as ethically and aesthetically significant strategies.

This is in line with Michelle Raheja's notions of visual sovereignty, developed in the context of Native North American communities. Raheja defines visual sovereignty as the strategic assertion of control over representation—including framing, content, and audience interpretation—through indigenous cinematic practices such as confronting viewers head-on or "laughing at the camera" [16]. She observes how these tactics extend into digital domains, creating "visual sovereignty on virtual reservations" of indigenous design. By applying this to digital masks, the work presents technological mediation as a type of co-sovereignty in which the community and the researcher negotiate visibility, access, and meaning. This concept is further extended into what is called digital sovereignty—that is, control over not just image content but also appearance, framing, accessibility, and the digital architecture itself. Such sovereignty demands awareness of how digital spaces may reproduce or disrupt colonial dynamics and how respect for cultural protocols, sacred knowledge, and invisibility must shape digital engagement. During fieldwork with the Kogi, this manifested as a concern for reciprocity, protection, and demarcation. As one interlocutor stated, "People come and take pictures, but nothing is returned" [11].

In this light, the depiction of the Kogi is not merely an artistic or ethnographic task—it is a relational act shaped by trust, reciprocity, and attentiveness to what should not be shown. Digital media and photography are being repositioned as potential tools for co-presence, listening, and ethical hesitancy instead of just as tools for taking pictures.

4 PHOTOGRAPHY AS A MASK

Ritual masks are central to this research—both materially and metaphorically. In the Kogi cosmology, masks are not symbols of identity; they are instruments of transformation and communication. Created by the spirits (personal communication, 2024), they mediate contact with spiritual dimensions that cannot be approached directly. Similarly, photography is treated as a liminal tool, mediating between seen and unseen, human and nonhuman, and material and digital.

The duality—concealment and revelation—has a parallel in photography. The camera is a portal: it records, transmits, transforms, and interprets. Like the mask, it can blur, obscure, or filter. Photography becomes a representational tool but also a relational and ritual interface. While the digital medium serves here as an intangible, poetic, and temporal layer, the analogue image remains the body—the visceral, relational core of the research. The tension between analogue and digital mirrors the dialectic between presence and absence, material and abstract, and ritual and code. Photography, like the mask, is not a window; it is a threshold, a portal or a teleport gate. In this sense, photography as a mask is more than a metaphor—it is a method. It allows the image to serve not as a revelation but as a protection, silence, or offering. It challenges dominant photographic paradigms centred on transparency and opens space for a visuality rooted in spiritual and relational sovereignty.

Colonial interventions have long disrupted indigenous communities—transforming landscapes, appropriating sacred objects, and violating spiritual protocols. Yet the spiritual knowledge of the Kogi has endured, rooted in cosmological continuity rather than in material permanence. The return of two sacred masks from the Ethnological Museum in Berlin in 2023, facilitated by the Kogi Mámas and the Colombian president, was perceived as a political act and, moreover, as a restoration of spiritual balance. These masks are not artefacts in the Western museological sense—they are living entities, embodiments of ancestral presence, cosmological guardians, and tools of communication.

The Kogi emphasise the need to protect sacred knowledge from visual appropriation. "There are certain things we do not want to show," says a community member, "for example, rituals—they are intended only for us." (personal communication, 2020). The presence of photographs or video recordings of masked rituals is rare and often treated with ambivalence. Therefore, all interventions in this research prioritise ethical curation, selective visibility, and the intentional layering of access, echoing the mask's protective function. The appearance of one such video, showing a masked Máma dancing in a village ceremony, raises critical questions about visual sovereignty and digital ethics: Who controls the representation of indigenous rituals? What protocols should govern the circulation of sacred images in a networked world?

Photography and video are not neutral tools in the Kogi cosmology. As Máma José Shibulata explains, "They say they took a photo of the sun, and that image is a mask used to communicate with Jate Sé, the father of darkness" [17]. Here, photography becomes a ritual interface—a mask, a mediator between the seen and the unseen. Visual media are extensions of ancient instruments that are ingrained in cosmic history in lieu of contemporary intrusions.

The Kogi masks are thought to balance natural and spiritual energies. Their removal from the Sierra Nevada was believed to disturb the land itself, contributing to disasters and ecological imbalance. Efforts to restore these masks have been met with Western conservationist resistance. This conflict underscores a deeper tension between preservation as conservation and preservation as continuity of use. From this perspective, photography is analogous to the mask. Both serve as liminal objects—they conceal, reveal, mediate,

and transform. The mask is not a symbol of identity, the way we often view it, but a portal of transformation, much like the camera mediates between visibility and invisibility. Photography becomes a form of spiritual negotiation—not documentation but reverence.

An artefact accompanying the arts-based research – digital masks – photographic, interactive, or immersive – can echo this function. One conceptual artefact envisions a series of 3D-printed masks derived from photographic portraits, placed in a gallery under veils. The veiling honours the Kogi protocol of invisibility. These veiled artefacts invite the viewer to imagine without accessing, to respect without seeing.

In other versions, the masks may become portals in virtual reality, allowing users to "visit" a Kogi-inspired space while remaining physically distant. Such projects must be guided by ethical engagement and consultation with community members, following the principles of reciprocal representation.

We may also ask: What is a digital object? If masks are spiritual technologies created by deities, and digital artefacts are governed by algorithmic abstraction, what ontological status do they share? Like masks, digital objects are structured by codes, designed for communication yet charged with symbolic power. They can preserve, distort, or activate cultural meaning depending on their use.

The ongoing research views masks and media as analogous mediators: both are ritual interfaces shaped by specific worldviews. Both demand ethical protocols. Both hold memory. And both—when handled with care—can offer paths of encounter rather than consumption. The artefacts discussed later in the case study section provide a physical representation of the digital mask's conceptual framing, as 3D-printed prototypes, immersive settings, and interactive works bring theoretical ideas to life.

5 Case Study: Digital and Material Interventions

5.1 Artefact: Creating the World of the Kággaba (Audiovisual Immersion)

This audiovisual installation builds upon the conceptual 3D masks, translating the principles of mediation, liminality, and ethical engagement into a layered, immersive digital-analogue environment. It further integrates participatory soundscapes, where the community contributes ambient voices, music, and environmental audio, embedding relational co-authorship into the installation itself. Combining black-and-white analogue photography with colour video, ambient soundscapes, and recordings of the Saga singing in the Kággaba Chibchan language, the work evokes cycles of creation, memory, and presence. Water, as a feminine element, appears in multiple forms, reflecting the Kággaba cosmology.

The image on white cotton, the fabric used to make traditional Kogi clothing, creates a dynamic, tactile space that encourages slow, attentive engagement. Takeaway photographs extend the experience, transforming viewers into custodians of the images and prompting reflection on ethical responsibility and co-presence. This artefact exemplifies the doctoral project's aim to explore digital media as ritual, relational, and ethically attuned spaces, connecting back to the conceptual framework of 3D masks and materialised in various layers of digital and analogue media.

5.2 Artefact: Family Map and Mask (Material Realisation)

A concrete example of the methodologies can be found in the prototyping of a 3D-printed mask created from the portraits of the whole family line. By doing it, the author honours the ancestors' line, which is important in the community teaching. The digital model would be intentionally hidden at the final presentation, which aligns with the Kogi understanding that masks are not inert objects but carriers of spiritual presence.

Building on the theoretical premise of the 3D masks, the Artefact Family Map and Mask represent the materialisation of these ideas. Inspired by Sally Mann's concept of "layers of unknown family history" (2015), the project constructs a visual family map of the Kággaba community through a series of portraits. Each person is photographed against a neutral natural background with consistent focus on the face, emphasising individuality within continuity.

The portraits are layered in projection, gradually blending faces to generate a composite form—a prototype face—that will then be materialised into a sculptural mask. This mask becomes a symbolic synthesis of lineage and collective memory, referencing Kággaba cosmology, where family structures connect past, present, and future. The process resonates with ancestral presence and oral traditions, echoing the liminal, mediating role of ritual masks.

In parallel, the act evokes performative and contemplative dimensions similar to therapeutic family constellations, where participants embody family roles, experiencing emotional clarity and ancestral connection. This reinforces the mask as a threshold object—both aesthetic and ethical—mirroring the original theoretical 3D masks and linking analogue, digital, and material practices into a coherent methodological approach.

6 CONCLUSION

This paper reports on arts-based research related to digital media and Kággaba, with a focus on masks and people in community life. It argues that a shift is needed in how we think about digital tools in this context, namely, as ritual and poetic spaces that permit respectful co-presence with communities, cosmologies, and the non-human world, instead of being tools of spectacle or extraction. The research also demonstrates that ethical design, community consultation, and careful digital curation are essential for maintaining relational integrity and cultural sovereignty.

By embracing concepts related to absence, fragmentation, opacity, and symbolic ambiguity, this approach challenges dominant representational paradigms and offers a methodology of care—one that privileges listening over showing, attentiveness over display, and refusal over disclosure. Digital media are understood not as neutral containers; they function as shaping forces with ethical weight and spiritual potential.

In reframing photography and digital artefacts as masks, as thresholds, the study revealed new pathways for artistic research grounded in spiritual responsibility, decolonial ethics, and relationality. Its implications extend beyond the context of the Kogi community, speaking to broader artistic and anthropological practices that seek to work *with* rather than *on* the world. The approach has broader relevance across indigenous visual studies, contemporary media art, digital ethnography, and critical posthumanities, as

it invites practitioners to reimagine the digital as a sacred, dialogical space of co-existence, resonance, and trace.

The project has fundamentally redefined the understanding of relationality and its forms, deepening the awareness of the topic's sensitivity and opening a wide field of creativity. Throughout the research, the knowledge of the communities, their histories, and the epistemologies of digital media has significantly expanded. Multilingualism—initially understood as a way of seeing and perceiving reality—has been enriched by the languages of the analogue and the digital. These insights will continue to evolve through future encounters, both personal and virtual, with the communities, where the artefacts will find their form through the process of realisation itself.

The study foregrounds the potential of digital media as spaces for ethical co-presence, highlighting that engagement can be relational, contemplative, and non-extractive. By integrating slow interactivity, iterative engagement, and ritualised digital encounters, these media offer pathways to co-experience without domination or objectification. The research also acknowledges the risks and limitations of digital mediation, including unintended circulation, loss of control, and potential misrepresentation, emphasising that ethical engagement requires continuous negotiation, reflexivity, and technological safeguards.

Explicit links between the Kogi cosmology and environmental concerns further reinforce the methodological significance: as glaciers and ecosystems in the Sierra Nevada face critical threats, digital artefacts become tools for reflection on ecological continuity and the spiritual-ecological balance central to the Kogi worldview. The study thus situates digital arts within pressing socio-environmental contexts, demonstrating how creative practice can engage with both cultural and ecological sustainability.

Finally, the paper distils practical methodological contributions that can guide future research: (1) privileging relational and process-based indicators of success; (2) centring community agency in the design, access, and dissemination of digital artefacts; (3) integrating analogue, digital, and material practices into layered, immersive, and reflective experiences; and (4) embracing absence, opacity, and ambiguity as ethical and aesthetic strategies. These points provide a transferable framework for artists, anthropologists, and technologists working in cross-cultural or sensitive contexts.

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Perturbatio — An artistic framework for the visualisation of the cumulative eco-impact of human activities

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Abstract

In this paper, we present *Perturbatio* — a framework for the creation of participatory art installations that seek to visualise the collective impact of human activities on the environment. Starting from a general concept where 3D point cloud representations of land- or cityscapes are distorted according to live or pre-recorded data of human activities (such as crowd movements or traffic data), we developed four specific installations that were exhibited during the 2025 edition of *Nuit Blanche* in Paris, France. While *Perturbatio* is designed to work with a variety of visualisation supports and data input sources, the central idea is always to engage the public in reflections on scale effects and the difficulty of linking activities of daily life to their global consequences. The conception and production of the *Perturbatio* installations is guided by eco-design principles such as using existing hardware and minimizing transportation requirements.

CCS Concepts

• **Applied computing** → **Media arts**.

Keywords

Interactive Art, Digital Art, Sustainability, Eco-criticism, Point Clouds, Particle Systems, LiDAR scan, Crowd Interaction

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1 Introduction

Modern societies are facing a strange conundrum where our mere existence is threatening the liveability of our planet. People in Western countries have an average carbon footprint between 5 and 15 tons of CO2eq per year [25]. At the level of the individual, this often looks like a regular lifestyle — working, cooking a meal, enjoying entertainment, maintaining one's home, going on vacation by plane. While the emissions of a single person would be completely negligible on a global scale, the combined effect of hundreds of millions of these lifestyles, particularly those in the so-called *global north*, is drastically altering climate conditions, ecosystems, and societies worldwide. From the perspective of the individual, it is hard, if not entirely impossible, to comprehend the link between these everyday actions and the ongoing ecological collapse — yet, it exists.

With *Perturbatio*, we are proposing a framework for participatory art installations that seek to visualise the emergence of such cumulative effects and to render them more comprehensible and palpable. The public shall be invited to think about scale effects and the difficulty of linking supposedly mundane activities to their global consequences. The general idea is as follows: The scanned image of an ecosystem, land- or cityscape is cast into the form of a 3D point cloud which gets connected to the camera feed (live or recorded) of a busy location, such as a public square, pedestrian zone, shopping mall, transportation hub etc. Using computer-vision algorithms, passers-by or vehicles are detected in the camera feed, their movements are assessed and translated into forces that push and pull at the point cloud particles, causing perturbations and deformations (Figure 1). Each single passer-by (or vehicle) introduces only a little extra disorder, usually too small to be directly perceived. However, as this process evolves for several hours, the combined effect of hundreds or thousands of individuals becomes apparent. The point cloud image, initially structured, intuitive and concrete, gradually morphs into a blurry, impressionistic, and finally, abstract chaos.

By design, *Perturbatio* can be realised using a variety of data inputs and visualization supports. In this article, we present four concrete examples that were developed for the 2025 edition of *Nuit Blanche* and exhibited at the Museum of Arts and Crafts in Paris, France, from June 7th to June 17th, 2025 as part of the exhibition *L'Air de rien*.

2 Technical details and implementation

2.1 Point clouds

An implementation of *Perturbatio* starts with the choice of the motif to be perturbed and the creation and editing of its point cloud representation. A point cloud generally describes any collection of data points distributed in three-dimensional space where each point can have one or multiple attributes assigned to it. For example, in the context of 3D modelling, the spatial distribution of a point cloud usually resembles the shape of an object and each point has



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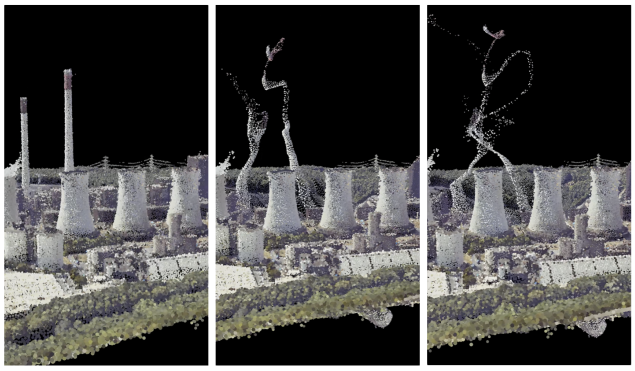


Figure 1: A point cloud showing the Scholven Power Station in Gelsenkirchen (Germany) getting gradually deformed as a result of the movements of multiple persons.

a colour assigned to it, corresponding to the colour of the object at that location. In *Perturbatio*, the focus lies on visualising the impact of human activities on the environment, point clouds typically depict threatened ecosystems (e.g., glaciers or river systems suffering from droughts) as well as urban centres and infrastructure (such as power plants, container ports or road systems). A good source for such motifs are 3D land survey data captured using aerial Light Detection And Ranging scanners (LiDAR) which are frequently provided by national geographic services. Alternatively, three-dimensional point clouds can also be computed from a series of conventional two-dimensional photos using photogrammetry applications such as Agisoft Metashape [4] or Polycam [22].

2.2 Render and physics engine

To display and manipulate the point cloud data, we developed a custom render and physics engine programmed in Python and OpenGL. The engine uses compute shaders to implement a simple model of Newtonian mechanics where the action of up to 512 forces on the individual point cloud particles is simulated in real time. Point clouds with well over 10 million points can be processed and rendered at a frame rate of 60 FPS (frames per second). The FFmpeg [29], OpenCV [6] and ffmpegcv [7] libraries are used to record time-lapse videos of an ongoing point cloud simulation.

2.3 Data input and interaction

Perturbatio is designed to work with a variety of data sources from which the forces acting on the point cloud particles can be computed. One approach is to use conventional video streams (real-time or pre-recorded) in which humans are detected and tracked using computer vision algorithms. For this, we used the default as well as custom-trained versions of the YOLOv8 detection and pose models [31] which were coupled to a custom-developed tracking algorithm. The algorithm allows it to follow the movements of individual persons across different frames, such that their displacements can be calculated and converted into the perturbing forces. Figure 2 shows an example where pedestrians in a busy public location are tracked using images streamed with a ceiling camera while Figure 3 illustrates the concept of pose tracking using a frontal-view webcam

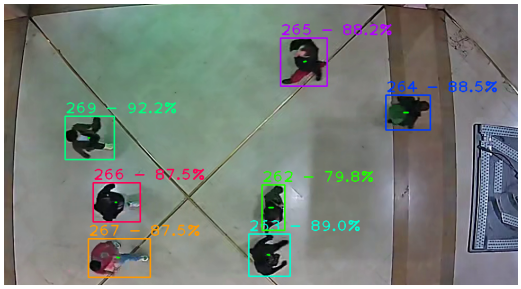


Figure 2: Passers-by in a busy pedestrian street detected and tracked by a custom algorithm. The image regions where persons were detected are indicated by coloured rectangles. The percentage values at the top right corner of the rectangles states the detection confidence. Individual persons are attributed a unique ID (top left corner of the rectangles), allowing it to follow their movements across multiple frames and to calculate their displacements (short green lines at the centre of the rectangles).

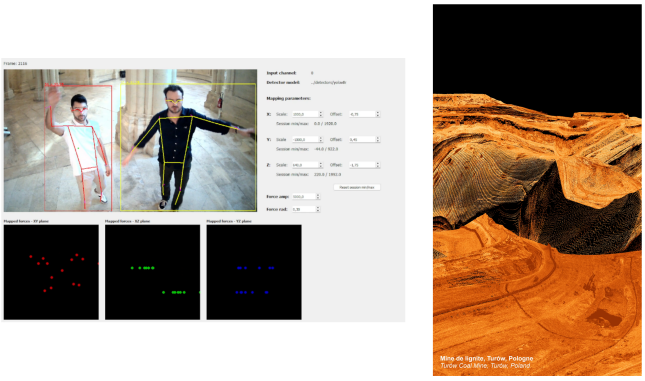


Figure 3: Two persons interacting in front of the installation described in section 4.4. Left: The results of the YOLOv8 pose detection model superimposed onto the webcam image. The parameters to the right of the image define how the detected body keypoints are mapped to the perturbing forces, the black panels below illustrate the mapping results. Right: A point cloud of the Turów Coal Mine in Turów (Poland) getting deformed as a result of the two persons' movements.

stream. It should be noted that in both cases only anonymous movement data is stored and used. We also explored an approach based on traffic data where forces correspond to vehicle movements. In particular, we used the global airspace data provided by the OpenSky Network [26] to retrace the flight routes of commercial aircrafts.

2.4 Eco-design principles

Given the growing ecological footprint of digital media — ranging from the raw material footprint of hardware to the greenhouse gas emissions required to operate both the hardware and software components of an installation — our team seeks to apply

eco-design methodologies during the production of *Perturbatio* artworks. Specifically, we apply principles of *frugality by design* and the theory of the *already-there*, ensuring that no new hardware is purchased for the production of *Perturbatio*. Instead, we rent equipment or utilize existing resources available at the exhibition site. To collect empirical data, we also metered the power consumption of an early version of *Perturbatio* (consisting of two TV screens, two laptop computers and a Mircosoft *Xbox One Kinect* depth camera) during an 8-hour-long exhibition, yielding a total power consumption of 2.35 kWh. Moreover, we performed a basic life cycle assessment for the used hardware: Assuming a material lifetime of 5 years, the resulting emissions attributable to the 8 hours of exhibition amounted to ≈ 1.2 kg CO2eq.

3 Inspiration and art context

3.1 Point cloud aesthetic

Following decades of scientific and technical development, point cloud imagery is increasingly used in both contemporary art and technical applications. In *Perturbatio*, we examine point clouds through their socio-technical origins and aesthetic potential. Socio-technically, they represent the Moderns' enduring quest — per Bruno Latour — to capture reality with precision [13], from Dürer's linear perspective [11] to today's LiDAR and photogrammetry [14, 21]. These tools abstract nature into mathematical relations, whether in painting, photography, or volumetric datasets.

Aesthetically, however, point clouds reveal a fragile, spectral reality. Their fragmented form, reminiscent of Lucretius' atomism [15], suggests not just representation but potential mutation and alterity. This challenges the viewer's perception, blurring boundaries between subject and object, self and environment.

Engaging with point clouds is a phenomenological experience. Augustin Berque's "trajective" gaze [5] describes this entanglement, where the viewer is neither purely objective nor subjective, but immersed in the image's volume. This fosters a "terrestrial" attention to ecosystems, inviting audiences to reconfigure their relationship with the world.

Perturbatio thus navigates a duality: acknowledging point clouds' roots in modernity's controlling structures, while using them to subvert the subject-object divide. As artistic artifacts, they offer a pointillistic, subversive aesthetic at the edges of late capitalism [30], prompting viewers to mediate their connection to the "other" — be it environment, artwork, or each other.

3.2 Particle systems

From a software engineering standpoint, *Perturbatio* represents a *particle system*, a technique that started out in the context of early computer graphics and physics simulations and whose origins can be traced back at least until the 1970s [8]. An important milestone for particle systems was William T. Reeves' eponymous paper from 1983 [23] where he described how they can be used to model complex, fuzzy phenomena like fire, smoke, and clouds. Back then, Reeves applied this technique to animate a short sequence for the 1982 film *Star Trek II: The Wrath of Khan* where the explosion of the *Genesis bomb* triggers a massive wall-of-fire. Today, particle systems have become a staple of virtually all 3D animation software where they are still used to model fire and smoke but also liquids and even hair.

The aesthetics of moving particle clouds have frequently been picked up in digital art with one of the most prominent examples in recent years being the works of Refik Anadol [24]. With the advent of powerful GPUs in the last two decades, real-time computation of particle systems has become feasible, allowing them to be integrated into interactive installations and live performances. Among the different examples that influenced the creation of *Perturbatio*, the most notable works are *Faire corps* [2] and *En amour* [3] by French artists Adrien M & Claire B as well as *Coded Nature II* by the Dutch art collective DRIFT [10]. Moreover, the large-scale interactive universes developed by the Japanese teamLab (such as the *Borderless* [27] and *Planets* [28] exhibitions) must be mentioned here, where a completely different immersive dimension is added to the visitor experience by replacing abstract particle systems with swarms of leaves and flowers, flocks of origami cranes, or schools of animated koi fish. In *Perturbatio*, however, we wanted to go beyond these either abstract, figurative or poetic particle aesthetics and work with concrete, realistic point cloud representations of actual places, in order to strengthen the connection between the virtual point cloud deformations triggered by the visitors' presence in front of the installation and the real environmental perturbations caused by human activities worldwide.

4 Installations developed for *Nuit Blanche* 2025

For the 2025 edition of *Nuit Blanche*, we developed four different versions of *Perturbatio* which were presented at the Museum of Arts and Crafts in Paris, France as part of the exhibition *L'Air de rien*. The exhibition was seen by more than 3400 visitors during evening of *Nuit Blanche* and remained open to museum goers throughout the two weeks following the event.

Mirroring the theme of the museum (science, engineering and technology), the point clouds selected for the installations exemplified human activities in various sectors of industry, traffic and business. The presented motifs included, among others, coal mines, power plants, road systems, ports, sports arenas, and skyscraper-dominated business districts. A total of 15 different point clouds were extracted and edited from publicly available LiDAR scan data provided by the national geographic services of France [18], Poland [19], Spain [16], Switzerland [20], and the UK [9] as well as by the city of Gelsenkirchen, Germany [1] and the GeoTiles project [12] hosted at the Delft University of Technology in the Netherlands. One half of the point clouds showed their motif in its real photographic colours while the other half was rendered as false colour images (a technique frequently used in data visualisation) by applying different colour lookup tables to the LiDAR signal intensity data. A 16th point cloud, representing Earth, was produced from one of NASA's ultra-high resolution *Blue Marble* photos [17] using a custom Python code.

The following subsections briefly present each of the four installations in the order a visitor might have encountered them in during *Nuit Blanche*.

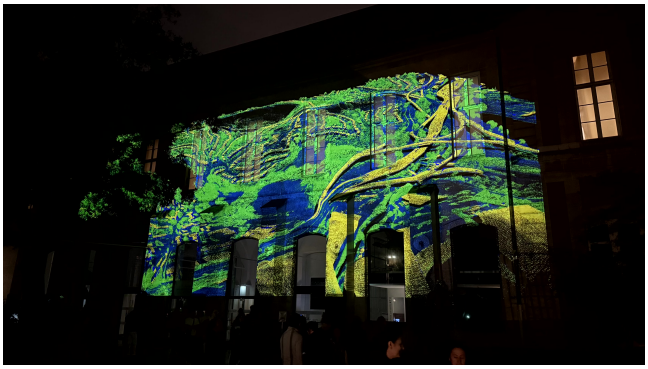


Figure 4: Video mapping on the facade of the Museum of Arts and Crafts during *Nuit Blanche* 2025. The point cloud shows an already perturbed false colour representation of the Gravelly Hill Interchange on the M6 motorway in Birmingham (United Kingdom).

4.1 Video mapping from pre-recorded crowd motion data

On the facade of the museum, visitors were greeted by a monumental video mapping spanning roughly 16 m × 10 m (Figure 4). The mapping was created using a 15,000 lm laser projector installed in the courtyard facing the main entrance of the museum. It showed a loop of 9 pre-recorded time-lapse videos of different point clouds slowly getting distorted. The perturbing forces corresponded to the movements of passers-by inside recorded at *Forum des Halles* using a ceiling camera installed above one of the pedestrian streets (Figure 2). Located at the city's epicentre, *Forum des Halles* is one of Paris' busiest commercial areas as well as its largest local transportation hub, connecting 5 metro and 3 local train lines. Passer-by movements along the pedestrian street were recorded for up to 16 hours per day, accumulating the trajectories of more than 50,000 individuals. For the time-lapse recordings, an acceleration factor of 60 (1 hour becomes 1 minute) was applied which resulted in point cloud videos lasting between 8 and 16 min. The video mapping was accompanied by a specially composed soundtrack.

4.2 Visualisation of flight trajectory data

Once visitors entered the museum, they found themselves in front of a wall onto which another pre-recorded time-lapse video was projected using a 6,000 lm laser projector. The video showed a point cloud of Earth being furrowed by the passage of hundreds of airplanes, corresponding to all the flights arriving at or departing from the two major Parisian airports (Charles de Gaulle and Orly) within the 24-hour-period from 29 April 2025, 2 a.m. to 30 April, 2 a.m. (Figure 5). The flight route data was acquired via the OpenSky Network project [26] and the final time-lapse lasted 2 minutes and 30 seconds.

4.3 Real-time many-persons interaction using video projectors and webcams

The main part of the exhibition during *Nuit Blanche* was located inside the deconsecrated St-Martin-des-Champs church belonging to the museum. Upon entering the church, visitors would see video projections inside the apse where two 6,000 lm laser projectors were casting point clouds onto the vaults (Figure 6, left). A webcam, mounted at a height of 3 m and set to one side of the apse, surveyed the individuals wandering beneath the vaults. In real time, their movements were assessed and translated into forces perturbing the currently projected point cloud which changed every 4 minutes, cycling through 7 different motifs. The video projectors and webcam were connected to a Dell Precision 5820 computer which handled the webcam streaming, movement detection and point cloud simulation and rendering. Several beanbag chairs were scattered around the apse to allow visitors to lay down and rest while looking up at the video projections.

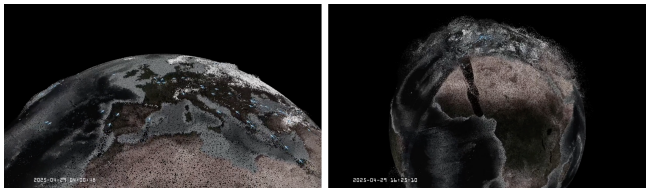


Figure 5: A point cloud representation of Earth getting perturbed by the flights arriving at or departing from the two major Parisian airports on April 29th 2025. Left: Early in the morning, Earth is still mostly unperturbed as the first planes take to the skies. Right: In the afternoon, the passage of several hundred flights has caused considerable perturbation.

The two video projectors displayed the same view of the point clouds, arranged symmetrically about the centre line of the apse, which resulted in an image evocative of Rorschach tests. The movements of the visitors quickly perturbed and scattered the point clouds to a degree where the projections started to resemble starry night skies. The installation was designed to invite audiences to reflect on the perturbation of Western cosmogonies, itself at the root of the Modern's ecological disruption, while also recreating the age-old act of stargazing as a way to reconnect to a deeper history of human's entanglement to their ecosystems and the universe as a whole.

4.4 Real-time few-persons interaction using screens and webcams

The *Perturbatio* tetraptych presented during *Nuit Blanche* was completed by a black, glass-enclosed, 2.5 m tall monolith that housed two 75 inch 4K screens, as well as two wide-angle webcams and two Dell Precision 5820 computers. The monolith was positioned close to the apse in the ambulatory of the church (Figure 6, right). Its two screens showed 8 photographic-colour and 7 false-colour point clouds, respectively, which, changing every 1 minute and 30 seconds, were displayed in a loop. Real-time interactivity was provided through webcam streams connected to the pose tracking algorithm described in Figure 3.

The monolith installation was conceived to allow individual visitors to explore the concept behind *Perturbatio* in a more direct way. For this purpose, the forces generated by the movements were intentionally amplified such that point clouds could be completely



Figure 6: The two real-time interactive versions of *Perturbatio* developed for *Nuit Blanche* 2025. Left: Video projections onto the vaults in the apsis of St-Martin-des-Champs church. Right: The monolith installation equipped with two screens (front and backside) being explored by interacting visitors.

distorted after a few seconds, as opposed to the time spans of several minutes or hours typical of the three other installations described above.

5 Conclusions and future work

In this article, we presented *Perturbatio* — an interactive, artistic framework conceived to visualise the impact that human activities collectively have on our environment. At the heart of the framework lies a custom-developed point cloud simulation and render engine that is capable of simulating the action of several hundreds of forces on millions of particles in real time. For the 2025 edition of *Nuit Blanche*, we developed four implementations of *Perturbatio* which were exhibited at the Museum of Arts and Crafts and seen by more than 3400 visitors. The presented versions included pre-recorded video mapping installations as well as real-time interactive stations where visitors could perturb point clouds of various industrial and urban sites through their movements.

In the two real-time versions of the installation, perturbation was deliberately amplified to ensure visitors could clearly see that their movements directly caused the deformations. While visitor experience was not formally surveyed during *Nuit Blanche*, observations of their reactions suggested this approach effectively communicated the interactive nature of the artwork. However, the result was a more playful, individual engagement that somewhat diverged from the original artistic intent of *Perturbatio* — to provoke reflection on collective effects and the individual's cumulative role within them. A key challenge moving forward is to strike the right balance: developing an artistic approach that both captures and represents the gradual emergence of cumulative effects, likely requiring a more subtle deformation over several hours, while still providing users with immediate, recognizable feedback that reinforces their active role in shaping the installation. Future exhibitions of *Perturbatio* could experiment with different feedback methods, such as timelapse visualizations, real-time displays of the motion detection underlying the interaction, or clear explanatory texts. In particular, a qualitative survey of the visitor experience should be conducted, assessing how the interaction with the artwork is understood.

In this context, we would like to develop a live version of the installation described in section 4.1 where, instead of a pre-recorded time-lapse, the point cloud is slowly deformed in real time and displayed on a screen visible from the surveyed passageway. Another interesting approach would be a web-based version of *Perturbatio* where the point clouds can be viewed in a normal web browser and where the perturbing forces are linked to online activity data. Finally, the eco-design principles considered in *Perturbatio* could be complemented through an extended CO2 footprint and energy consumption analyses as well as a survey to assess the mobility behaviour of exhibition visitors (from where and how did visitors travel to come to the exhibition).

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Osmosis Among Art, Sealife and Citizen-Science

Promoting Sustainability through Sci-Art Participatory Experiences

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Abstract

In this ASTER+S project, we address a central question from a scientific-artistic perspective: How can citizens contribute to the understanding and protection of marine ecosystems affected by the Anthropocene? Our focus lies on studying marine life beneath the surface, particularly in the context of climate change. Two types of practices are addressed. Firstly, Citizen Science as a core methodological axis, developed by our Sea Science scientific EMBIMOS research group. Secondly, the ASTER+S experience using our own 'eco-SciArt' participatory method, developed by the authors' research group to involve participants to co-create contemporary art prototypes inspired by some sustainability Sealife research topics. The final prototypes were exhibited and mediated to general public twice, in Seville and the Ars Electronica Festival 2024.

On one hand, our citizen-science approach promotes citizen participation in documenting marine biodiversity, discovering new species, and systematically monitoring the impacts of climate change and human activities. The goal is to generate meaningful data that can support more informed decision-making processes aimed at protecting and mitigating the effects of the Anthropocene.

On the other hand, our 'eco-SciArt' methodology is rooted in a transdisciplinary co-creation practice that brings together science and contemporary art as catalysts for critical reflection and public engagement with knowledge. We consider art to have a transformative potential to spark curiosity, foster systemic thinking, and raise awareness of pressing ecological issues across diverse audiences.

Within this framework, we examine one of the produced SciArt work as a successful case study.

CCS Concepts

• **Applied computing** → Art and humanities; Media arts.

Keywords

Insert comma delimited author-supplied ASTS, SciArt, Participatory

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1 Introduction

The project "ASTER+S > ART ^ SEALIFE" [1] (funded by the Institut de Ciències del Mar (CSIC) [2], the Colegio Oficial de Arquitectura Técnica de Sevilla (COATS), Fundación Aparejadores, and the University of Seville), aimed to provide methodological supported experiences in two social contexts: educational and cultural. This was achieved through the co-creation of artworks developed by using our own transdisciplinary participatory method called 'eco-SciArt'which has been successfully implemented in three editions, being two of them related to sustainability: the first one about Environment & AI, and the second one about Sealife & Citizen Science. Those types of SciArt research applied to sustainability is a trend internationally, as it has been documented in literature [3, 4].

Art-Science hackathons, such as Museomix, function as interdisciplinary spaces combining design thinking, participatory methods, and rapid prototyping to foster creative collaboration between artists, scientists, and technologists. These events emphasize experiential learning and transdisciplinary synthesis, where diverse participants co-create innovative solutions and generate new knowledge that transcends traditional disciplinary boundaries. Examples like Museomix, HackArt, and the Quantum Art Hackathon demonstrate how such formats encourage cultural innovation, youth engagement, and philosophical reflection on science and technology. Ultimately, these hackathons establish a "third space" where artistic intuition and scientific empiricism merge, as illustrated by the LIFT_C Hackathon 2025, which promotes ethical and imaginative inquiry [5–14].

The ASTER+S project seeks to foster individual and collective awareness of state-of-the-art research topics, as well as scientific-artistic communication to society, cultural innovation, service-learning, and the encouragement of ASTS and STEAM vocations. In section 2 the 'eco-SciArt' method is presented. In section 3 a case study is analyzed in detail. In section 4 the objectives accomplishment is analyzed. Finally, in section 5 some conclusions are presented.

The project aimed to foster individual and collective awareness of coastal and marine ecosystems' sustainability, as well as scientific-artistic communication to society, cultural innovation, service-learning, and the promotion of ASTS (Art, Science, Technology, and Society) vocations, based on some objectives:

Obj-A: To promote creative transdisciplinary thinking in the ASTS field, strengthening individual and collective reflection on Sea major SDG and challenges, as well as the emotional connection between local communities in the Mediterranean Sea.

Obj-B: To encourage social innovation derived from transdisciplinary collaboration among scientists, artists, technologists, humanists, etc as well as citizen science and local communities.

Obj-C: To foster artistic innovation based on ASTS in a post-media context (any medium might be used), based on the premise that contemporaneity lies mainly in processes and discourse, and ideally those processes may trigger individual's and communities' moving into action.

Obj-D: To develop SciArt artifacts to innovate in the scientific-artistic communication of scientific knowledge and societal challenges to society, thanks to the involvement of creative people, local communities, in direct contact with top scientists.

To achieve these objectives, the 'eco-SciArt'method's activities were based in the conjunction of the afore-mentioned scientific themes: Environment, Sealife science and Citizen-Science, in collaboration with biologist of the EMBIMOS research group [2] (*Institut de Ciències del Mar* research institute, CSIC -Centro Superior de Investigaciones Científicas i.e. the Spanish national public research network).

That research group is specialized in implementing Citizen Science research projects, and the ASTER+S Sealife edition supported them in diversifying their science communication strategy to general society. Those biologists usually work with local communities, engaging them in eco-activism through citizen-science actions along the Catalan Mediterranean coast, increasing their commitment to caring Sealife ecosystems.

A participatory sci-art method to foster transdisciplinary outcomes

Our 'eco-SciArt'method includes interdisciplinary participatory activities mediated by arts, with the goal of impacting and transforming participants' perceptions in a specific social context. The method is based on a Nature-inspired metaphor with a few phases (Figure 1), and in the Sealife edition the main features were:

1. **Initial inspirational workshop ("Scientific seed phase")**: Three biologists of the EMBIMOS research group accepted the invitation "to plant the SciArt Seeds", i.e. to create multidimensional descriptions of research topics (template guided). All those seeds were published on the project website. Among the dimensions there were two types: objective (name of the topic, summary, research method, motivation) and subjective (metaphor, ethical, metaphysical, aesthetical and synesthesical). Those seeds were highly motivational for the creative teams in the next phases (Figure 2).
2. **Participatory co-creation experience ("SciArt Flower phase")**: During a 3-day hackathon, six interdisciplinary creative teams were formed to propose an art concept and describe the corresponding art projects called the "SciArt Flowers" (template guided). The creative teams were composed by nineteen people, maily artists (visual, electronic and performance arts), but also people from other disciplines: engineering, psychology, math and architecture. All of them were working in equal terms for the conceptualization of the artwork, splitting their responsibilities for parallel co-production after the hackathon.
3. **Production ("SciArt Fruit phase")**: After the hackathon, for three months those flowers were transformed into the "SciArt Fruits" (i.e. the final SciArt works), that were financed by the ASTER+S project.

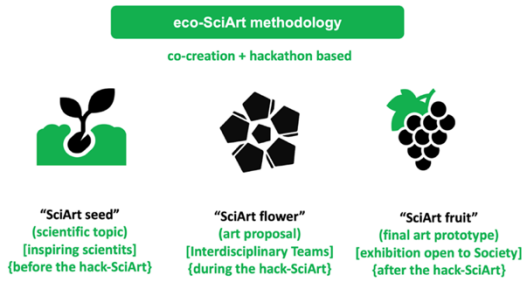


Figure 1: The 'eco-SciArt' method (own source by R. García Robles)

4. **Exhibition(s) and mediation phase**: The produced art prototypes were locally exhibited at *Fundación Aparejadores* (June 2024, Seville, Spain), and a selection of them were showcased at the Ars Electronica Festival 2024 (September, Linz, Austria) [15, 16].

In the framework of that Sealife edition [17, 18], on the one hand a summary of the scientists' contributions is detailed, and on the other hand an outline of the creative teams' contributions is presented.

As afore-mentioned, three biologists of the EMBIMOS research group (ICM, CSIC, Barcelona) were involved in ASTER+S experience. The specific seed titles and a summary of their scientific topics were [14]:

1. "Yaku sumaq": It is related to the importance of citizen-science for better knowing and caring of Sealife.
2. "Kduino buoy and water transparency": It is about the color and transparency of sea water to study micro-organisms as well as pathologies such as micro-plastic contamination.
3. "A silent death": It is regarding with the impact of temperature increasing -due to the Climate Change- in local Mediterranean ecosystems.
4. "New neighbors": It is about the consideration of what an invader species is about, and how human species in one of the most invading one.
5. "Beaches with life": It is regarding the relevance of citizen-science platforms to support scientists in exploring larger coastal zones.

The EMBIMOS research group specializes in Citizen Science (CS), and they have published about how relevant this CS approach is for supporting researchers in enlarging the observational area, the number of results to be further analyzed scientifically, as well as other benefits. As stated by those scientists jointly with others at international authors in one of their most relevant papers [20]:

- "Citizen science is an increasingly acknowledged approach applied in many scientific domains, and particularly within the environmental and ecological sciences, in which non-professional participants contribute to data collection to advance scientific research".

- "Contributory citizen science is a valuable method to scientists and practitioners within the environmental and ecological sciences, focusing on the full life cycle of citizen science practice, from design to implementation, evaluation and data management".

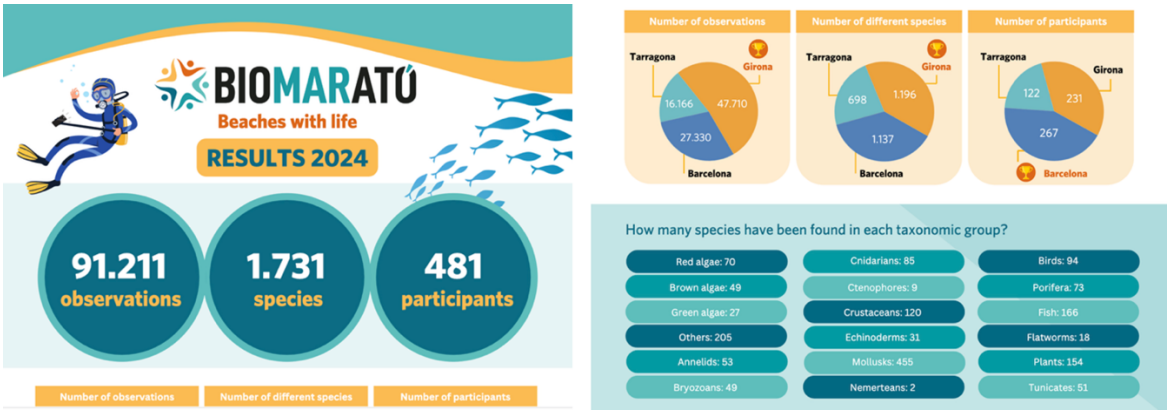


Figure 2: EMBIMOS Biomarató indicators [19]

- Among key issues in citizen science and how to address them, there are some "such as participant engagement and retention, data quality assurance and bias correction, as well as ethical considerations regarding data sharing".

- This citizen science approach "provides a range of examples to illustrate the diversity of applications, from biodiversity research and land cover assessment to forest health monitoring and marine pollution. The aspects of reproducibility and data sharing are considered, placing citizen science within an encompassing open science perspective".

Some indicators of the Biomarató 2024 are shown in Figure 2. The EMBIMOS research group participating in that marathon was formed by thirteen scientists (two seniors, two postdocs, four predoc and five technicians). The number of participants were 481people, contributing with 91.211 observations and documenting 1.731 species, covering the Catalan coast in its three provinces (Barcelona, Girona and Tarragona). The ratio of human resources was 2.7 % of scientists, and therefore the observational and cataloguing team was enlarged by 97,3%, demonstrating the empowering dimension of Citizen Science practices. Other considerations about the afore-mentioned journal paper [8].

In the ASTER+S framework, the "SciArt seeds" were explored and experienced by three target groups: the scientists, the hackathon's participants during the co-creation phase, and the public in both exhibitions at Seville (Spain) and Linz (Austria).

It is important to remark that this ASTS hackathon-based experience was taking place in parallel to the Citizen Science activities of the EMBIMOS research project. They can be considered as complementary activities related to CS, SciArt participatory innovation, as well as art-science communication practices. ASTER+S team was committed to promoting at the same time: the citizen-science literacy (what is citizen science about?), contemporary art literacy (how can be implemented and interpreted contemporary artworks?), the SciArt + STEAM literacies (what are SciArt practices about?), and in this edition especially the Sealife Sustainability literacy (what is happening in Mediterranean coast affected by Anthropocene?, and how can Citizen Science and SciArt may contribute to support environmental caring of sea-life ecosystems?).

In the ASTER+S experience the interest for the ecological research topics were asked to the hackathon's participants, and according to the responses (Figure 2), the most popular seed was the number 1 "Yaqu sumaq", seed number 2 "Boya kaduino" and seed number 5 "Beaches with life2 occupy the 2nd position, seed number 4 "New neighbors" was second the last position, and the less popular one was seed number 3 "A silent die".

The statistical analysis presented in Figure 3 provides a clear overview of the creative teams' evaluative responses to the five scientific "seeds" proposed by the EMBIMOS research group. The distribution of preferences reveals differentiated levels of resonance between the scientific proposals and the artistic interpretations derived from them.

Specifically, the seed "Boya Kduino and the transparency of water" achieved the highest proportion of maximum-preference votes, indicating a strong alignment between its scientific focus (centered on the monitoring of water transparency and microplastic contamination) and the creative teams' interest in tangible, data-driven environmental phenomena. Similarly, "A silence die", addressing the effects of climate change on Mediterranean marine ecosystems, received notable consideration within intermediate preference categories, reflecting its conceptual depth and emotional impact.

Conversely, the seeds "Yaku sumaq" and "Beaches with life", both of which emphasize the role of citizen science and collective environmental stewardship, were predominantly positioned in the lowest preference categories. This may suggest that while their themes are socially and scientifically significant, they presented fewer immediate or visually compelling entry points for artistic interpretation. The seed "New neighbors", which problematizes invasive species and anthropogenic expansion, occupied an intermediate position, evidencing a balanced but not predominant level of creative engagement.

The results underscore the selective nature of artistic reception toward scientific discourse. Creative teams tended to favor topics offering empirical visibility and measurable processes, such as water quality and ecological transformation, over more abstract notions of participation and environmental ethics. This outcome reinforces the need for interdisciplinary mediation, wherein scientists and artists

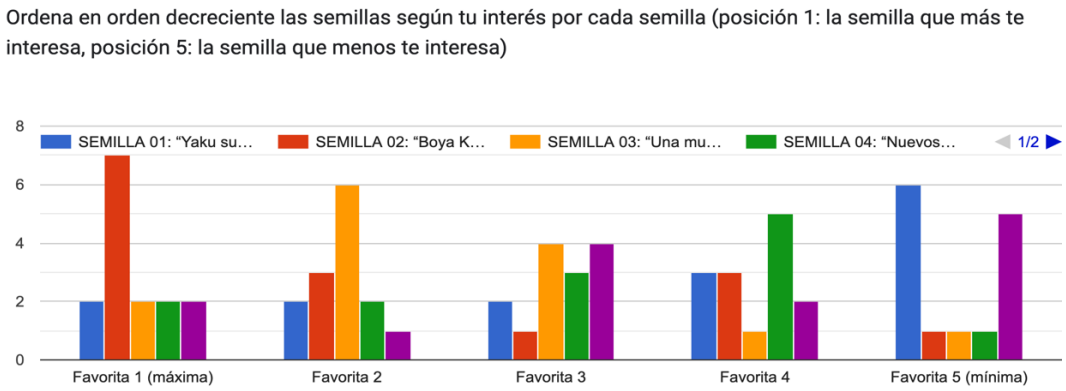


Figure 3: Sort the seeds in descending order according to your interest in each seed (position 1: the seed that interests you the most, position 5: the seed that interests you the least)

Table 1: Summary of the ASTER+S > ART ^ SEALIFE SciArt edition

SciArt work (fruit)	Interdisciplinary team	Scientific topic (seed)	Type
The dance of data	Design Engineer, Computer Science Engineer, Electrical Engineer, Mathematician	The dance of data (citizen- science platforms)	VR & sculpture
Liquid transparency	Artist, Artist, Digital artist, Computer Science Engineer	BoyaKduino and the transparency of water	Digital interactive LEDs installation
No one knows you, but I sing you	Four new media artists	A silent death	Haptic sculpture
Sea invaders	Artist, Computer Science Engineer, Creative programmer	New neighbors	Digital interactive video installation
SEA: reflection and connection	New media artist, Photographer, Computer Science Engineer	Beaches with life	Digital interactive video installation and App
The light and the sea	Playwriter and Psychologist, Actress, Fashion designer	BoyaKduino and the transparency of water	Theatrical performance

collaboratively refine conceptual frameworks and communication strategies to bridge analytical rigor with expressive potential.

Overall, the results underscore the selective nature of artistic reception toward scientific discourse. Creative teams tended to favor topics offering empirical visibility and measurable processes, such as water quality and ecological transformation, over more abstract notions of participation and environmental ethics. This outcome reinforces the need for interdisciplinary mediation, wherein scientists and artists collaboratively refine conceptual frameworks and communication strategies to bridge analytical rigor with expressive potential.

Therefore, the 'eco-SciArt' seems to be inspirational for engaging participants in a co-creation experience, promoting critical thinking about the specific Sealife research and societal topics. This method may be considered innovative, emphasizing the proactive role of scientists, university students and professors of any discipline, collaborating during and after the hackathon. The citizens visiting the final exhibition, experiencing it through mediation were also innovative aspects, although there was no further study for the visitors to measure the impact of that SciArt exhibition. According to the indicators published officially by the Ars Electronica, more than 112.000 people were visiting the festival [9]. In Seville exhibition the visitors were only a few compared to Linz. The exhibition is expected to be shown again in Brussels and Barcelona, and then there will be an effort to collect visitors' opinion as a complement to the mediation activities.

2 Analyzing a Case Study: "The Liquid Transparency" Artwork

In the Sealife edition of our project, six SciArt works were produced: five new media art installations, and one micro-theatre. The titles and types of the final artworks, the teams, and their corresponding scientific topics are listed in table 1. The SciArt work entitled 'Liquid Transparency' is further analyzed in the current section.

2.1 The Scientific Seed: The scientist's vision on "BoyaKduino and the water transparency"

As summarized by the corresponding scientist Carlos Rodero:

> "The color of the sea has been an intriguing phenomenon since ancient times. Over time, the ever-changing colors of lakes and seas amazed travelers and inspired painters and writers. Later, scientists interested in explaining the phenomenon realized that sea color and transparency could be related to organic and inorganic materials. There were even navigators and explorers who associated chromatic changes with the topography of the seabed. Knowing the diffuse attenuation of light in water (Kd parameter) allows us to estimate water quality based on transparency. Thanks to the involvement of people in a citizen science project and their active role in building their own low-cost devices, we can obtain more information about the different processes occurring in the water and their early detection, such as the appearance of algal blooms or pollution spills into the sea. The Kduino buoy and its successor KduPRO are equipped with light sensors placed at different depths, allowing data collection and calculation of light attenuation in the water column" [14].

2.2 The SciArt Flower: The vision of the creators of the work

As stated by the authors of the artwork:

> "The transparency of water, which under certain circumstances allows us to see the depths of the sea or the bed of a spring, is the result of a delicate balance between light and the matter it contains. Thus, we are not always aware of the transformations occurring in aquatic environments and the entropic processes that can alter the state of transparency" [14].

From the perspective of the artists who created the piece titled Liquid Transparency, the goal is to give voice to the water, so the viewer can perceive what scientific data reveals to us. The reference for this work is related to the readings of watercolor tones collected by scientists at various points in the Mediterranean Sea. The scientific conclusion is that humans play an active role in the changes the water undergoes, affecting its transparency and, consequently, the way light interacts with it, altering its colors.

In this interactive installation, visitors are invited to take an 'underwater walk' that encourages them to perceive how the qualities of water are altered, among other factors, by human presence. This artistic proposal aims to contribute to the understanding of the phenomena causing changes in our aquatic environment detected by scientists, encouraging reflection that promotes us the protection and appreciation of the natural heritage represented by the water masses of the blue planet".

2.3 The "Sciart Fruit": The curator's vision

As explained by the curator of that SciArt exhibition:

> "The work 'Liquid Transparency' invites us to explore various concepts that resonate deeply with philosophical questions about reality, perception, and human interaction with the natural world. Just as substances in water can obscure its transparency, misinformation or lack of awareness can cloud our understanding of current environmental issues. The changing transparency and colors of the water, influenced by human presence, suggests a dialogue about the boundaries between our activity and natural processes. It invites us to think that all parts of the universe are interconnected and that changes in one part can affect the whole.
>
> The act of walking through the installation can be seen as a metaphor for the journey of life, making us aware that the choices one makes impact one's surroundings. It raises questions about the nature of cause and effect and the potential for transformation through self-awareness and individual and collective action. It not only sheds light on the dynamic and often invisible changes occurring within aquatic environments but also fosters a deeper understanding and connection between humanity and marine ecosystems, turning this 'underwater walk' into a call to action, while aligning with the hopeful message that we indeed can 'turn the tide' by adopting more sustainable practices and respecting our natural heritage.
>
> While humans have the capacity to disrupt natural balance, we also possess the power to restore it. By making visible the invisible changes in our waters, the installation empowers viewers to become part of a movement toward greater ecological awareness" [14].

3 Objectives AND OUTCOMES

In the current section, the accomplishments of the project's objectives are discussed.

3.1 Objective A: ASTS practices to promoting critical thinking

One central objective within the ASTS framework is to promote creative transdisciplinary thinking to foster deeper individual and collective reflection on critical socio-environmental challenges. In the context of marine ecosystems, this approach aims to support the advancement of the United Nations Sustainable Development Goals (SDGs), particularly SDG 14 (Life Below Water), while also addressing intersecting priorities such as SDG 13 (Climate Action) and SDG 17 (Partnerships for the Goals). This is exemplified in the 'Liquid Transparency' installation, which translates scientific data such as light attenuation, (the Kd values collected through the BoyaKduino buoy system), into a sensory artistic experience that invites viewers to 'walk underwater' and perceive transformations in water transparency.

Transdisciplinary thinking is facilitated through the integration of artistic and scientific methodologies that not only represent ecological issues but actively reconfigure how such issues are perceived,

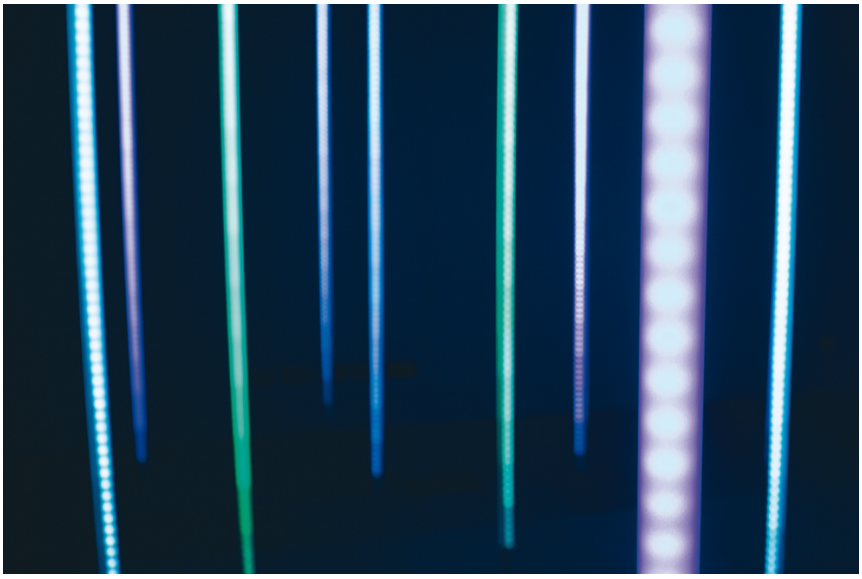


Figure 4: "Water Transparency", Cachito Vallés, Áurea Muñoz del Amo, Carmen Salazar, Rocío García Robles (own source [14] by Miguel Mendoza)

experienced, and engaged with. Artistic practices emphasizing participatory, immersive, or speculative modes function as epistemic tools that challenge conventional boundaries between disciplines, enabling the co-creation of new imaginaries and modes of knowledge production. In relation to 'Water Transparency', by enabling audiences to emotionally and physically engage with the changing qualities of water, the installation supports not only cognitive understanding but also affective engagement, a key strategy for promoting sustainable behavior. The interactive nature of the exhibit encourages reflection on how human presence influences marine ecosystems and emphasizes the role of collective action and awareness, directly advancing SDGs 13, 14, and 17 through participatory and educational mechanisms.

This process also emphasizes the cultivation of emotional and affective connections between individuals, communities, and their surrounding marine environments. Particularly in regions such as the Mediterranean basin, where socio-cultural identities are closely tied to the sea, fostering such connections is essential for building community resilience and long-term ecological awareness. The Citizen-Science jointly with the SciArt experiences promote those connections.

By activating emotional responses (such as empathy, attachment, or awe), creative transdisciplinary approaches contribute to a more situated and inclusive engagement with sustainability challenges. This emotional engagement complements analytical reasoning, enhancing the potential for meaningful public involvement and context-specific action. Through metaphor and immersion, the project generates new imaginaries that challenge existing narratives and inspire deeper, more responsible engagement with marine life and ecological processes. In this sense, promoting creative transdisciplinary thinking within the ASTS field is not only a conceptual and methodological imperative, but also a strategic one, enabling more holistic, participatory, and impactful responses to the complex dynamics of marine conservation and climate resilience.

3.2 Objective B: Fostering Social Innovation Through Transdisciplinary Collaboration and Citizen Engagement

A key objective within the ASTS framework is to foster social innovation through sustained transdisciplinary collaboration among diverse actors (including scientists, artists, technologists, humanists, and local communities) supported by participatory methodologies such as citizen-science. This objective recognizes that complex socio-environmental challenges, particularly those affecting marine ecosystems and coastal regions, cannot be addressed solely through disciplinary knowledge or top-down interventions. Instead, they require new forms of collaboration that integrate multiple ways of knowing and doing things.

In 'Liquid Transparency' this objective was achieved through the implementation of the Kduino and KduPRO technologies in citizen-science contexts. These low-cost, DIY sensing devices empowered non-experts to actively contribute to marine data collection, democratizing access to scientific tools and knowledge. Transdisciplinary collaboration enables the convergence of epistemologies, practices, and creative processes across sectors. By facilitating dialogue and co-creation among traditionally separate domains, such collaboration can give rise to novel ideas, tools, and systems that respond more holistically and inclusively to shared challenges. When embedded within participatory frameworks, such as citizen observatories or community-driven monitoring initiatives, these collaborations also serve to democratize innovation, positioning local knowledge and lived experience as integral components of the problem-solving process.

Social innovation in this context refers not only to the generation of new products or services but, more fundamentally, to the reconfiguration of social relations, governance practices, and value systems. It includes the development of participatory infrastructures, open data ecosystems, and new modes of environmental stewardship rooted in shared responsibility and mutual learning. Artistic and creative interventions can act as mediators in these processes, enabling inclusive narratives and speculative imaginaries that broaden the scope of possibility for civic engagement and institutional transformation. By aligning transdisciplinary collaboration with citizen science and local engagement, this objective advances a model of innovation that is contextual, socially embedded, and ecologically responsive. It underscores the importance of fostering inclusive ecosystems of knowledge production where diverse actors can co-create sustainable futures, particularly in regions such as the Mediterranean, where environmental degradation intersects with cultural, economic, and political complexity.

3.3 Fostering Artistic Innovation in a Post-Media Context Within the ASTS Framework

Another core objective within the ASTS paradigm is the promotion of artistic innovation situated in a post-media context, an environment in which artistic practice is not constrained by medium specificity but is instead defined by conceptual approaches, processual dynamics, and discursive engagement. This objective aligns with contemporary understandings of artistic practice as a site of inquiry, experimentation, and critical reflection, capable of contributing meaningfully to social and environmental transformation.

In the post-media condition, any medium (digital, biological, performative, analog, etc) may be mobilized according to the needs of a given project, theme, or community context. What defines contemporaneity in this framework is not the technological novelty of a given tool or platform, but the relevance, intentionality, and criticality of the processes through which knowledge, meaning, and relationships are produced. Artistic innovation, therefore, is not merely formal or aesthetic, but fundamentally processual and situated in dialogue with broader socio-technical and ecological realities.

'Liquid Transparency' stands as a strong example of artistic innovation operating in a post-media condition. It does not rely on a single medium but draws on spatial installation, environmental data, light and movement to create a layered experience that defies conventional categories of art or science. This open, conceptual approach situates the artists as both storytellers and mediators, transforming empirical marine science into an emotional and cognitive encounter. The ability of the installation to make visible the often-invisible changes in marine ecosystems speaks to the potential of post-media practices to engage with systemic complexity and provoke ethical reflection. By aligning itself with processual and context-sensitive methods such as the 'eco-SciArt', the project models how artistic innovation can become an integral part of environmental knowledge systems, not as an aesthetic afterthought but as a critical and transformative force in sustainability discourse.

Within this perspective, artistic practices serve as laboratories for new modes of engagement, both speculative and pragmatic, that intersect with scientific, technological, and civic domains. This approach positions the artists not only as creators of objects or images but as instigators of reflexive and transformative processes. These processes are ideally designed to provoke critical awareness, generate new narratives, and activate emotional and cognitive responses that can inspire individuals and communities to reconsider their relationships with the environment and to take concrete actions toward sustainability and justice. Moreover, this accomplished objective supports the emergence of new forms of public imagination and agency by embedding artistic innovation within transdisciplinary networks and participatory ecosystems. In doing so, it expands the role of artistic research within ASTS as a dynamic and responsive practice, capable of bridging disciplinary divides, engaging with systemic complexity, and fostering ethical and affective responses to the challenges of the Anthropocene.

3.4 Objective D: Developing SciArt Artifacts for Innovative Scientific-Artistic Communication

An essential objective within the ASTS framework is the development of SciArt artifacts as tools for innovative communication of scientific knowledge and complex societal challenges. In contrast to traditional science communication formats, SciArt artifacts operate within a multi-sensory and symbolic register, capable of addressing audiences at cognitive, emotional, and experiential levels. Their development involves the active participation of creative practitioners in collaboration with scientists. This process is inherently dialogic and transdisciplinary, emphasizing mutual learning and co-creation across epistemic and cultural boundaries. Direct interaction with scientists plays a pivotal role in grounding these artifacts in rigorous research, while the involvement of local communities ensures that the issues addressed are socially situated, relevant, and inclusive. Through this integrative approach, SciArt artifacts become mediators between knowledge systems, capable of translating abstract data, complex models, and environmental risks into tangible, affective, and socially resonant forms.

The Kduino buoy data and the 'Liquid Transparency' installation together exemplify the creation of SciArt artifacts that transcend traditional communication tools. Rather than merely illustrating scientific findings, the installation embodies them, translating invisible parameters of marine health into an immersive narrative. These artifacts operated on symbolic, emotional, and multisensory registers. Visitors engaged directly with scientific principles such as watercolor variation and light attenuation without needing prior expertise, fostering accessibility and deepened public understanding of marine degradation and human impact. By transforming abstract data into tangible experiences, these artifacts became conduits for environmental literacy and systems thinking. The collaborative design of the installation (incorporating citizen-sourced data and participatory methods) ensured the resulting communication tool was not only scientifically robust but socially resonant and inclusive.

So, such types of SciArt artifacts are particularly effective in fostering environmental literacy, ethical reflection, and systems thinking, offering alternative modes of access to scientific content and facilitating deeper public understanding of urgent issues, such

as climate change, biodiversity loss, and marine health. Moreover, they hold the potential to generate situated responses and participatory actions, especially when deployed within public exhibitions, workshops, and community-based initiatives. The development of SciArt artifacts within this framework reflects a commitment to reimagining the role of science communication in the Anthropocene, not as a unidirectional transmission of facts, but as a creative, inclusive, and transformative practice embedded in broader processes of social innovation and ecological care.

4 CONCLUSIONS

This study demonstrates that the integration of Citizen Science and transdisciplinary SciArt practices can significantly enhance public engagement with marine sustainability research in the context of the Anthropocene. Through the ASTER+S framework, participants contributed not only to data collection and scientific understanding but also to the creative interpretation of marine ecosystems via the 'eco-SciArt' participatory methodology. This dual approach facilitated both cognitive and affective forms of learning, linking scientific precision with artistic expression to foster deeper environmental awareness.

Findings from the Citizen Science activities indicate that participants developed a stronger sense of ownership and appreciation for scientific inquiry, perceiving their contributions as meaningful within broader ecological monitoring efforts. Simultaneously, the SciArt co-creation process provided an avenue for participants to translate data into tangible artistic outcomes, enabling reflection, empathy, and dialogue around issues that are often intangible or abstract. Public exhibitions in Seville and at the Ars Electronica Festival 2024 extended this engagement to wider audiences, demonstrating the communicative and transformative potential of participatory art-science practices.

The outcomes directly align with the ASTER+S program's objectives: advancing transdisciplinary collaboration (Obj-A), fostering social innovation through citizen participation (Obj-B), promoting artistic exploration within a post-media paradigm (Obj-C), and enhancing science communication through creative reinterpretation (Obj-D). More broadly, the project offers a methodological contribution to participatory design and science communication by illustrating how co-created processes can merge empirical inquiry, aesthetic experience, and collective reflection.

In conclusion, the ASTER+S experience highlights the transformative capacity of art-science collaboration to bridge disciplinary boundaries and cultivate environmental responsibility. By integrating citizen engagement, scientific research, and artistic creation, the project proposes a replicable model for inclusive and emotionally resonant forms of knowledge production, one that can inform future participatory approaches to sustainability, digital culture, and ecological awareness within and beyond the Sea context.

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From the Atelier Populaire to Artivism. Situationist Strategies Reimagined.

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Abstract

The following paper examines the progression of *artivism* by tracing the visual strategies employed by the *Atelier Populaire* during the May' 68 protests, tactics influenced by the *Situationist International,* and investigates their relationship to contemporary *artivist* practices, particularly in the field of digital media art. The article focuses on the legacy of these strategies and explores the trajectories of Richard Hambleton, Blek le Rat and Banksy, emphasizing their contributions to social and political discourse through art. It highlights the prioritization of message over aesthetics, the democratization of public space, unsigned drawings, stencils, and other low-cost techniques, direct as well as symbolic imagery. The study concludes by examining the current relevance of *artivism* across various platforms, including digital media, and investigates how these new mediums reshape and amplify the scope and modalities of *artivism* in the contemporary context.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

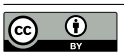
Artivism, Atelier Populaire, Situationism, May' 68, Digital Media Art

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1 INTRODUCTION

The modern-day *avant-garde* is characterized by artistic productions that blur the boundaries between life and art, between public and private, and that privilege political engagement and criticism of consumption [7].

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The term *artivism* was first introduced in 2008. It was coined by Chela Sandoval and Guisella Latorre in an article, as a neologism. It aims to articulate a connection between art and activism, prioritizing political consciousness and critical positioning over aesthetics. *Artivism* employs artistic practices as tools for political and social intervention, operating either individually or collectively, and often subverting conventional frameworks. It provokes ruptures by proposing alternative modes of creation and reception, incorporating multiple languages and continuously redefining itself. It engages with alternative imagery, metaphors, irony and humour to challenge dominant narratives [2] [28].

This phenomenon, however, has endured since the late 19th century, when art began to be regarded as a powerful instrument for social movements, particularly in countries subjected to heavy censorship, where such methods represented the only viable means of expression [18]. The origins of what is now understood as *artivism* can be traced to the artistic *avant-gardes* of the early 20th century, including the Dadaist, Surrealist and Futurist movements. These movements culminated in the 1960s, with actions led by groups such as Fluxus, which sought to disrupt the idea of art as a commodity by removing it from elitist spaces such as museums and galleries, and democratizing access through interventions in public and urban spaces. This shift gave rise to practices that were not easily commercialized, like video art, body art, performance, happenings and conceptual art. These expressions have, according to Valdivieso, "the dematerialization of the artistic object" as their core feature [29, p. 7].

2 THE SITUATIONIST INTERNATIONAL AND THE MAY' 68

Founded in 1957 in Cosio d'Arroscia, Liguria, through the union of three different groups, namely, The Lettrist International, The International Movement for an Imaginist Bauhaus and the Psychogeographical Association of London, the Situationist International (SI) was an organization that brought about a revolution not only because of the questions it raised, but also because of its management structure. It was extremely critical of class society, and its actions were predominantly carried out in capitalist countries, where the rejection of this economic system was fundamental. It was an international organization, with operations in France, Germany, Scandinavia, Belgium, the Netherlands, England, the United States and Algeria [6] [19].

At first, there was an emphasis on the fields of art and culture, and it was considered "an attempt to organize professional revolutionaries in culture", as Guy Debord himself indicates in the first issue of the magazine. However, according to *Baderna* [6], Debord preferred that the SI no longer resembled an *avant-garde* art group but rather a political organization, which led to the departure of most of the group's members. This phase was marked by the introduction of Vaneigem and became more focused on theoretical writings, which resulted in the iconic situationist books: *The Society of the Spectacle*, by Debord, and *Treatise on Living for the Use of Young Generations*, by Raoul Vaneigem.

In *The Society of the Spectacle*, Debord appropriates Bertolt Brecht's vision of spectacle and the distancing effect in theatre. By exposing the tricks of theatrical illusion, Brecht made the spectators critically aware of what they were watching. However, Debord aims higher when he proposes that the illusion belongs to the entire society, which sees itself as alienated in its own representation. In a world mediated by images, the individual becomes a spectator, rather than an actor. He stops being a subject to become an object, an image to be contemplated [35]. In 1966, a pamphlet titled *On the Poverty of Student Life* was disseminated throughout universities, triggering an uprising at the *University of Nanterre-Paris,* which led to the events of May '68.

The first requests came from students, who sought to change the strict dormitory rules. Male and female students were not allowed to interact in dorm rooms, and women were required to return to their student residences before 11 p.m. These restrictions, combined with broader dissatisfaction regarding university administration and calls for educational reform, ignited a larger movement that spread to the *Sorbonne*. The demands included increasing spots at universities and greater student participation in governance and decision-making. The protests soon escalated into nationwide strikes involving workers, as several labour disputes broke out across key sectors, notably in the automobile industry and railways. Political tensions between the left and right intensified, with many activists identifying with anarchist movements. These developments unfolded against the backdrop of economic instability in France, marked by high inflation and rising unemployment. Additionally, widespread opposition to the Vietnam War and France's support for U.S. military intervention further fuelled the unrest. Artières and Zancarini-Fournel [5] state that it was a profound social movement that affected the entire country. It led to the largest general strike of the 20th century. Inside the factories, the unions' imperative was to establish democracy, break free from the monarchic hierarchy, and call for better wages. For several days, there was a clash between police and protesters, until Charles de Gaulle yielded to pressure and gave workers a 35% raise. Nevertheless, he did not lose the elections. Instead, he resigned in 1969.

In a publication by the British group *Solidarity* (2003), a testimony states that it is no coincidence that the Sociology and Psychology faculties of *Nanterre* were the birthplace of the revolution. Students felt that what they were being taught was not useful for understanding or improving society, but rather a tool for control and manipulation. It also emphasizes that there was an attempt to downplay the power of the student struggle by portraying it as adventurous, and that it only gained significance after the participation of the working class. However, he reiterates that it was the students who took direct action, thereby influencing the workers. The student groups, sympathetic to Marxism, Trotskyism, and Maoism, were influenced by various events from other countries, such as the *Prague Spring*, the armed struggle against dictatorships in South America and revolutions taking place in Africa, in favour of decolonization [21].

The posters were produced at the time by artists, students and workers who organized themselves at the *Atelier Populair*e, in the *School of Fine Arts,* in Paris and they are closely linked to the collective memory of the events of May' 68. The first posters contained only text, but later they combined text and image. There were several sources of inspiration. From Maoism, the arrow, the fist and the slogan *The fight continues*[1], elements commonly seen on wall newspapers in China. From Trotskyism, the *United Front*[2] and the word *Union*[3], brought primarily by architecture student activists. Themes inspired by Cuba, South America, Germany and the Soviet Union were also incorporated. A Latin American community present at the *Atelier* was responsible for many of the models. It was not in May' 68 in France that the extreme left began interacting with art, but this is one of its most emblematic moments [4].

Political messages should come before any aesthetic concerns. By submitting individual ideas to the collective, there was a rupture with a form of creation that originated in the Renaissance and reached its peak in modernism, while the property system was being challenged. For the same reason, the drawings were not signed, in opposition to individualist *bourgeois* creation. Drawing, lettering and the use of stencils had to be done by different authors. Even though the artists are known today, the majority remain unpaid for the image copyrights in order to preserve the spirit of the *Atelier*. There is opposition to its use for commercial purposes. Many proposals were presented, but only a few made it to the streets. There were different styles, sometimes very elaborate and colourful, but the preference was for the most effective ones: those that had a direct and symbolic image (Figures 1 and 2). The objective was to create simple designs, which could be easily outlined with flat gum arabic and without halftones. Each poster should have a monochromatic design. They used symbolic imagery based on non-spectacularization and proposed the deconstruction of traditional components, reducing abstraction. They also needed to be produced quickly and at a low cost, which is why lithography, the technique originally used, was replaced by screen printing [11] [17] [18]. According to a statement by the *Atelier*, the posters were intended for the struggle and should be associated with it, never to be used as decorative elements or serve as objects of aesthetic interest. Their legitimate place was to be on the walls of factories or in the streets, in other words, the centres of conflict. They should not be seen as the final goal, but as a call to action, to fight [23]. The posters from May' 68 are intrinsically linked to the movement and continue to be emblematic today, influencing art and design.

In addition to posters, other formats were included. Students and artists also used graffiti, writing slogans and messages on walls, buildings, and other public spaces, often using stencils or spray. It

[1]At the original: La lutte continue
[2]At the original: Front uni
[3]At the original: Unité



Figure 1: *La lutte continue.* Ecole nationale supérieure des Beaux-Arts et Atelier populaire, 1968. [Public domain], via Wikimedia Commons. (Bibliothèque nationale de France)



Figure 2: *Mai 68 début d'une lutte prolongée.* Atelier populaire, 1968. [Public domain], via Wikimedia Commons. (Bibliothèque nationale de France)

allowed the movement to spread its message beyond the limits of traditional media and to reach a broader influence. Some artists used performance, challenging the status quo. Theatre and other forms of public performance disrupted the daily routines of urban life and questioned the authority of the state and other institutions. Producing their own newspapers, magazines and alternative media, the activists communicated their messages directly to the public. These publications often featured artwork and visual elements alongside articles and essays, helping to foster a sense of community and shared purpose among the movement's supporters.

3 GRAFFITI AND STREET ART

In the 1980s, two artistic movements emerged on the streets: graffiti and street art. Both share the fact that they appear in urban spaces, but there are key differences between them. Herrero argues that graffiti is more focused on individual affirmation [20]. Street art is a protest movement that aims to provoke reflection, incite political criticism and social struggle, question ownership, appropriate



Figure 3: *Shadowman,* Richard Hambleton, 1981-1982. [Public domain], via Wikimedia Commons. Photo by Allan Molho.

public space and denounce established systems. It uses irony as a tool and carries a challenging component. Despite the diversity of themes and the search for specific techniques that distinguish them, some common characteristics must also be considered. Urban artists refer to these as guerrilla tactics, as they allow for speed and ease during the production of the works. Abarca highlights that in urban art, property boundaries are blurred, expanding the limits of action, no longer constrained by the divisions imposed by money, even raising questions about these very limits and their arbitrariness [1]. It is as though matter and space reverted to their primary state, that is, when everything belonged to everyone and, in reality, no one owned anything at all.

3.1 Richard Hambleton

In the 1970s, Canadian artist Richard Hambleton gained widespread notoriety and became one of the precursors of street art by drawing, in low-crime areas, a silhouette with the symbol commonly made by the police to demarcate a murder, and painting blood-like stains around it in the work *Image mass murder. Shadowman* (Figure 3) is his most famous work and has been reproduced in several countries. These works were created using manual techniques but already contained the characteristic social critique of urban art [20].

3.2 Blek le Rat

French artist Xavier Prou, better known as Blek le Rat, is a pioneer in the use of stencils in street art (Figure 4). On his website [8] he justifies that Rat is an anagram of Art and that rats are the only animals that will survive the apocalypse. In an interview with Steven Sulley [36], he states that he was greatly impacted and influenced by what he saw on the streets of New York. Ten years later, in the 1980s, he started drawing his rats on the walls of Paris. However, it was when he saw Hambleton's work that he realized he needed to do "something bigger". He began creating characters, such as the Irishman, inspired by a newspaper image showing a man shouting at a soldier who had his gun pointed at a civilian.



Figure 4: *Riot police at Blender,* Blek le Rat. Melbourne-Australia, 2011. [Public domain], via Wikimedia Commons.
4

According to the artist, "when you leave an image on the streets it takes on different meanings, which is very interesting, because people have their own interpretation". Blek le Rat adds that it is very challenging to exhibit street art in a gallery. It is a form of art where the surrounding environment is crucial, adding different meanings and layers to the image. On the other hand, a gallery allows the preservation of the memory of the original work. In his manifesto he affirms that, for the evolution of art, it is essential for the work to be taken to the streets. "I would like to take the characters out of the museums and give them back to the people of the city" [9, p. 1]. He influenced an entire generation of artists.

> "The streets of Paris afforded us ample space to work in, and the practice of graffiti was completely unknown at that point, so the roaming police rarely disturbed us unless they wanted to know what we were doing and whether our agenda was political. We answered: "No it's art", and the game was won." [8]

In an interview with Jacobi [22], he justifies his choice of the stencil, because it is a technique that does not depend on luck, it is ideal because it is fast, allows for infinite reproduction and results in beautiful and clean images. Furthermore, it has the advantages of low cost, being able to be applied to a variety of surfaces, being combined with other techniques and being durable, giving the work a long life. However, there is a limitation in what can be designed, it requires unique colours and requires pieces with little detail, with synthetic ideas [20].

3.3 Banksy

The identity of the British artist is still shrouded in mystery. He is the most influential figure in this movement, having elevated street art to a privileged paradigm (Figures 5 and 6). His messages reach a massive audience. In 2010, TIME magazine [15] named him one of the hundred most influential people in the world. Numerous



Figure 5: *Banksy art on Brick Lane,* East End, London, 2004. [Public domain], via Wikimedia Commons.



Figure 6: *Banksy on Thekla barge,* 2008. [Public domain], via Wikimedia Commons. Photo by Confusedmiked.

theories and jokes surround his identity. The mystery further amplifies the attention given to his work, which has been carried out in unlikely locations, such as the Gaza Strip.

> "He is a contemporary poet who transforms words and images into works that invite you to participate in a critical discourse. Never before had an artist interacted so forcefully with the city and its inhabitants. His incredible interventions, some of them almost performances, and a constant active presence on the internet expanded his fame like wildfire. He even named himself the Robin Hood of the 20th century. His objective is to return humanity to the inhabitants of big cities through poetic, harsh and utopian interventions, with the contradictions of the world as protagonists" [20, p. 166][5].

[5]Translation by the authors. Original quote: "Es un poeta contemporáneo que trasforma las palabras e imágenes, en obras que invitan a participar en un discurso crítico. Nunca antes un artista había llegado a interactuar de una forma tan contundente con la ciudad y sus habitantes. Sus increíbles intervenciones, algunas casi performances, y una constante presencia activa en Internet han expandido su fama como la pólvora. Él mismo se ha erigido como el Robin Hood del siglo XXI. Su objetivo es devolver la humanidad a los habitantes de las grandes ciudades a través de intervenciones poéticas, duras y utópicas, con las contradicciones del mundo como protagonistas".

Banksy cited that Blek le Rat is his greatest influence, and he reinterpreted many of his works. The artist himself has stated that whenever he comes up with an idea, he remembers that le Rat already did it better twenty years ago [12]. Herrero [20] analyses and compares the works of both artists: they use stencils and create almost real, life-size images, with political-social themes and critiquing consumption, war and xenophobia. Certain elements recur, such as the rat, images of children and soldiers and the reinterpretation of iconic artworks. For him, graffiti is a form of guerrilla warfare that provides individuals with the opportunity to challenge those in power. His works subvert many conventional artistic norms, such as authorship and the appropriation of public spaces. His works address social and political issues, highlighting urgent topics [2]. In 2009 he directed the film *Exit through the gift shop*, dubbed the "first street art disaster movie" [27].

4 DIGITAL *ARTIVISM*

In the 21st century, changes in communication methods have given rise to different experiments and new modes of expression [2]. As noted by Carvalho, the advent of the internet and the growing accessibility of digital technologies further amplified the reach of artistic production, contributing to the greater dematerialization of artistic objects and exhibition spaces [10]. Artistic expressions gained renewed spaces and formats, expanding beyond galleries to occupy the streets, unconventional venues, and virtual environments. Online environments also fostered new modes of audience engagement, marked by interactivity and participation [28].

Contemporary *artivism* appropriates strategies from the SI and the May' 68. Veiga reaffirms this heritage and adds the influences of 1970s punk, do-it-yourself (DIY) and hacktivism:

> "From the *détournement* of the SI to the current meme, the culture of opposition to established power has led to the renegotiation of artistic perceptions, giving rise to ideas of the momentary concatenation of the outdated and the prospective, of organisation and spontaneity, of the studio and the street, of presence and ephemerality, of art and politics. Taking advantage of the media convergence that the digital environment favours and stimulates, and the ease with which messages can be disseminated on social networks, artivism has a growing impact on people's lives, both through its participatory characteristics and its exposure to a wide audience" [30, p. 105][6].

Forms of media-related activism, *mediactivism*, have diversified, introducing new ways of confronting institutional power in the field of communication, influenced by counterculture collectives and movements as well by the hacker ethic [16]. Digital tools have become essential, especially for young people, though not exclusively [26]. In the present times, protests occupy hybrid spaces, bridging the streets and the internet, which plays a crucial role in democratization. This capacity has been crucial for contemporary mobilizations, such as *Occupy Wall Street* and the *Arab Spring* [18]. Notable instances of *artivist* expressions include Tactical Media, *Culture Jamming* and *Subvertising*.

4.1 Tactical media, culture *jamming* and *subvertising*

In 1993, Amsterdam hosted the first edition of the N5M festival, an event dedicated to showcasing and debating politically engaged audiovisual works from the latter half of the twentieth century. Originally focused on the idea of tactical television, the festival quickly expanded its scope to include tactical media. This concept refers to the subversive and non-commercial use of media, utilized either by individuals or by marginalized or oppressed groups. Instead of merely reporting events, such approaches express a critical perspective [16].

The concept gained prominence and was embraced as the central theme of the festival's 1996 edition. However, tactical media can also incorporate the use of older technologies, such as low-power radio transmitters and the distribution of videos created with digital cameras. Currently, even for established artists, such practices have extended beyond the gallery spaces, taking place in the streets, unconventional venues, and across social media platforms. In the realm of visual arts, tactical media's application goes beyond artivism, including experimental, conceptual, and poetic forms of expression.

Culture jamming emerged as a means of opposition to the media exploitation carried out by major companies, which increasingly encroach upon public areas with intrusive and aggressive advertising campaigns. These actions aim to subvert commercial messages by blending art, media, parody and an outsider attitude [14]. The first time the term Culture Jamming was used was by the collective *Negativland* – an experimental art and music group, in 1984. The purpose was to describe methods of media sabotage, such as altering billboards. The word *jamming* is an American slang used among amateur radio operators to refer to the "illegal practice of interrupting radio broadcasts or conversations between fellow hams with lip farts, obscenities, and other equally jejune *hijinx*" [3] [13]. *Subvertising* is a type of *jamming*. The term merges "subvert" and "advertising". It consists of using advertising pieces and subverting their original significance, changing existing images or reinterpreting slogans [26]. The goal is to provoke a feeling like the original one while revealing the underlying messages found within commercial marketing. In Figure 7, an intervention at Billboard, *Buy Shit!*, draws attention to excessive consumption.

There are also other tactical media manifestations, such as performance or guerrilla theatre, artistic vandalism, *hacktivism*, video artivism, video art, street art, direct actions, radio, urban art, manifestos and demonstrations, or civil disobedience. Due to its symbolic and aesthetic essence, *artivism* questions, provokes, raises awareness, and elaborates on facts and issues related to specific social and historical conditions, with the purpose of fostering resistance and transformation. It proposes new forms of expression, triggering both artistic and social ruptures. In the digital realm,

[6]Translation by the authors. Original quote: "Do *détournement* da IS ao atual meme, a cultura de oposição ao poder instituído implicou a renegociação das perceções artísticas, surgindo ideias de concatenação momentânea do ultrapassado e do prospectivo, de organização e espontaneidade, de ateliê e rua, de presença e efemeridade, de arte e política. Aproveitando a convergência mediática que o meio digital favorece e estimula, e a facilidade de disseminação das mensagens nas redes sociais, o artivismo tem um impacto crescente na vida das pessoas, quer por via das suas características participativas, quer pela sua exposição a um público vasto".



Figure 7: Subvertising. *Buy Shit!* by Sr. X, street art intervention Billboard, 2017. [Public domain], via Wikimedia Commons.

countless possibilities emerge, as numerous technologies have radically transformed the ways of protesting. In fact, this change is pervasive, affecting the way we communicate and relate to one another [28].

These diverse manifestations demonstrate how art has adapted to technological innovations. These practices seek to appropriate the means of communication, challenging hegemonic narratives, further blurring the boundaries between art and activism, and proposing engagement with the urgent needs of today. By incorporating a mode of resistance that reclaims agency in the face of mass communication systems, they reaffirm the political potential of art as a disruptive and transformative tool.

It is possible to observe that some criteria proposed by the *Atelier Populaire* are employed in artworks created by digital artists, such as the prioritization of political messages over aesthetics; direct and symbolic imagery; simple design and the use of limited colours. The following examples demonstrate this proximity:

4.2 Bijari

Composed of designers, architects, photographers, videographers, and visual artists, *Bijari* is a Brazilian collective known for its numerous interventions in urban spaces. The artists make use of technologies such as video mapping, 360° video, and live image projection. Their research into urban intervention and public art has inspired the creation of political and poetic territories that reestablished connections between the public sphere and the art system, while also extending beyond it [34]. In the artwork *Carro Verde*, they transform abandoned vehicles found on city streets into garden green spaces that emerge organically from the metal frames (Figure 8.

In 2016, the group started a set of works featuring graphic aesthetics, with saturated colours. Titled *Vocabulário Combativo*, it aims to reinforce progressive agendas that were under threat due to the coup in Brazil. The images were projected onto buildings and widely shared on social media (Figure 9).

4.3 Naziha Mestaoui

Through technology, Belgian artist Naziha Mestaoui sought to raise awareness about the impact that every action or decision has on the world and nature. One of her works is the installation *One heart, one tree*. Through a mapping projection and a downloaded application, anyone can grow a tree on the Eiffel Tower. For every virtual tree created, a real one is planted. Participants can follow the growth of their trees for three years. It is an invitation to act for the environment (Figure 10). "However ephemeral this artwork may seem, it gives weight to the decisions you make today, by engaging in an action that will have a lasting impact on all of us and on the world we live in" [25].

> "I really mix physical, tangible experiences with immaterial worlds. What I wanted to do is create an artwork that would combine art technology and humanity so that we could understand that we are totally interconnected with nature, because we are part of nature, we are not separated from nature. But I also wanted to show that our technologies, that also symbolize our future, can help us reconnect with nature and that is in fact how the inspiration for the project *One heart one tree* came to me." [33]



Figure 8: *Carro Verde*. Bijari, 2007. (bijari.com.br)



Figure 9: *Vocabulário Combativo*. Bijari, 2016. (bijari.com.br)

4.4 Krzysztof Wodiczko

Polish artist Krzysztof Wodiczko is known for projecting large-scale videos and slides onto monuments and architectural façades [31]. In *Sans-Papiers*, from 2006 (Figure 11), four immigrants are seen sitting on the roof of the *Kunstmuseum Basel*, talking to one



Figure 10: *1 Heart, 1 Tree,* Naziha Mestaoui, 2015. (unfccc.int)



Figure 11: *Sans-Papiers,* Krzysztof Wodiczko. Projection onto the *Kunstmuseum Basel's* façade, 2006. (krzysztofwodiczko.com)

another and singing in their own languages. However, their faces remain unseen. The work draws attention to the invisible, undocumented people living in Switzerland, known as *sans-papiers* [32]. Wodiczko uses public space as a political and aesthetic medium, transforming architecture into a means of resistance and collective visibility. *Homeless* was a projection onto a theatre building, where participants became spectators (Figure 12). Presented at *Théâtre Maisonneuve,* within P*lace des Arts* in Montreal, in 2014, the work offered homeless people a space to share their stories and experiences, as well as to express their fears and desires. "Giving voice to marginalized persons, the artist included their narratives in the city's public discourse" [32]. The projection was part of *La Biennale de Montréal*, co-produced by the *Musée d'art contemporain de Montréal*, the *Quartier des Spectacles*, and the *Phi Centre*, in collaboration with St. Michael's Mission.



Figure 12: *Homeless,* by Krzysztof Wodiczko. Projection onto the *Théâtre Maisonneuve,* Montreal, 2014. (krzysztofwodiczko.com)



Figure 13: Light projection on the *Merchandise Mart,* Chicago. Jenny Holzer, 2008. (Photo by John Faier)

4.5 Jenny Holzer

The conceptual artist Jenny Holzer was born in Ohio, U.S. She creates LED electronic sign sculptures that display phrases that function as verbal meditations on power, trauma, knowledge, and hope. She uses minimalist and textual language, often with monumental light and typography.

> "Celebrated for her inimitable use of language and projects in the public sphere, Holzer creates a powerful tension between the realms of feeling and knowledge, with a practice that encompasses both individual and collective experiences of power and violence, vulnerability and tenderness." [37]

A light projection on the *Merchandise Mart*, Chicago, in 2008 with the text *The joy of writing,* from *View with a grain of sand,* by Wisława Szymborska, translated into English by Stanisław Barańczak and Clare Cavanagh (Figure 13). In *For the City,* she features *Hymn*, from *Blackbird and Wolf*, by Henri Cole. It was projected onto New York Public Library, in 2005 (Figure 14).

4.6 Rafael Lozano-Hemmer

Lozano-Hemmer was born in Mexico City and creates platforms for public participation through works situated at the intersection of architecture and performance art. *Border Tuner* connects the cities of El Paso, Texas, and Ciudad Juárez, Chihuahua, through spotlights that create a blanket of light (Figures 15 and 16). There are six interactive stations, each with a microphone, a speaker,

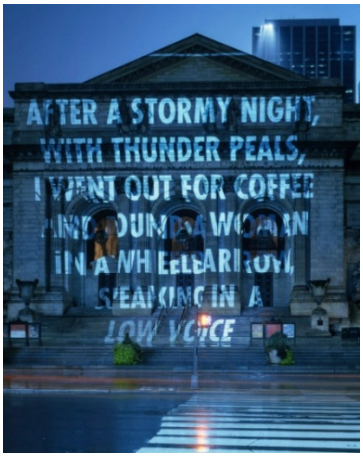


Figure 14: *For the City,* Jenny Holzer. New York, 2005. (Photo by Atilio Maranzano, newyorker.com)



Figure 15: *Border Tuner,* by Lozano-Hemmer. Border between Texas and Chihuahua, 2019. (lozano-hemmer.com)

and a large wheel or dial. Visitors can manipulate this dial, which projects a light that follows their movement. When two "arms of light" meet in the sky and intersect, a two-way sound channel automatically opens, connecting people at two remote stations. The brightness is modulated in sync with speech, resembling a flicker in Morse code [38].

> "The community leaders selected to coordinate various topics have committed to connecting their existing networks on both sides of the border for these topic-specific conversations, in addition to the spontaneous conversations that the public will generate each evening" [24][7].

5 FINAL CONSIDERATIONS

The posters created during the events of May' 68 influenced, and continue to influence, the way art is conceived and produced. They were well structured and grounded on the ideas proposed by the SI. The designs, crafted not only by artists, but also by students and workers with no formal training in arts or communication, were highly functional and focused on their greater purpose: resistance. They repeated formulas that have already been proven effectively in political propaganda.

[7]Translation by the authors. Original quote: "Los líderes de la comunidad seleccionados para coordinar varios temas se han comprometido a conectar a sus redes existentes en ambos lados de la frontera para estas conversaciones de temas en específico, además de las conversaciones espontáneas que generará el público cada noche".



Figure 16: *Border Tuner,* by Lozano-Hemmer. Border between Texas and Chihuahua, 2019. (lozano-hemmer.com)

Street art, with aims to provoke social and political discourse, effectively adopts many of these principles. The works of Richard Hambleton, Blek le Rat and Banksy share many similarities, both in techniques and in the themes they address. The option for unique colours and easily recognizable drawings, prioritizing a single, clear message to avoid ambiguity, with intention placed above aesthetics, from a social and political perspective, are characteristics found in the posters of the *Atelier Populaire* and echoed in the work of contemporary artists, as *Bijari*; Naziha Mestaoui; Krzysztof Wodiczko; Jenny Holzer and Rafael Lozano-Hemmer. Digital artworks can be produced meeting nearly all the criteria set forth by the *Atelier Populaire.* Currently, the primary difficulties may be the costs of production, given that digital art depends on costly tools and technology. It is crucial to acknowledge its naturally elevated production expenses in comparison to other art forms. Another challenge is the struggle to uphold anonymity in a society that is under constant surveillance. For *Bijari*, as a collective, the focus is not on individual artists' names, though their identities remain recognized.

In the face of the climate crisis, ongoing wars, rising rates of femicide, xenophobia, racism, homophobia, and other forms of alterophobia, it is urgent to find ways to draw attention to these issues and *artivism* stands out as a very powerful instrument. Understanding the enduring power of these posters contributes to the development of *artivist* strategies across diverse artistic expressions, going beyond aesthetics and becoming a tool for awareness and change.

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AFASTAR E APROXIMAR: Narrativa audiovisual sobre a (re)conexão entre o Homem e a Natureza. Presença entre imagem, som e natureza

ZOOM OUT and ZOOM IN: An audiovisual narrative on the (re)connection between Humans and Nature. Presence between image sound and nature.

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Abstract

Este artigo analisa a instalação AFASTAR E APROXIMAR (Zoom In and Zoom Out), focando-se no uso do vídeo como meio de expressão artística ao serviço da consciencialização ecológica e da transformação de atitudes. Inserida no campo da média-arte digital, a obra propõe uma experiência sensorial e envolvente que convida o visitante a refletir sobre a sua relação com a natureza. Através da articulação de som, imagem e movimento, a instalação cria um ambiente de contemplação e diálogo poético entre o Homem e a Natureza. A justaposição de camadas visuais, a presença do corpo em simbiose com a paisagem e a integração de uma narrativa poética contribuem para uma perceção expandida do tempo e da existência ecológica. Inspirando-se em práticas contemporâneas de artistas como Marshmallow Laser Feast e Thijs Biersteker, e em sintonia com a visão de Sacha Kagan, que propõe a sustentabilidade como uma nova fronteira para as artes e culturas, AFASTAR E APROXIMAR exemplifica o potencial do vídeo enquanto linguagem artística capaz de gerar empatia, introspeção e responsabilidade ambiental.

ABSTRACT

This article analyses the installation AFASTAR E APROXIMAR (Zoom In and Zoom Out), focusing on the use of video as a means of artistic expression in the service of ecological awareness and attitude change. Part of the field of digital media art, the work offers an immersive sensory experience that invites visitors to reflect on their relationship with nature. Through the articulation of sound, image and movement, the installation creates an environment of contemplation and poetic dialogue between Man and Nature. The juxtaposition of visual layers, the presence of the body in symbiosis with the landscape and the integration of a poetic narrative contribute to an expanded perception of time and ecological existence. Inspired by contemporary practices of artists such as Marshmallow Laser Feast and Thijs Biersteker, and in tune with Sacha Kagan's vision, which proposes sustainability as a new frontier for the arts and cultures, AFASTAR E APROXIMAR exemplifies the potential of video as an artistic language capable of generating empathy, introspection, and environmental responsibility.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Arte e sustentabilidade, Média-arte digital, Vídeo, Narrativa audiovisual, Homem e Natureza, Art and sustainability, Digital media art, Video, Audiovisual narrative, Man and Nature

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1 Introdução

A interseção entre arte e sustentabilidade tem vindo a consolidar-se como um campo fértil para práticas críticas, sensoriais e transdisciplinares, especialmente no contexto das crises ecológicas e civilizacionais que caracterizam o Antropoceno. Como defende Joanna Page [1], muitas obras contemporâneas rejeitam a simples representação da crise ambiental, propondo antes formas de pensamento sensível que revelam forças planetárias incontroláveis. Neste enquadramento, a arte não se limita a representar a crise, mas atua como um dispositivo de escuta e de reconexão com o mundo natural, promovendo uma ética da interdependência.

Em sintonia com esta visão, Sacha Kagan [2] propõe a sustentabilidade como uma nova fronteira para as artes e culturas, sublinhando que esta não deve ser entendida apenas como temática, mas como um reposicionamento profundo — ético, estético e epistemológico — que exige das práticas artísticas uma reinvenção dos modos de pensar, criar e agir no mundo. Ao reconhecer a arte como um campo capaz de integrar reflexão crítica, sensibilidade ecológica e diversidade cultural, Kagan defende que os artistas têm um papel essencial na construção de novos imaginários sustentáveis, articulando justiça social, cuidado ambiental e inovação cultural [2].

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Esta abordagem torna-se visível no trabalho do coletivo TeamLab, cujas obras operam na confluência entre arte, tecnologia e ecologia. Criações como Forest and Spiral of Resonating Lamps in the Forest [3] e Borderless [4] propõem experiências sensoriais imersivas que exploram a complexidade dos ecossistemas naturais, como florestas e rios, enquanto respondem ativamente à presença do público. Ao integrar o movimento dos visitantes na transformação visual e sonora das obras, o TeamLab promove uma perceção ecológica do mundo, onde Natureza, corpo e tecnologia se entrelaçam [3] [4]. A dimensão participativa das suas instalações convida a um envolvimento direto e poético com o ambiente, sugerindo novas formas de atenção, cuidado e coabitação com o planeta.

Nesta mesma linha, o coletivo britânico Marshmallow Laser Feast, com a obra Evolver [5], proporciona uma experiência multissensorial de introspeção e de ligação com a biologia do corpo e os ciclos naturais. Apresentada no Frankfurter Kunstverein, esta instalação virtual conduz o visitante por uma viagem meditativa através do processo respiratório humano, cruzando dados biométricos, imagem e som para explorar a interdependência entre o interior do corpo e o ambiente envolvente [5]. A obra dissolve fronteiras entre sujeito e ecossistema, tecnologia e vida, propondo uma estética relacional que encoraja empatia e consciência planetária.

Também Thijs Biersteker, com a instalação Plastic Reflectic [6], evidencia a potência crítica da arte digital em tempos de emergência climática. Utilizando sensores de movimento e dados em tempo real sobre a poluição marinha por plástico, a obra confronta o visitante com o impacto das suas ações quotidianas, visualizando a transformação de microgestos em consequências ambientais globais. Ao refletir o corpo do observador numa nuvem plástica pulsante, a instalação cria uma experiência de espelho ético e ecológico, instigando responsabilidade e ação.

Estas práticas exemplificam uma estética da interdependência, que rejeita o paradigma cartesiano da separação entre cultura e natureza. Em consonância com esta perspetiva, Davide Brocchi [7] defende que, para enfrentar a crise ecológica, não basta mudar tecnologias ou comportamentos individuais. É necessário cultivar novas formas de pensar, sentir e viver no mundo, que valorizem a diversidade, o cuidado e a interdependência. O autor propõe o conceito de "culturas da sustentabilidade" — visões de mundo alternativas que rompem com o monoculturalismo globalizado e com a lógica extrativista dominante, que trata a natureza como mera fonte de exploração, ignorando a sua dimensão viva, simbólica e relacional. A arte, neste quadro, não é acessória, mas central na construção de futuros sustentáveis, na medida em que atua simultaneamente a nível cognitivo, emocional, ético e político. Ao inscrever-se nesta perspetiva, AFASTAR E APROXIMAR propõe uma experiência estética que é, simultaneamente, ética e transformadora — uma criação artística que convida a imaginar outras formas de coexistência mais equilibradas, conscientes e inclusivas.

2 O Vídeo Como Meio de Expressão Artística em Média-Arte Digital

O vídeo, desde a sua emergência como tecnologia de registo nos anos 1960, tem desempenhado um papel central na reconfiguração das práticas artísticas. A sua democratização, potenciada por avanços tecnológicos tornou-o um meio acessível, flexível e profundamente expressivo para artistas de diferentes contextos. No campo da média-arte digital, o vídeo não se limita a ser um suporte técnico, mas afirma-se como uma linguagem complexa que articula imagem, som, tempo, corpo e espaço. Explora-se, neste enquadramento, a ontologia da imagem em movimento — fílmica ou videográfica — e as implicações dos avanços tecnológicos que têm expandido os seus campos estético, concetual e representacional da imagem em movimento [8].

A mediação tecnológica do vídeo permitiu o surgimento de uma nova sensibilidade artística, marcada pela imersão, interatividade e presença do corpo. O vídeo operou desde o início como meio de contestação e de expressão pessoal e política, sendo explorado por artistas como Nam June Paik, Joan Jonas ou Bruce Nauman, que romperam com convenções estéticas ao experimentar com a presença corporal e a manipulação do tempo visual [9].

Esta capacidade do vídeo de documentar e ao mesmo tempo performar, registar e poeticamente construir significados, permitiu a emergência de uma estética videográfica centrada na presença do corpo, na duração da imagem, na repetição e no desvio da narrativa linear. O vídeo tornou-se, assim, num "confessionário", como refere Gonçalves, onde se exploram subjetividades, identidades, e críticas às convenções sociais e culturais [9].

Contemporaneamente, o vídeo expandiu-se para novos territórios artísticos através da arte digital e interativa. Segundo Hernando Urrutia, Pérez e Fernandes-Marcos [10], o vídeo na arte contemporânea não se limita a representar: mas gera conhecimento, estimula a reflexão e constrói novas relações entre a obra e o público. O vídeo, enquanto linguagem visual, propaga ideias complexas que desafiam normas sociais e culturais [9] [11]. A capacidade do vídeo de cruzar fronteiras entre arte e tecnologia é uma característica que reforça seu valor como meio de expressão artística, permitindo novas formas de envolvimento e interação com o público.

Neste sentido, no contexto da média-arte digital, o vídeo evolui como um meio híbrido, que articula as linguagens das artes plásticas, da performance, do cinema experimental e das tecnologias interativas. Com a integração de sensores, interfaces e ambientes imersivos, o vídeo deixa de ser apenas projeção para se tornar experiência incorporada. A imagem em movimento passa a responder ao gesto do visitante, à sua presença e aos seus movimentos, abrindo caminho para obras que promovem um envolvimento sensorial e cognitivo sem precedentes.

Em suma, o vídeo constitui hoje um dos meios relevantes da arte contemporânea, oferecendo aos artistas não apenas um suporte, mas uma linguagem expandida, performativa e crítica. A sua capacidade de integrar imagem, som, corpo e interação tecnológica torna-o central na produção de experiências artísticas que questionam, emocionam e transformam.

É neste contexto expandido que se inscreve a obra "AFASTAR E APROXIMAR", onde a linguagem videográfica é mobilizada para convocar o visitante a repensar o seu lugar no mundo e a sua ligação ao planeta. Através da articulação entre som, imagem e corpo, a obra convida o visitante a um encontro poético com a sua relação com o mundo, reafirmando o papel do vídeo como meio de expressão estética e sensorial na média-arte digital.



Figure 1: Sala de exposição da instalação AFASTAR E APROXIMAR.

3 Instalação Audiovosual "AFASTAR E APROXIMAR" / "ZOOM IN and ZOOM OUT"

A instalação AFASTAR E APROXIMAR (ZOOM IN and ZOOM OUT) inscreve-se no campo da média-arte digital, assumindo um compromisso ético e estético com a sustentabilidade ambiental e cultural [12]. Exibida no Fórum da Maia, em Portugal [13], a obra foi concebida como um espaço de reconhecimento, evocando um "jardim de memória e contemplação do futuro".

A instalação não se limita a evocar a harmonia entre o Homem e a Natureza, mas procura interrogar a perceção linear da história [12]. Por "perceção linear da história" entende-se uma visão do tempo como uma linha contínua e progressiva, onde o passado conduz inevitavelmente ao presente e este, por sua vez, a um futuro idealizado de progresso. Esta lógica, profundamente enraizada na modernidade ocidental, tem sustentado modelos de desenvolvimento que ignoram os ciclos naturais, os tempos ecológicos e as múltiplas temporalidades culturais.

A experiência audiovisual expandida da obra AFASTAR E APROXIMAR propõe romper com a narrativa linear do tempo e da história. A instalação convida à escuta e à contemplação, explorando a relação entre o Homem e a Natureza. Através da alternância entre imagens microscópicas e paisagísticas, e da evocação simultânea de memórias do passado e de possibilidades futuras, a obra propõe uma nova forma de compreender o tempo — não como uma linha reta, mas como um tecido interligado onde natureza, memória e imaginação coexistem.

À medida que o visitante se aproxima da instalação AFASTAR E APROXIMAR, é acolhido por duas projeções que decorrem em simultâneo: uma é exibida por um videoprojetor sobre uma parede específica, e a outra num ecrã LCD estrategicamente posicionado (Figura 1) [12]. Com a duração de 1 minuto e 34 segundos, as projeções alternam entre planos abertos e detalhados da paisagem natural, compondo uma coreografia de som e imagem que evidencia a interligação entre diferentes elementos do mundo natural. Ao posicionar-se sobre um ícone de pés marcado no chão, ativa um sensor de movimento que desencadeia uma nova fase da instalação: uma segunda sequência audiovisual, com a duração de 4 minutos e 13 segundos, em que a presença do visitante deixa de ser meramente passiva e se converte numa participação ativa, ainda que mediada pela própria lógica do dispositivo (Figura 1) [12].

A superfície de projeção integra um espelho, cuja função vai muito além do reforço visual. Ao refletir as imagens em movimento, acrescenta uma dimensão de introspeção, convidando o visitante a confrontar-se não apenas com a paisagem projetada, mas também com a sua posição dentro dela. Esta configuração espacial estabelece uma dinâmica visual onde imagem e reflexo se entrelaçam. O espelho não apenas amplia a paisagem projetada — convida o olhar a voltar-se para dentro, a questionar a relação entre o ser humano e o mundo natural que observa. A separação física entre os espelhos marca, de forma subtil, a rutura que se foi instalando entre o Homem e a Natureza. Essa distância, tornada visível na instalação, transforma-se num apelo à consciência: a urgência de reconhecer o lugar do homem no ecossistema.

Na conceção da instalação AFASTAR E APROXIMAR, foram produzidos quatro vídeos distintos, que tecem uma coreografia entre imagem em movimento e som. Dois deles, silenciosos e projetados por um videoprojetor, são refletidos pelos espelhos da instalação, multiplicando-se no espaço e criando uma perceção fragmentada da paisagem.

Os outros dois vídeos, exibidos num ecrã LCD, introduzem o som como elemento central. No primeiro, escutam-se fragmentos do mundo natural — a água que corre, o vento que sussurra, a vegetação que se agita — sons captados, transformados e reinterpretados para intensificar a textura sonora da paisagem.

No vídeo principal, uma *voz-off* enuncia o poema da instalação, articulada com a composição musical original de Marçal dos Campos, resultando numa fusão entre palavra e som.

Esta sequência foi concebida para propor um diálogo simbólico entre o Homem e a Natureza, evocando memória, consciência e a responsabilidade ambiental. Através da articulação entre imagem, som e palavra, constrói-se uma dimensão poética que convida à introspeção e à empatia ecológica.

3.1 Construção da narrativa audiovisual dos vídeos principais "AFASTAR E APROXIMAR"

Os dois vídeos principais que integram a instalação AFASTAR E APROXIMAR — um projetado por videoprojetor e outro apresentado num ecrã LCD — têm ambos a duração de 4 minutos e 13 segundos e são exibidos em simultâneo, compondo uma narrativa audiovisual articulada entre dois suportes distintos (Figura 2). Esta

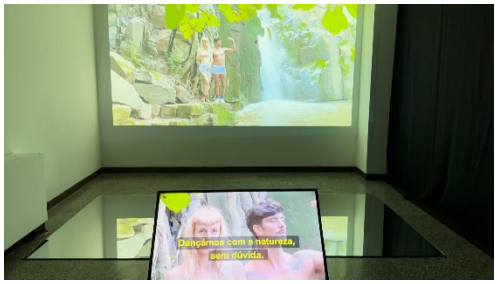


Figure 2: Exibição dos vídeos principais no espaço, com recurso a videoprojetor e LCD.

secção descreve os vídeos numa perspetiva concetual, analisando as suas componentes poética, visual e sonora, que se revelam fundamentais para a construção da experiência proposta pela obra.

A estrutura visual da instalação assenta na divisão entre dois dispositivos: o videoprojetor apresenta planos mais amplos e abertos, proporcionando uma visão alargada da paisagem; enquanto o ecrã LCD projeta planos aproximados, revelando texturas e pormenores do mundo natural (Figura 2). Esta alternância de planos materializa simbolicamente o conceito de "Afastar" e "Aproximar", permitindo ao visitante transitar entre a intimidade do detalhe e a vastidão do território. Foi ainda introduzido, de forma intencional, um ligeiro desfasamento temporal entre as imagens apresentadas em cada suporte. Esse intervalo subtil, quase impercetível, introduz uma descontinuidade que acrescenta complexidade à experiência, sugerindo que a (re)conexão com o mundo natural exige tempo, escuta e atenção.

Em articulação com a componente visual, o poema surge como elemento central na construção da narrativa do vídeo principal. Recitado em *voz-off*, em inglês, e acompanhado por legendas em português no ecrã LCD (Figura 2, Figura 3), o poema assume o papel de fio condutor simbólico e narrativo, atravessando e interligando as dimensões sonora e visual da instalação.

Estruturado como um monólogo poético de tom confessional, dirigido a um interlocutor indefinido — "meu descendente" — o texto remete simultaneamente para o visitante da instalação e para as gerações futuras. Com uma linguagem imagética e emotiva, o poema constrói um diálogo intergeracional entre uma voz do passado e um futuro em crise, evocando uma perceção idealizada de harmonia entre o Homem e a Natureza. Esta dimensão literária da obra aproxima-se de práticas contemporâneas de arte ecológica que, como refere Kagan [2], recorrem à poética e à estética como dispositivos para problematizar a sustentabilidade cultural e ambiental.

Desde o início, o poema evoca uma sensação de deslocamento temporal com a expressão — "from the past I come" — que situa o verso num tempo perdido, de onde emerge uma tentativa urgente de (re)conexão.

Estrofe recitada em voz-off no video principal
(versão original em inglês e tradução em português)
Hey there, from the past I come,
Olá, do passado eu venho,
A voice echoing from where you're from.
Uma voz ecoando de onde tu terás vindo.
In the 21st century, we thrived,
No século 21, nós prosperamos,
But now I see, it's nature we've deprived.
Mas agora vejo que foi da Natureza que nos privámos.

A voz poética atua como uma testemunha do passado e um alerta para o presente, evocando uma época em que a humanidade "Dançava com a Natureza", metáfora que sugere uma relação de equilíbrio, fluidez, simbiose e respeito com o mundo natural:

We danced with nature, without a doubt.
Dançámos com a Natureza, sem dúvida.
But it seems, my descendant, you forgot,
Mas parece, meu descendente, que te esqueceste,
The harmony we had, now it's all a mess.
Da harmonia que tínhamos, agora é tudo uma confusão.

Esta "dança" simboliza um estado de coabitação harmoniosa entre o Homem e a Natureza, em que ambos partilhavam ritmos, ciclos e interdependências. No entanto, esse equilíbrio foi quebrado por um caminho de progresso desenfreado, marcado por esquecimento, destruição e distanciamento do mundo natural. A voz poética denuncia ainda os efeitos devastadores desse progresso desmedido, evocando para um "renascimento desastroso" que resulta da rutura com os ciclos naturais.

Ao afirmar "Homo sapiens, that was our name" (Figura 3), o poema convoca uma reflexão sobre a identidade humana e a sua responsabilidade no colapso ambiental. Esta referência não só relembra a origem evolutiva da nossa espécie, como sublinha a distância que se criou entre o ser humano e os seus laços com a natureza.

O poema faz ainda uma crítica clara ao conceito de "progresso", revelando o seu lado sombrio: "In pursuit of progress, we played the game / But in our stride, we trampled the earth". A ironia contida na ideia de um "jogo" sugere que como muitas decisões humanas foram tomadas com leviandade ou cegueira face às consequências ecológicas. A degradação ambiental — simbolizada pelas "ilhas de plástico" e pelos "céus poluídos" — é apresentada como o colapso não apenas de ecossistemas, mas também de valores éticos e espirituais ligados à Terra.

Homo Sapiens, that was our name,
Homo Sapiens, esse era o nosso nome,
In pursuit of progress, we played the game.
Em procura do progresso, jogámos o jogo.
But in our stride, we trampled the earth,
Mas nos nossos passos, espezinhámos a terra,
Forgetting nature's worth, a disastrous rebirth.
Esquecendo o valor da Natureza, um renascimento desastroso.

O poema recorre a uma estrutura circular e reiterativa, sugerindo num apelo urgente à escuta e à mudança:

So, don't walk away, lend me your ear,
Por isso, não te afastes, apenas ouve-me,
I come with a message, crystal clear.



Figure 3: Fotogramas do vídeo principal AFASTAR E APROXIMAR, com legendas em português exibidas no ecrã LCD.

Eu venho com uma mensagem, clara como cristal.

Estas repetições funcionam como refrão e apelo insistente à escuta e à tomada de consciência. A estrutura repetitiva dos versos, intercalada com imagens visuais que oscilam entre a serenidade natural e a presença humana em simbiose com a paisagem, reforça a carga simbólica da mensagem.

Apesar do tom melancólico e crítico, o poema encerra com uma mensagem de esperança e abertura à transformação:

It's not too late, to change the song,

Não é tarde para alterar a melodia,

Let harmony and nature stay forever.

Que a harmonia e a Natureza perdurem eternamente.

Ao utilizar a metáfora da música e da dança, o texto sugere que há ainda possibilidade de regeneração — desde que se aprenda com o passado e se reencontre uma "verdadeira crença" na natureza como lugar de pertencimento, e não apenas de exploração.

A força evocativa do poema — transmitido através da *voz-off* e apoiado por legendas — exigiu uma composição visual pensada para prolongar e ampliar a sua dimensão simbólica. Para além da palavra, construiu-se um fluxo contínuo de imagens em movimento que leva o visitante a uma vivência de caráter sensível e empático com a memória de uma relação ancestral entre o Homem e a Natureza.

As filmagens decorreram em espaços naturais emblemáticos, como a Mata de Monsanto, em Lisboa, e as Cascatas do Rio Mourão, em Sintra. Estes cenários foram cuidadosamente escolhidos pela sua capacidade de revelar, simultaneamente, a imponência e a delicadeza dos ecossistemas naturais.

A serenidade das paisagens — como a cascata tranquila ou o reflexo da água — contribui para um tom contemplativo que sugere uma atitude de escuta e respeito perante o mundo natural (Figura 4). Os movimentos dos bailarinos, espontâneos e orgânicos, estendem essa mensagem através do gesto: cada deslocamento e cada pausa inscrevem no espaço uma forma de reverência silenciosa à vida e à sua complexidade. O vídeo apresenta-se como um convite sensível à preservação da natureza, à aceitação das diferenças e à redescoberta de uma ligação íntima e consciente com o planeta (Figuras 3, 4, 5, 6, 7, 8, 9, 10, 11), aproximando-se da perspetiva de Page [1], que defende a necessidade de repensar a agência no Antropoceno e de questionar a centralidade do humano nas relações com o mundo natural.



Figure 4: Bailarinos evocam referências clássicas como David de Michelangelo e "O Nascimento de Vénus" de Botticelli.

As imagens projetadas celebram a presença do corpo humano em harmonia com a natureza. Dois bailarinos — um homem e uma mulher — surgem como figuras arquetípicas que simbolizam forças criadoras e elementos primordiais. Os seus corpos, quase nus, são apresentados com simplicidade e delicadeza, remetendo para um estado de pureza original, livre de artifícios sociais ou culturais (Figura 4).

Um dos aspetos mais relevantes da instalação AFASTAR E APROXIMAR é a presença do corpo humano e a sua relação com a natureza. A escolha estética não recorreu ao corpo nu integral, mas antes a uma evocação mais simbólica, inspirada em arquétipos clássicos como o David de Michelangelo ou a Vénus de Botticelli



Figure 5: Evocação simbólica do corpo humano em diálogo com a natureza, inspirada em referências clássicas.

(Figura 5). Essa decisão não resultou de uma limitação técnica, mas de uma ponderação ligada ao contexto da exposição e à diversidade dos visitantes: tendo em vista que a instalação seria visitada por públicos diversos, incluindo grupos escolares de diferentes idades, optou-se por uma abordagem simbólica, garantindo que a obra pudesse ser experienciada de forma inclusiva.

Idealmente, a representação do corpo humano em estado de nudez poderia ter reforçado de forma mais imediata a ligação com a natureza, evocando a beleza natural, a essência e a valorização do corpo como expressão do ser humano.

Tal como referido em Cruz e Bidarra [14], "a representação do corpo humano em estado de nudez evoca a beleza natural, a sua essência, a valorização do corpo como expressão natural do ser humano, a força humana animal, deixando a mente leve e livre de impurezas numa procura incessante de liberdade. Ao mesmo tempo, representa o que tem de mais íntimo em cada ser humano, mas também o que tem de mais universalmente humano, sem máscaras, padrões e artifícios. Por outro lado, cria um espaço íntimo com os visitantes, colocando-os voluntariamente numa relação de proximidade".

A ausência do nu integral abriu também espaço para outra leitura: o corpo fragmentado, parcialmente velado ou mediado por gestos e referências contemporâneas, pode ser entendido como figuração simbólica da distância atual em relação à natureza — uma presença raramente vivida em estado puro e quase sempre condicionada pela cultura.

Na sua quietude, os bailarinos evocam referências artísticas clássicas: o David de Michelangelo, símbolo de coragem e beleza, e a Vénus de Botticelli, associada ao amor, à origem e ao renascimento [15, 16] (Figura 4, Figura 5). Estas imagens não funcionam apenas como citações visuais, mas como metáforas que reforçam a ligação entre corpo e natureza. Ao evocar estas figuras históricas para o presente, a instalação convida à reflexão sobre como a humanidade se foi afastando das suas raízes naturais — uma fratura simbólica que a obra procura tornar visível e abrir à possibilidade de reparação.

Os movimentos coreográficos evocam tanto a leveza como a força da vida natural. Gestos suaves, fluidos e instintivos desenham no espaço uma dança de comunhão com os elementos — uma expressão física da "dança com a natureza" que o poema propõe como caminho regenerador. Essa coreografia presta homenagem à diversidade da vida no planeta e destaca a importância de todas as formas de existência, humanas e não humanas. Através desta linguagem visual e performativa, o vídeo reafirma que, na sua essência, o ser humano é parte da Natureza, partilhando a sua beleza, resiliência e vulnerabilidade.



Figure 6: Corpo (in)completo: sublinha a beleza da imperfeição e a força da vulnerabilidade.

Entre os elementos mais marcantes do vídeo destaca-se a presença de um dos bailarinos com uma diferença física visível — a ausência de uma mão (Figura 6). Longe de ser ocultada ou suavizada, esta característica é integrada na narrativa visual como símbolo de força e autenticidade. Através desta escolha artística, a obra desafia os padrões convencionais de perfeição corporal e estética,



Figure 7: Fotogramas do vídeo principal de AFASTAR E APROXIMAR, com momentos simbólicos da colheita do medronheiro e da queima ritual da sálvia.

sublinhando que é precisamente na imperfeição que reside a beleza da existência. Esta presença corporal reconfigura a ideia de vulnerabilidade como potência, evocando a capacidade humana, e também da própria natureza, de se adaptar, resistir e florescer mesmo diante da adversidade.

A imagem do corpo (in)completo torna-se, assim, símbolo da resiliência ecológica e humana, reforçando a mensagem de que a harmonia não depende da ausência de falhas, mas da capacidade de integração e aceitação da diversidade (Figura 6). Num dos momentos mais simbólicos do vídeo, um dos bailarinos recolhe cuidadosamente o fruto do medronheiro, gesto que evoca, de forma subtil, a narrativa bíblica de Adão e Eva [17] (Figura 7). No entanto, ao contrário da tradicional associação da maçã ao pecado e à transgressão, aqui a colheita do fruto adquire um novo significado, não como um ato de desobediência, mas como um gesto de respeito e responsabilidade para com a natureza. O medronheiro, planta nativa valorizada pela sua resistência, beleza e relevância ecológica, torna-se símbolo de equilíbrio, sabedoria e renovação. O seu fruto, o medronho, assim como as propriedades medicinais da madeira, reforçam esta associação à vida, à cura e à sustentabilidade.

Complementando esta ação, os bailarinos protagonizam também a queima de folhas de sálvia, num gesto performativo que remete para rituais ancestrais de purificação (Figura 7). Este ato carrega um forte simbolismo de conexão com os elementos naturais e com práticas culturais que reconhecem o poder terapêutico das plantas. A defumação com sálvia não só purifica simbolicamente o espaço, como ativa sensações de calma, bem-estar e introspeção, ampliando a carga sensorial do video. O fogo, aqui presente de forma controlada e cerimonial, representa também a possibilidade de transformação, renovação e regeneração, tanto do ambiente como da própria consciência humana.

Ao conjugar dança, elementos naturais e gestos ritualizados, o video cria um espaço de meditação ecológica, onde se torna possível repensar a relação entre o ser humano e o mundo vegetal. Estes momentos sugerem que uma convivência harmoniosa com o planeta implica reconhecer o valor intrínseco da natureza, respeitar os seus ritmos e integrar os saberes tradicionais como parte de um futuro mais sustentável. O vídeo não apenas representa essa ligação, mas cria as condições para que ela seja experienciada de forma sensível e significativa.

A imagem da bailarina refletida na água é um dos momentos mais poéticos do vídeo, condensando múltiplos significados simbólicos (Figura 8). Para além de evocar qualidades tradicionalmente associadas ao feminino, como o amor, a intuição e a dimensão emocional, o reflexo na superfície líquida remete também para o caráter sagrado da água, associada à purificação, à espiritualidade e à renovação. Esta presença da água funciona como símbolo de introspeção e autoconhecimento, sugerindo um momento de bênção silenciosa e consagração interior. A fluidez da água, que se adapta a qualquer forma sem perder a sua essência, espelha a capacidade humana de se transformar, de se ajustar e de evoluir perante os desafios da existência.

Em sequência, os bailarinos são mostrados em estreita relação física com os elementos naturais: abraçam árvores, deslizam entre os seus ramos e deixam-se envolver pelo ambiente vegetal (Figura 9). Estes gestos não são meramente coreográficos, mas expressam uma ligação ancestral e sensível com o mundo natural, uma comunhão que ultrapassa o plano físico e se inscreve também nas dimensões emocional e espiritual. A natureza não é aqui apenas cenário, mas entidade viva com a qual se partilha espaço, ritmo e energia.

No desenrolar do vídeo, os movimentos dos bailarinos tornam-se progressivamente mais instintivos, quase animalescos (Figura



Figure 8: Bailarina refletida na água, evocando fluidez, introspeção e renovação.



Figure 9: Fotogramas do vídeo principal de AFASTAR E APROXIMAR, com os bailarinos em comunhão ancestral entre corpo e natureza.

10). Esta transformação gestual evidencia a continuidade entre o ser humano e os outros animais, sublinhando que, apesar da complexidade do pensamento e da cultura, mantemos uma ligação profunda com o mundo biológico. Estes movimentos, espontâneos e vitais, evocam liberdade, autenticidade e a importância de escutar os impulsos mais elementares, não como regresso ao primitivo, mas como forma de reencontrar equilíbrio na relação com a vida. Esta linguagem do corpo reforça a mensagem central da instalação: a urgência de uma coexistência respeitosa e consciente entre todas as formas de vida, na qual o ser humano se reconhece como parte do todo.

No final, as imagens do vídeo principal abrandam, conduzindo-nos a planos mais serenos, onde o Homem e a Natureza se reencontram numa fusão silenciosa. Os corpos, gradualmente absorvidos pela paisagem, tornam-se parte do cenário natural, evocando a essência da narrativa audiovisual: a (re)conexão profunda entre o



Figure 10: Fotogramas do vídeo principal de AFASTAR E APROXIMAR, inspirados no comportamento animal.

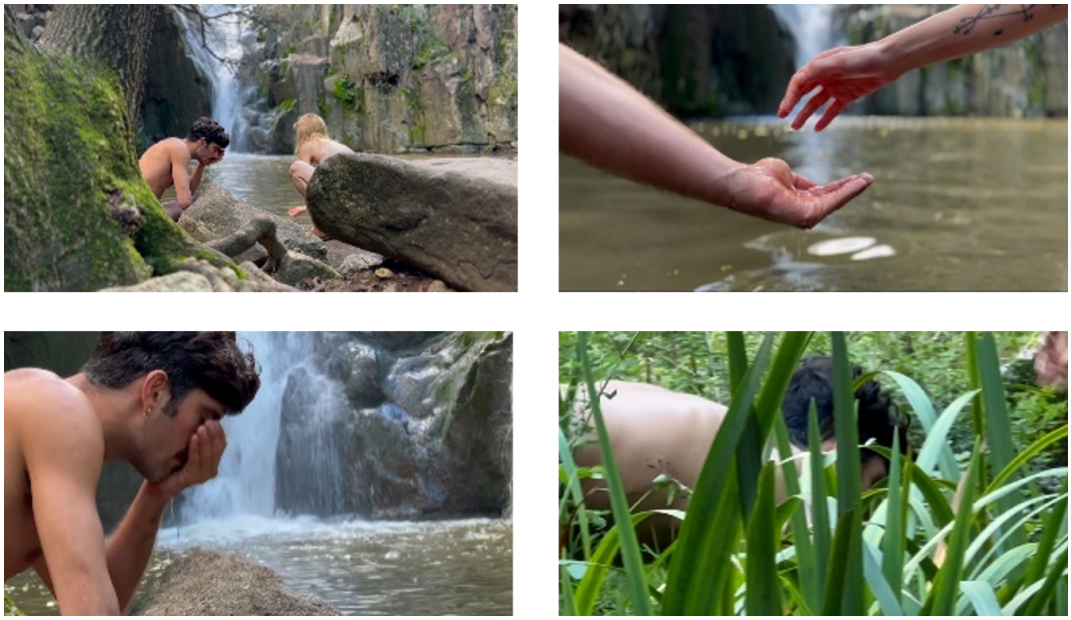


Figure 11: Fotogramas do vídeo principal de AFASTAR E APROXIMAR, representando a reconexão simbólica entre o Homem e a Natureza.

ser humano e o meio que o envolve. Após a expressão instintiva e intensa da vida, emerge uma harmonia primordial, em que a separação entre o Homem e a Natureza se dissolve, restabelecendo um vínculo ancestral de pertença e equilíbrio. Esta fusão entre o Homem e a Natureza manifesta-se de forma sensível nos gestos captados: mãos que mergulham na água da cascata, tocando-a com uma reverência quase ritual, corpos que se curvam junto ao solo, corpos que se inclinam junto ao solo, entre a vegetação densa, numa aproximação íntima à terra (Figura 11).

O movimento das mãos — ora recolhendo a água, ora acariciando suavemente a superfície líquida — expressa uma relação de escuta, respeito e pertença. As imagens fluem num ritmo desacelerado, acompanhando este gesto de entrega e comunhão. Neste processo de aproximação e afastamento, o visitante é também convocado a rever o seu próprio lugar no mundo: não apenas como observador externo, mas como parte integrante de uma ecologia sensível, interdependente e em constante transformação (Figura 11).

4 CONSIDERAÇÕES FINAIS

A instalação AFASTAR E APROXIMAR uma proposta que ilustra como a média-arte digital pode atuar como mediadora entre a sensibilidade estética, a consciência ecológica e a ação ética. Ao recorrer à linguagem do vídeo como meio de expressão artística, a obra não se limita à representação visual da natureza, propondo antes uma experiência sensorial e envolvente, onde som, imagem e movimento se conjugam para estimular uma vivência profunda e afetiva da relação entre o Homem e a Natureza.

Através da justaposição de diferentes planos visuais — do microscópico ao panorâmico — e da ativação simultânea de múltiplos sentidos, a instalação procura romper com uma perceção linear, utilitarista e antropocêntrica do tempo e da história. Em vez de uma narrativa progressiva e unidirecional, AFASTAR E APROXIMAR propõe uma experiência multitemporal, onde passado, presente e futuro se entrelaçam numa ecologia de relações. Ao mesmo tempo, a

obra inscreve-se numa linhagem contemporânea de práticas artísticas que exploram a tecnologia como instrumento sensível de aproximação à natureza. Artistas como Marshmallow Laser Feast e Thijs Biersteker têm demonstrado como a mediação tecnológica pode ampliar a perceção sensorial e emocional do visitante, tornando visível — e experienciável — aquilo que normalmente permanece invisível ou ignorado. AFASTAR E APROXIMAR partilha esta abordagem, utilizando o vídeo, os espelhos, os sensores e a coreografia como meios para criar um espaço onde a arte digital atua como catalisador de atenção, contemplação e empatia ecológica.

Mais do que transmitir uma mensagem explícita sobre sustentabilidade, a instalação cria as condições para que essa mensagem seja sentida no corpo e interiorizada pela experiência. Convida o visitante não apenas a observar, mas a habitar um espaço de reconexão, onde os gestos, os sons, os reflexos e as palavras compõem uma paisagem sensível de reencontro com o mundo natural. A instalação não fala sobre a natureza — fala com a natureza, estabelecendo um diálogo poético que atravessa tempo, matéria e emoção.

Num tempo atravessado por urgências climáticas, colapsos sistémicos e crises de sentido, torna-se essencial valorizar práticas artísticas que propõem outras formas de estar, de sentir e de imaginar o futuro. A arte, neste contexto, não se limita a ilustrar problemas ambientais ou sociais: ela torna-se um campo de experimentação simbólica e sensorial, onde se ensaiam formas de cuidado, de pertença e de transformação. AFASTAR E APROXIMAR participa ativamente nesta tarefa, oferecendo ao visitante não respostas, mas uma experiência viva — uma paisagem onde é possível reaprender a ver, a ouvir e a cuidar.

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Haunted Aurora: Hauntological Experience through Miniaturization of Media-Mediated Nature

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Abstract

This study explores how media-mediated images of nature generate hauntological experiences through physical miniatures. The installation artwork *Emergence* employs dye laser and 3D printing to materialize idealized images of the aurora, evoking nostalgia for something never experienced. By integrating the historical context of 18th-19th century aurora mimetic experiments with aesthetic concepts of miniaturization, this paper discusses how miniaturized nature brings past mediated memories and future potential experiences into collision within the present. This disjointed temporality is explained through the concept of hauntology proposed by Derrida and Fisher, with the miniature functioning as a physical mediator that makes this distorted time palpable. This research extends hauntological theory into contemporary installation art and offers new insights into experiences of nature in the media age.

CCS Concepts

• **Applied computing → Media arts**.

Keywords

Hauntology, Miniature, Nostalgia, Aurora, Mimetic Experiments, Dye Laser

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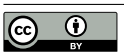
1 INTRODUCTION

Due to recent increases in solar activity, auroras have been observed in low-latitude East Asia for the first time in over 20 years. While the media used images of intensely glowing green curtains for promotion, the actual aurora that appeared was merely a faint red glow barely visible to the naked eye [23]. There were no curtains, no intense green light. In contemporary society, most people do not directly experience the aurora but rather experience it as mediated images through media. The aurora, characterized by its sublime visual features, including vibrant green and purple lights and swaying curtains, draws people to the polar regions. However, few have actually experienced the aurora. Observable only in polar regions and difficult to see even during extended trips due to weather variables, the aurora has become a fantastic tourism product. Media continuously reproduces the most idealized aspects of the aurora, forming vivid images, and people harbor expectations that they might someday experience the fantasy obtained from media.

This paper explores the coexistence of media-created images and expectations of fantasy from the perspective of hauntology. The concept of hauntology, introduced by Jacques Derrida and further developed by Mark Fisher, suggests that we can be influenced by insubstantial, ghostly entities. Hauntology emphasizes beings or ideas that belong to neither past nor future in temporal terms, drifting like ghosts and penetrating the present. Fisher particularly provides an original perspective on 'a cultural impasse: the failure of the future' shown in music and film through a cultural critical lens [3]. This perspective on hauntology has expanded into various academic fields, inspiring criminology [16], sociology [22], psychoanalysis [19], and anthropology [9]. These fields have primarily focused on experiences of haunting that are absent yet affect the present, such as past trauma or violence [21, 22]. However, in this context, the role of media and contemporary art has been relatively marginalized, and particularly the role of physical objects that mediate hauntology beyond theoretical connections has not been addressed.

This paper proposes that the ideal aurora mediated by media as fantasy can contribute to hauntology discourse through *Emergence*, an installation artwork that imitates the aurora. In particular, this paper emphasizes the importance of physical reduction of nature in hauntological discussions, exploring how miniaturization generates disjointed temporality via the concept of the miniature. *Emergence* is an installation artwork that intentionally materializes the idealized image of the aurora using laser and 3D printing. Although it does not follow the aurora's operating principles, it creates light and forms analogous to the aurora. Most audiences observing the work recognize the aurora analogue as the aurora and feel familiarity despite never having actually seen the aurora. The work resonates with the image of the aurora that audiences have at the boundary of resembling but never being identical to the aurora. Through this process, this study expands hauntological theory by connecting nostalgia for the never-experienced and out-of-joint time through the form of installation artwork. In particular, it discusses how the miniaturization of media-idealized nature can create such nostalgia. Ultimately, this paper argues that media mediation offers a disjointed sense of time, and physical miniatures can trigger this.

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2 AURORA AS MEDIATED MEDIA

The image of the aurora as a fantastic and mysterious phenomenon has long drawn many people to the Arctic. Difficult to capture photographically and with causes that remained unclear, the aurora fascinated both the public and scientists. Imaginary polar expeditions gained popularity in Europe from the 18th century, and the aurora, as the most mysterious phenomenon among them, became deeply embedded in Western consciousness through the pioneering work of mid-19th century photographers [8]. In the modern era, the aurora evolved into a national symbol, occasionally representing hope and future progress through its evocation of strange and mysterious worlds [7, 8]. The aurora remained so rare that Edmund Halley, renowned for his work on comets, famously lamented that he was "dying to see the aurora and expected to die without seeing it" [15].

The mimetic experiments of the 18th and 19th centuries which attempted to recreate mysterious natural phenomena in laboratories reveal how people understood the true aurora that existed in their imagination. The aurora was a popular subject that captured the imagination of people from various social classes as a fantastic and magical phenomenon, and numerous attempts were made to recreate it. However, almost all of the public and viewers at that time had never actually seen the aurora. Therefore, they evaluated the completeness of aurora reproductions by comparing them with imaginary auroras and other mimicked versions [1]. This led them to prioritize visual spectacle and plausibility over understanding what fundamentally defined and constituted the aurora. Rueger [2] argues that these mimetic experiments primarily aimed to pursue aesthetic sensibility rather than achieve accurate reproduction. He notes that imitation generates profound aesthetic pleasure when achieving similarity or resemblance to the original, demonstrating how, in cases where the original aurora remained inaccessible, mediated representations become the objects of imitation.

Ironically, in contrast to the commonly known fantastic image of the aurora, people are often disappointed when they first see the aurora directly [20]. Since the 20th century, technological and media developments have further solidified the fantastic image of the aurora. In particular, advances in low-light photography, editing, and image processing technologies have enabled the capture of aurora images that were previously difficult to photograph, sometimes faithfully, often with dramatic exaggeration. Social media platforms like Instagram share aurora photographs featuring intensified colors achieved through long exposures and digital manipulation. National Geographic documentaries present majestic and sublime auroras through time-lapse and exaggerated production techniques. Moreover, films and recently popular immersive exhibitions [14] employ computer graphics to create artificial expressions of auroras that surpass natural phenomena in their spectacle and overwhelming presence. Such media mediation creates a common understanding of the aurora without requiring direct experience. Yet crucially, the vast majority of people have never actually witnessed an aurora firsthand.

3 MATERIALIZING THE AURORA FANTASY

3.1 Historical Mimetic Experiments and the Fantasy of Aurora

The desire to understand the vast and fantastic aurora led to attempts to imitate it. The mimetic experiments of the 18th and 19th centuries, which attempted to recreate the aurora at a tabletop scale, aimed to understand this mysterious phenomenon by implementing and observing similar effects [15]. These mimetic experiments were based above all on the belief that the essence of the aurora could be understood through visual similarity. They represented both an intellectual desire for the mysterious phenomenon and an aesthetic aspiration to approach its fantastic beauty [1].

Early experiments focused on imitating the appearance of the aurora. They attempted to recreate the visual effects of the aurora using light rays passed through prisms [26] or through discharge tubes. Discharge tube experiments received particular attention because the light they produced was considered similar to auroral light [15]. Since it is impossible to jump into the vast aurora in the atmosphere or bring it into the laboratory, people of that era tried to understand the majestic northern light through the faint light within small glass tubes. Although these attempts showed merely beautiful light rather than capturing actual auroral characteristics, such as curtain-like dynamic movement, the visual similarity fostered the belief that it would provide understanding about the aurora in people's fantasy.

Over time, mimetic experiments evolved beyond simple visual resemblance to pursue artificial copies that reproduce the essence of the phenomenon, and in this trend, discharge tube experiments began to have their practical value questioned [1]. The experiment that best aligned with these changing scientific standards was Norwegian scientist Kristian Birkeland's terrella experiment. He modeled the interaction between the sun and Earth using metal spheres, reproducing the process by which solar wind guides light in polar regions [28]. His experiment provided an excellent understanding of aurora formation principles, yet ironically lacked visual similarity. While discharge tube experiments focused on the visual similarity provided by light, the terrella experiment concentrated on meeting scientific objectives.

In this context, the experiment conducted by Finnish scientist Karl Selim Lemström holds special significance. Unlike conventional laboratory-scale experiments, he attempted to recreate the aurora by installing discharging devices on a large scale on mountain tops. The device he created formed yellow light columns in the sky, and he believed this plausible light phenomenon generated the same spectrum as the aurora. According to Amery, his artificial aurora perfectly reflected the fascination with the aesthetic experience of the imagined aurora. Although ultimately evaluated as mere analogues, witnesses at the scene reportedly had experiences that were overwhelming and sublime and fell into 'dumb admiration' [1]. Lemström's experiment clearly shows how his aurora imitation attempts aligned with the fantasies of people at that time.

This history of aurora mimetic experiments reveals that the aurora served as an object embodying the desires and fantasies of people at that time. While the purpose of mimetic experiments may have been reproduction for scientific understanding, they reflected a fundamental intention to realize and express the imagined ideal

of the aurora. The scale of aurora mimetic experiments varied from small glass tubes to outdoor installations, but these were ultimately attempts to stimulate more intense fantasy by capturing representative visual characteristics and pursuing visual similarity. Thus, aurora mimetic experiments show that visual imitation and changes in scale can become channels connecting viewers' fantasies beyond scientific models.

3.2 The Aesthetics of Miniaturization of the Aurora

Reducing nature is not merely a technical act of shrinking size but a process of transforming ways of seeing the world and creating alternative realities [11]. East Asian traditions such as bonsai, scholars' rocks, and penjing demonstrate the long history of such practices of nature reduction. However, according to Bailey, these do not pursue precise representation by proportionally reducing the original nature. They abstract and compress nature's complex forms to suggest the entire world through small spaces, strictly distinguished as miniatures [11]. What is crucial in miniatures is that elements are intentionally omitted or made ambiguous [24]. When miniatures exclude elements such as birds and clouds that clearly exist in the real world, viewers fill these voids with their memories or imagination [11]. Thus, miniatures make viewers participate in a new world detached from reality while simultaneously referencing reality [11, 32].

The world created by miniatures is fundamentally fantastic, detached from reality and dominated by imagination and fantasy [5, 11]. In this fantastic world, miniatures create distance from reality by manipulating the scale between human bodies and objects [6], consequently providing a sense of control and possession over objects [4]. The core of this fantasy lies in idealization. Miniatures embody the ideal of the objects by requiring aesthetic choices regarding specific forms, styles, and other details [24]. Such attempts to substitute the whole with parts, as Stewart emphasizes, create an illusion of reality [32]. The fantastic world thus created is an alternative reality onto which imagination and ideals are projected. As Bachelard noted, miniatures become gates that open up an entire world through imagination [33], viewers enter the world of fantasy through miniatures and trace the ideals and fantasies contained within.

In this context, aurora mimetic experiments can be regarded as miniatures that vividly demonstrate fantastic characteristics. Mimetic experiments attempted to reproduce the aurora by implementing aurora-like light on a reduced scale but ultimately resulted in imitation. This occurred because they selectively emphasized or omitted certain characteristics rather than creating complete replications of the aurora, aligning with the properties of miniatures mentioned by Bailey [11]. Attempts to implement the aurora, whose principles were not precisely understood, inevitably had to rely on fantasy and idealization. Thus, the miniaturization of the aurora reflects the ideal light in fantasy, and viewers fill in the absent elements like polar regions' magnificent scenery and dancing curtains with their memories and desires from the reduced light. As Bailey emphasizes the importance of three-dimensionality in miniatures, physically implemented aurora miniatures encourage viewers to actively participate in the world of fantasy [11]. As Stewart points out, these worlds of fantastic are brought to life through the physical representation of miniatures [32].

The aurora as a miniature embodies the aesthetic fantasies people harbor about the aurora's visual light. As Bailey notes that miniatures provide ways to understand the world, the visual resemblance of mimetic experiments was believed to offer insights into nature [2, 11]. Lemström believed he could reach the essence through the process of learning-by-making [2]. While Rueger states that these mimetic experiments did not substantially contribute to the advancement of knowledge, he emphasized the aesthetic value they provide. According to him, visual similarity seemed to immediately connect the laboratory and nature, further providing an effect as if nature were revealing itself in different forms [2]. He particularly emphasizes that art imitates not nature in reality but nature in its possibilities. Similarly, mimetic experiments created more complete and ideal forms of nature than reality by implementing nature's potential power in the laboratory [2].

3.3 Emergence: Implementing the Miniaturized Fantasy

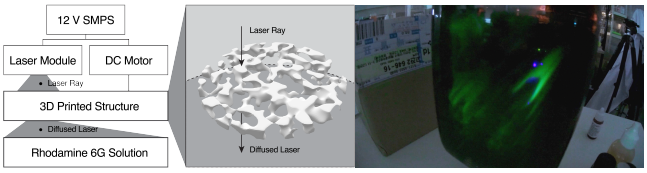


Figure 1: (left) The diagram shows the overall operation and the role of procedural generation in imitating aurora curtains, as the organic forms enable laser light to create aurora-like patterns when passing through empty spaces. (right) In the experiment, it was clarified that rhodamine 6G emits green light closely matching the aurora's wavelength range, and the liquid dyed with black pigment emphasizes the green luminescence.

This research dramatically expresses the fantasy of reduced nature by implementing a miniature aurora that physically creates the visual characteristics of an idealized aurora. Moving beyond previous mimetic experiments that derived visual resemblance in the process of reproducing the aurora, this paper intentionally creates an analogue that resembles the aurora. Specifically, *Emergence* uses lasers and 3D printed structures to imitate the green light and undulating curtain forms that the public universally associates with the aurora. This technological application reinforces the idealized aspects of the aurora and induces immediate fantasy about the phenomenon. As Bachelard stated that miniatures cause men to dream [10], the miniaturization of the aurora makes audiences dive into fantasies of the perfect aurora.

The aurora rays created by *Emergence*, which self-illuminate and emit wavelengths very close to those of actual auroras, demonstrate the ideal fantasy. *Emergence* implements aurora-like light formations through the physical interaction between rhodamine 6G dye laser and laser light. Dye lasers operate on the principle that dye



Figure 2: *Emergence*, Sungbaek Kim, 2022. The installation work suspended from the ceiling glows with a vibrant green light analogous to the aurora in a dark room. (©Sungbaek Kim)

molecules become excited when absorbing energy from external light sources and amplify light through stimulated emission [29]. Rhodamine 6G is one of the representative dye lasers. It absorbs wavelengths in the 480-540 nm range and emits in approximately the 540-640 nm range. The peak varies with concentration, showing maximum emission around 550 nm at low concentrations and around 560 nm at high concentrations [36]. Thus, rhodamine 6G can emit light ranging from yellow to green. Since the aurora is light emitted by excited oxygen atoms in the atmosphere, with the most common green aurora having a wavelength of approximately 557.7 nm, the wavelength range of rhodamine 6G ensures visual similarity by inducing colors close to the aurora [25].

As shown in Figure 1, the laser beam emitted from the laser installed at the top of the work passes through the 3D printed structure below and is projected onto the rhodamine 6G solution beneath. When laser light is directed at rhodamine 6G solution, green rays become visually apparent. Unlike simple scattering when laser light passes through a colloidal solution, the solution itself emits intense green light at approximately 560 nm. Even when black pigment is mixed into the solution for visual distinction, the solution that absorbs the laser's energy reveals vivid green light, which is visually more effective against the black background. In particular, the structures with complex patterns modeled in organic forms through procedural generation transform these green rays into aurora-like shapes. The 3D-printed structure rotates at slow speeds with DC motors, thus creating unpredictable patterns when the laser passes through the empty spaces within the structure. The rays that randomly change form, like nature's variability, visually take on shapes similar to the aurora's curtain formations when projected onto the solution. The work ultimately induces the impression of the fantastic aurora inherent within audiences to emerge as they observe the undulating green light.

4 HAUNTOLOGICAL EXPERIENCE OF MEDIATED NATURE

4.1 Miniature Aurora: Nostalgia for the Never Experienced

The fantasy created by the miniature aurora evokes nostalgia. Jozwiak points out that people tend to idealize what has been lost or cannot



Figure 3: Detail of *Emergence* showing aurora-like luminescence. (©Sungbaek Kim)

be achieved in reality, such as toy worlds or unpurchasable objects [5]. Similarly, the aurora, known yet unexperienceable, has traditionally been an object that evokes poignant emotions. For modern people who spend most of their lives in cities, the aurora remains a fantastic natural mystery beyond easy reach. As Stewart emphasizes, such desire for the absent is precisely what nostalgia yearns for, and the miniature stages this idealized desire as an arrested time [32].

In particular, the aurora generated by *Emergence* represents an impossible ideal as it references what has been mediated by media. The work implements not the actual form of the aurora but the aurora reproduced in fantastic and idealized forms by media. The image of the aurora, exaggerated beyond reality through the development of media and technology, clearly differs from the actual aurora. Thus, the aurora image produced by media makes audiences recall universally imagined images through the work, creating an illusion that they know the natural phenomenon they have never actually experienced. Viewing the plausible aurora, audiences do not feel they are having a completely new experience but rather recall and reminisce about past memories known only through media such as photographs and videos. As Stewart points out, nostalgia is a sadness without an object, but it is not real [32]. It is merely fantasy and cannot be reproduced, what Boym defines as "longing for a home that no longer exists or has never existed" [5, 12].

According to Boym, nostalgia is not always about the past but can simultaneously be a gaze toward the future [12]. The nostalgia evoked by the miniature aurora is dual. The past exists as longing for idealized images formed through media, while the future exists as imagination of the experience when one might actually see the aurora someday. As Trigg describes, nostalgia depends on images of the past fixed in the present, causing feelings of estrangement and emptiness from the past [35]. The miniature aurora generated by *Emergence* merely resembles media images and cannot provide the same sublime. Thus, audiences hold expectations that if they visit polar regions and see the real aurora, they might witness media's

idealized aurora. Therefore, the aurora miniature condenses past mediated images and future potential experiences into the present. Within this dual nostalgia, audiences remember what they have never seen and longing for what has not yet come. The fantasy of the miniature becomes a spectral device that enables this disjointed temporality.

4.2 Disjointed Temporality and Hauntological Experience

The dual nostalgia created by the miniature aurora reveals not mere sentiment but a fundamental disjunction of time. The concept of hauntology proposed by Fisher provides an important framework for understanding this aurora experience. Hauntology, originally coined by Derrida, explicitly raises the question of time by referencing Hamlet's line "the time is out of joint" [18]. This disjointed time signifies a state where the linear progression of past, present, and future collapses and interpenetrates. Fisher distinguishes hauntology into 'the no longer' and 'the not yet' [18]. According to Coverley, the former haunts the present from the past, returning repeatedly. The latter haunts the present from the future, existing through the unfulfilled promises. The former returns to us, the latter awaits us, but in both instances their impact is felt now, in the present [13]. The miniature aurora is the point where these two temporalities collide. Past media images return repeatedly like specters, while future actual experiences drift as promises not yet arrived.

Audiences are affected by disjointed time through the miniature aurora. As Fisher points out, hauntology concerns the force of action at a distance that produces causal effects without existing [17]. The aurora image created by media, despite having no substance, makes people pursue an ideal aurora that does not exist, and their expectations are already formed by spectral characteristics. Thus, the miniature aurora makes audiences realize that the aurora they thought was familiar is actually unknown to them. This is, as Gordon describes, a moment like when home becomes unfamiliar or bearings on the world lose direction. It changes the way we separate the past, present, and future and alters the experience of being in time [22]. As Derrida describes the specter as neither present nor absent, neither living nor dead, a paradoxical existence that simultaneously announces the repetition of the past and expectations of the future [13], the miniature aurora leads to a state of 'time out of joint' by making us realize we can be haunted like ghosts by events that have not yet occurred or may never occur in the hauntological context.

The temporal distortion created by the miniature aurora induces a hauntological experience of losing the present. Past media images of the aurora create present expectations, and these expectations define future experiences. However, the aurora experience promised by media cannot be realized. Though it is an image that never existed in reality, people continuously pursue the aurora mediated and idealized by media. This is the point Jameson identified when he noted that "as our knowledge of the past and ability to imagine the future diminished, we now find ourselves stranded, almost by default, in an endless present of our own creation" [13]. Fisher emphasizes that the future is always experienced like a specter. According to him, the future affects the present as an effective virtuality and motivates cultural production [17]. Therefore, the expectations formed by media's aurora make people reproduce ideal images even though they cannot actually be experienced. The once unpopular mysterious phenomenon has now become an easily accessible universal past through media development and lies in a process of continuous decomposition and recomposition between past and future [31]. The fantasy of the aurora dominates the present, blurring the distinctions between past, present, and future and trapping viewers in an eternal cycle of expectation and disappointment. This is the essence of the hauntological experience created by mediated nature.

5 DISCUSSION

This research contributes to the theoretical expansion of hauntology by exploring how media-mediated images of nature generate hauntological experiences through physical miniatures. By integrating the history of mimetic experiments with aesthetic concepts of miniaturization, this paper argues that *Emergence* demonstrates how miniaturized nature operates as a mediator that embodies disjointed temporality beyond simple scaled-down imitation. In particular, the technical implementation that intentionally creates light and forms similar to the aurora of fantasy using a dye laser contributes to *Emergence* resonating with audiences' fantasies about the aurora. The miniaturization of the aurora's fantasy mediated by media simultaneously invokes memories audiences have not experienced and futures that have not yet been realized. This evokes nostalgia in audiences for what they have never experienced, creating a state of 'time out of joint' where past media images and future potential experiences collide in the present. This paper ultimately specifies this state of rupture as a hauntological experience and argues that the miniature performs the role of a medium through which disjointed time is perceived.

This discussion fundamentally resonates with Fisher's view by emphasizing that we are trapped by stagnant media. According to him, we have lost the capacity to conceive of a world radically different from the one in which we currently live [17]. This expression, which Fisher emphasized in the context of music and film, clearly applies to contemporary media as well. The fantasy created by media overwhelms reality as an ideal in itself, making people either lose the will to see the original or participate in reinforcing the fantasy by reproducing idealized expressions. As Fisher states, new technology did not invent new forms in the same way; rather, new technology was used to look towards the past more than ever [30]. As Reynolds emphasizes through the concept of retromania, the world focuses on discovering what has passed rather than contemplating the future [27].

Miniature calls for a critical perspective that allows us to move beyond past mediated images to perceive the reality and imagine future possibilities. As Stewart emphasized that even fantasy can be miniaturized [32], the miniature of *Emergence* reduces the fantasy idealized by media. In a situation where fantasy has replaced reality, the physical original of the aurora is no longer the object of miniaturization. However, this research expects audiences to recognize that the aurora is a fantasy created by media. While Fisher pessimistically views the future, saying the past has a way of using us to repeat itself [34], Reynolds sees hauntology as providing a means to escape cultural impasse by reviving our sense of past and

future [13, 27]. Additionally, Coverley states that hauntology alerts us to the present perils by transporting us to a similar moment of crisis in the past [13]. Therefore, the hauntological experience provided by the miniature can help audiences to realize the fantasy at the boundary of disjointed time. Future theoretical and technical exploration of the role of objects that enable audiences to break through fantasy is expected to further strengthen this effect.

6 CONCLUSION

This paper has explored how media-mediated images of nature disrupt our sense of temporality through the miniature aurora. The hauntological experience created by *Emergence* represents both a symptom of the 'lost future' that Fisher warned about and offers a clue for overcoming it. When audiences recognize that what they have pursued is fantasy rather than reality, new possibilities emerge. This suggests that technology can transcend its role as a tool for reproducing the past and become a medium for imagining futures. By reducing vast nature to a graspable scale, the miniature paradoxically reveals what we have been missing. This research demonstrates that hauntological theory can move beyond theoretical discourse to become a concrete aesthetic experience, suggesting that contemporary art can play a vital role in mediating between theory and practice.

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Glitch Cartographies: Reconfiguring Memory and Territory in Virtual Reality

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Abstract

This article investigates how the deliberate introduction of glitches into the photogrammetry pipeline can transform territories into immersive spaces for critical reflection in virtual reality (VR). Starting with a deliberately corrupted capture process, we question the promise of objectivity in photogrammetric 3D and discuss how such imperfections can serve as an aesthetic stimulus, a preserver of memory, and a guardian of heritage. Through the case study of the transformation of the small village of Paradela de Guiães, we develop an open-source, replicable glitch-photogrammetry methodology and a VR prototype that invites visitors to navigate digital ruins echoing physical depopulation. A preliminary user study suggests that glitch aesthetics without photorealism can foster immersion, emotional engagement, and reflection, pointing toward a participatory and multisensory future for digital heritage.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Photogrammetry, Glitch art, Virtual reality, Digital heritage, Cultural sustainability

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1 Introduction

The quest for high-fidelity representation has guided much of the work in photogrammetry, from heritage preservation to mixed-reality (XR) applications. However, assuming that an exact digital copy inherently carries cultural significance [1–3] may overlook the interpretive and affective dimensions of memory and place. As a grandchild of a Portuguese immigrant from the Trás-os-Montes region, I grew up listening to my grandfather's stories of his homeland. Now, living in Portugal, I have witnessed the gradual emptying and degradation of that region. The memory of shuttered cafés, childless squares, and ruined historic buildings fuels this project:



Figure 1: Record of the on-site exploration. Paradela de Guiães village, Vila Real district, 2024.

How might technology restore voice, visibility, help recover and share the stories of communities at risk of being forgotten?

Rather than striving for seamless visual realism, we foreground glitch as both method and message. Building on Menkman's notion of error as expressive and political material [4], and related critiques of operational images and cultural mediation, we ask whether controlled deviations from photorealism can sustain presence in VR while opening space for reflection on memory, authenticity and loss. Three guiding questions steer our inquiry: How can reproducible glitches be induced within an accessible photogrammetry pipeline? How do these faults shape the subjective experience of engagement and reflection? What narratives emerge when visitors or residents explore, in first person, a deliberately corrupted cultural heritage?

Our approach combines technical experimentation and artistic production, enriching the debate between technological realism and the aesthetics of error. On the social plane, it illustrates how glitch-oriented photogrammetry can activate collective memories and local identities. The modelled village, Paradela de Guiães, located in the district of Vila Real, in Trás-os-Montes, Portugal, has fewer than fifty permanent residents and has faced continuous depopulation since the 1980s. By working alongside local residents during data capture (Figure 1), we gathered geometry and textures through an affective cartographic approach [5, 6]. This collective process not only enriches the digital model but also foregrounds gaps in collective memory and the precarious state of rural heritage. In this context, glitches were adopted as both metaphor and material: they signify fractures in memory and heritage, while highlighting the tension between technological progress and places left behind.

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2 Related Work

Our approach sits at the intersection of glitch aesthetics and digital-heritage reproducibility. Prior work treats error as expressive, political material and calls for transparent, parameterized pipelines in heritage visualization. We extend these lines by shifting glitch from an incidental artefact to a controlled independent variable within a Structure-from-Motion (SfM) workflow; formalizing a minimal, low-resource VR path that preserves presence with non-photorealistic models; and situating this test in a rural, demographically stressed territory as an indication for how mediation is perceived in context.

2.1 Glitch as a Device of Memory and Presence in Virtual Space

Glitch is no longer treated as a defect to be hidden; in recent artistic practice it is used to expose absence, ruin and the passage of time [7, 8]. This aesthetic was formally recognized in the Ars Electronica Festival of 2018, which adopted "ERROR – The Art of Imperfection" as its central theme, celebrating failures as critical tools for artistic and technological reflection [9].

In virtual-reality reconstructions, such faults read as "digital ruins", a term that Miller and Garcia [10] use to examine abandoned or decaying virtual environments that, having fallen out of fashion, no longer have a significant user base to animate their virtual spaces. In the context of this project, just as chipped stones in a real wall speak of decay, broken textures or collapsed geometry reveal the fragility of memories stored in code. Visitors who encounter these ruptures in the model of Paradela de Guiães are reminded that both the village and its digital double are at risk of erosion. At the same time, glitch drives the scene toward abstraction: flat-coloured blocks and stray polygons interrupt photorealism and lay bare the photogrammetric mesh. This "aesthetics of failure" transforms compression artefacts into material for reflection, echoing the inversion of values proposed in the Glitch Studies Manifesto [11]. Cognitive psychology suggests that such gaps enhance recall: by mentally completing what is missing, spectators become co-authors of the image.

Controlled faults do not eliminate presence. Experiments that inject glitches into VR show that users alternate between immersion and awareness of the apparatus without losing overall engagement [12]. Similar results appear in mixed-reality studies: stylistic discrepancies modulate, rather than cancel, the sense of "being there" as long as the environment remains coherent and responsive [13]. In our prototype these visual cracks reinforce the heritage narrative, acting as metaphors for interrupted family lines and fading local stories.

Accepting error also widens the project's critical scope. Glitches mark the limits of the algorithm, signal what the scan left out and hint that the village itself is a system under stress. This stance aligns with artistic approaches that use chance as a motor for discovery [7] and with heritage evaluations that show non-realistic effects can coexist with positive usability metrics. In short, making room for glitch replaces the search for documentary purity with a dialogue about uncertainty, memory and cultural loss.

2.2 Critical Photogrammetry and Digital Heritage

We regard photogrammetry here not as a neutral mirror of reality but as a process that inevitably produces gaps, seams, and computational debris. Every 3D model in the project is born already marked by this technical-aesthetic noise, which exposes the algorithmic mediation of memory.

Photogrammetry is frequently presented as a neutral technique of geometric capture, yet recent research demonstrates that every choice of viewpoint, point-cloud density, and texturing algorithm reconfigures the result and, by extension, the constructed memory of the object or place. Large-scale initiatives such as the national Património Cultural 360 program, which plans to digitize more than 59000 artifacts and produce 65 high-fidelity virtual tours [14], reinforce the ideal of the perfect copy while also highlighting how technical mediation shapes the memories that circulate online. In this scenario, even the most precise sensors can distort fine details if parameters are not made explicit [1]. Subsequent studies quantified these distortions, revealing that sparse photogrammetric networks can generate metric errors exceeding 8mm in objects with planar or repetitive structures [15], for example.

Some practical recommendations reinforce this view, and they go beyond capture guidelines; there are some warnings that note that the most popular SfM workflows are proprietary and opaque algorithms, true black boxes whose internal functioning remains (intentionally) obscured for the end user [1]. Without documentation of parameters such as number of interactions, type of bundle adjustment, and weighting of control points, it becomes impossible to predict, audit, or replicate the produced mesh. Therefore, it's a good idea to require annexes with complete processing reports and metadata, ensuring that third parties can evaluate, correct, and, if necessary, redo the reconstruction.

Finally, the digital infrastructure in which data circulates shapes policies of access and heritage value [16]. By embracing errors, glitch photogrammetry seeks to de-neutralize such infrastructures, revealing the hidden algorithmic labor and inviting reflection on who controls the digital narrative of the territory.

2.3 Digital Territories and Participatory Practices

While the previous subsection exposed the technical limitations and fissures of the digital copy, this section focuses on what happens when such imperfect meshes circulate among people. The virtual territories of the case study become co-creation platforms where the community reinscribes memories into the very cracks of the model.

This approach connects with contemporary collaborative digital-visualization practices, in which local communities not only consume but actively participate in the creation of collective meanings through the digital tools available [17–19]. The abstraction present in glitches facilitates interpretative and subjective processes, opening space for individual experiences, such as dream interpretation mediated by interactive technologies, to be collectively shared and discussed, fostering dialogue enriched by technological subjectivity and ambiguity [20]. This highlights how technology can enhance

participatory processes by allowing personal and subjective abstractions to be transformed into experiences shared by the community.

Furthermore, embedded museography demonstrates that reenacting the digital archive in its place of origin, whether through on-site installations or VR interfaces, shifts curatorial authority from the institutional center to an ecosystem of local agents. This shift is not merely symbolic: by enabling inhabitants to identify and comment on fragments of the model, digital heritage ceases to be a cold representation and becomes an ongoing social practice.

When populations participate directly in the collection and interpretation of data, a co-creation of value occurs: the technical content gains layers of memory, affect, and narrative that cannot be captured by sensors [18]. Recent collaborative workshops confirm that these exchanges increase the social relevance of the work and extend public engagement well beyond the initial exhibition [5], as seen in the reinvention of craft practices with technological mediation in local communities [19], indicating how digital art can activate cultural heritages in a sustainable and symbolic way.

Our process in Paradela de Guiães followed this logic: routes, framings, and also the decision to preserve certain glitches arose from guided walks with residents. This method resonates with contemporary community-driven platforms for 3D heritage modeling, such as platforms that crowdsource imagery for automated model generation [6], and introduces a critical dimension: the glitch functions as a visual marker of memory gaps, revealing which parts of the village lack care or documentation. Instead of aspiring to a normative realism often associated with "clean" tourist narratives, we kept flaws that allude to infiltration, disuse, and abandonment. Such a choice answers the criticism that hyper-polished heritage visualizations tend to neutralize conflicts and render precarities invisible [2].

By integrating failure and participation, we propose a digital ontology in which error is not noise but a collective commentary on the territory's present state. The VR interactions walking through cracks, traversing torn textures, make visitors viscerally feel the tension between conservation and ruin, opening space for debates about what future the community desires for the place.

3 Technical Process and Methodology

3.1 Field Capture

Four historic structures that hold deep symbolism for the local population were recorded: a cross in the village square, a stone where people once sat to meet, a former school building, and a ruined alleyway. Thirty to forty photos were taken per site, totaling 120 RAW photographs with an overlap of approximately 70%, using average settings of ISO200 and f/8. Diffuse light on an overcast day was chosen to minimise hard shadowing, yet chromatic aberration from the lenses was left untouched to generate micro-variations.

3.2 Inducing Glitches

We induced reproducible faults at three stages: capture noise, data degradation and mesh/textures. The full photographic set represents a low sample size when compared with conventional workflows (≥300 images per site). This lack of data forces the software to interpolate geometry and infer connections between distant viewpoints, which results in mesh imperfections. A black-box logic



Figure 2: (a) Façade of the village's school. (b) Narrow stone alley between village walls. (c) Weathered granite bench the of main square. (d) Pillory-style stone cross in the main square. Paradela de Guiães village, Vila Real District, 2024.

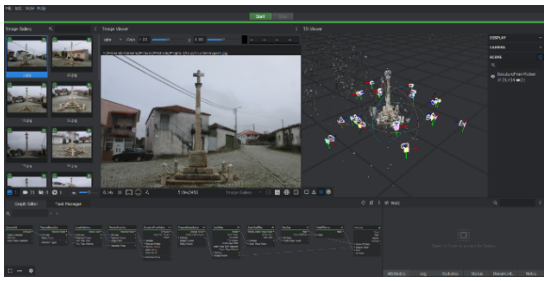


Figure 3: Structure being processed by the software, 2024

becomes noticeable at such moments, when digital environments attempt to "fill in the gaps", concealing their own operation and producing surfaces that are simultaneously intuitive and problematic [1, 21].

In addition to this semi-automatic effect, the weather conditions added a new element of disturbance: the lenses were constantly wet due to light rain during the daytime capture, generating smudges and blurs in the RAW images that translated into unpredictable artifacts in the 3D mesh. Diffuse illumination and a high depth of field, without keeping the chosen structure in primary focus, confused the software as to what we wanted to reconstruct in 3D. These factors were deliberately preserved when the photographs were imported into an open-source tool for 3D reconstruction, *Meshroom* (version 2023.3.0). Further corruption techniques complemented the above:

- *Extreme decimation* — a *Blender* modifier reduced 90% of the polygons while preserving contour edges.
- *Textual corruption* — random permutation of lines within the .obj file, causing vertex-index drift.
- *Lossy compression* — textures converted to JPEG at 30% quality, followed by bicubic resampling.

Additionally, a lack of variation in surface textures generated correspondence ambiguities inside *Meshroom*. Repetitive patterns

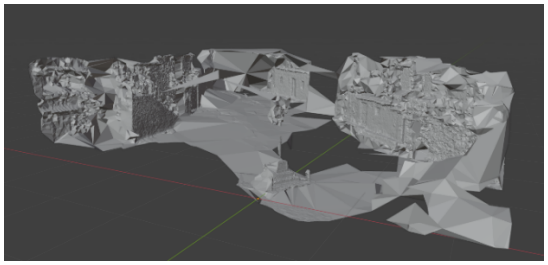


Figure 4: Glitches during the processing of the cross, 2024.

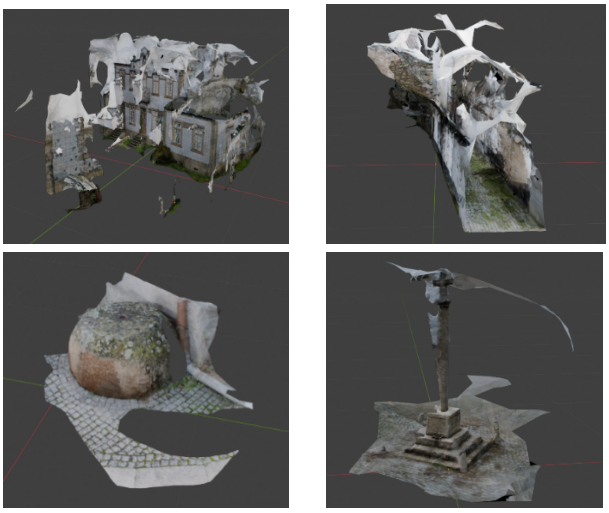


Figure 5: The results of the four structures photographed, with the glitches, 2024.

make it difficult to precisely align the images, resulting in mapping errors and stretched surfaces, which further increases the glitch character of the meshes. In the case below, the software ended up reconstructing the entire environment around the cross, except for the cross itself.

In Figure 5, we can see at the top left image that the regularity of the ceramic tiles confuses the program about where each wall of the building should be placed, leading it to re-imagine the space completely. All remaining models were left exactly as rendered by *Meshroom*, with no error cleaning.

After generating the models, several visual prototypes were produced to test how a semi-realistic scene would relate to the VR experience. With this in mind, the village square was recreated in Blender, using photographs for texture, 3D models, and glitches.

4 VR Experience Design

The models resulting from photogrammetry and their merging in Blender were exported as .fbx files and imported into the Godot 4.3 game engine. Simplified physically based materials (PBR) and basic colliders were configured for navigation. The application targets Meta Quest2 at 72fps, with a 1:1 scale and minimalist binaural audio to reinforce presence.

The VR environment adopts first-person navigation, allowing users to explore the glitch models at full scale. Simplified controls (gaze-based movement plus teleport) increase accessibility with optional comfort settings like snap-turn and vignette. The visual errors, far from distractions, become points for reflection.

The village space was recreated with photographs, low-polygon objects, and the scanned models with their glitches. The school, for instance, originally sited away from the square, was relocated there. While the scene conveys familiarity, it prompts reflection precisely by juxtaposing an old, empty place with technology riddled with faults.

5 User Experience Preliminary Evaluation

One of the main challenges of this project was the absence of structured feedback from community members. This challenge has also been observed in other collaborative heritage projects, where sustained participation is hindered by technical, logistical, or contextual barriers [5, 18]. To address this, a preliminary questionnaire was created to gather user impressions, emotional responses, and interpretative insights related to the VR experience. As proposed in HCI (human-computer interaction) methodologies, such early-stage user evaluations are essential for identifying affective and experiential responses to interactive systems [22]. Therefore, we framed this as an exploratory pilot using convenience sampling to obtain early, design-oriented feedback. Particular focus was placed on how users perceive the intentionally applied visual glitches in the 3D representation of Paradela de Guiães (both the questionnaire and participants' responses are accessible at the link docs.google.com/forms/d/1_tyLI_GuOQGjk-cyy6gchBy1KwmOD4uB3cgfSd8rvwD8/viewanalytics).

The questionnaire employed a Likert scale, widely used in interaction design to measure user attitudes, beliefs, and opinions through numerical or verbal degrees of agreement [22]. This enabled participants to express their perceptions regarding immersion, clarity, and emotional resonance within the VR environment. It was directed at two distinct groups: participants who experienced the VR environment firsthand and those who engaged with the project through video or images only. This dual structure allowed for the comparison between embodied immersion and visual expectation. The questions addressed aspects such as presence, spatial understanding, emotional resonance, usability, and the interpretive potential of visual imperfections.

In total, 16 responses were collected, primarily 18–35, with moderate-to-high digital fluency and interest in heritage. This convenience, young-skewed sample and the absence of local residents mean results should be interpreted as exploratory rather than representative.

Although no respondents were residents of the reported village, the feedback provided relevant interpretive insights and reinforced the viability of using proxy participants in exploratory evaluations; however, this relatively homogenous profile, while useful for early-stage testing, limits the generalizability of results to broader or less digitally literate populations. Overall, responses contributed qualitative data on possible enhancements to sensory depth and inclusivity, which will inform future design iterations.



Figure 6: Concept images of the merge of the digital and real worlds, 2024.



Figure 7: (a) Recreated square of Paradela and (b) player perspective inside the experience as seen at the link vimeo.com/1039275686, 2024



Figure 8: (a) Example of participant responses on immersion and (b) the impact of visual imperfections on interest.

5.1 Analysis of Results

The analysis of the questionnaire responses indicates that the Glitch Cartographies experience was largely successful in generating immersion, aesthetic engagement, and critical reflection, especially among participants with limited prior familiarity with VR technologies. Following the methodologies proposed by Rogers, Sharp and Preece [22] and Mendes et al. [23], along with the categories developed by Skarbez et al. [24], the evaluation was structured around three main axes: presence/immersion, emotional and aesthetic engagement, and usability/accessibility.

Key limitations include a small user sample, young-skewed demographics and non-resident respondents, and potential novelty effects. We also note social desirability bias in arts contexts, device variance (headset vs. video), and lack of counterbalancing. Mitigations used: brief neutral onboarding, anonymous responses, separate reading of VR and video and explicit prompts on accessibility. Future studies will expand the quota sampling, add objective traces and include brief standardized metrics alongside interviews in-situ.

In terms of presence, most participants who experienced the VR environment reported feeling ”inside the virtual space” and, at times, forgetting their physical surroundings. Even without prior knowledge of the village represented, participants were able to identify architectural structures and comprehend the spatiality of the experience. The intentional visual imperfections did not significantly hinder the sense of realism, suggesting an effective balance between aesthetic distortion and spatial legibility.

Regarding emotional responses, participants described the experience using terms such as ”uncanny valley”, ”dreamlike”, and ”displacement”. These reactions suggest that the distortions supported speculative engagement rather than being perceived as flaws. Instead of reconstructing a realistic replica, the VR environment fostered an interpretive encounter shaped by ambiguity and memory.

In terms of usability and accessibility, several participants highlighted the need for richer sensory integration. Suggestions included the addition of ambient audio, distorted glitch sounds, local voices, and historical narrations. Others pointed out the potential for audio description and sensory translation to accommodate visually impaired audiences, aligning with the concerns on multisensory engagement and inclusive interaction design [22]. Notably, participants who only interacted with visual or video excerpts

(without full VR immersion) were able to engage conceptually with the project and form meaningful expectations. This validates the adopted methodology and supports the use of such participants as proxies in early-stage evaluations, especially in contexts where direct access to target communities is limited.

6 Discussion and Final Considerations

The preliminary evaluation suggests that the glitch, as both a visual strategy and conceptual device, can meaningfully support engagement with themes of memory and presence in digital heritage. Participants reported a balance between spatial coherence and expressive distortion, suggesting that non-photorealistic models, when conceptually grounded, can deepen engagement without compromising immersion. Although the sample consisted mostly of young adults with digital fluency, this demographic alignment may have influenced participants' tolerance or appreciation for visual distortion, as well as their ease of navigation in VR. In future evaluations, efforts will be made to diversify the sample by including older adults, individuals with limited VR experience, and members of the community represented in the virtual reconstruction itself. Such diversity will allow for a more inclusive understanding of how glitch aesthetics are perceived across different cultural and technological contexts. Nevertheless, the feedback gathered points to two major areas for future development.

First, participants consistently suggested the inclusion of ambient sounds, oral histories, and glitch-based audio to complement the visual distortions. These elements could enhance the emotional depth of the experience and make it more accessible to visually impaired users through sonic cues and audio description. This multisensory enrichment has become a central axis for the next design implementation.

Second, while the community was involved in the initial stage of 3D capture, they were not able to experience the completed VR environment due to technical and logistical limitations. This gap in the participatory process suggests that future project phases should prioritize returning the digital heritage to its origin site through local installations, headset-based sessions in public spaces, or online delivery via WebXR. These approaches would enable situated interpretation and cultural feedback loops essential for ethical heritage mediation. This return is not only a matter of restitution but also a necessary condition to capture culturally situated interpretations that may differ from those of external observers.

Taken together, these findings provide provisional answers to the core questions posed in the introduction, indicating that glitch-based digital heritage can be both technically accessible and experientially engaging. Stronger cultural impact claims require broader, in-place evaluation with diverse participants. In addition, planned developments informed by the questionnaire, including expanded sound design and direct community return, mark a transition toward more participatory and context-sensitive stages of the project. In this trajectory, the glitch evolves into a point of negotiation: an interface between collective memory and mediated authorship.

More broadly, the project invites a rethinking of how memory, place, and technology intersect. Instead of striving for perfect replication, it embraces distortion as a space of reflection, where absence and ambiguity contribute to a narrative of shared temporality and cultural transformation. The glitch, then, emerges not as an obstacle, but as a proposition: a way to inscribe rupture, fragility, and collective authorship into digital reconstructions.

By bridging experimentation and critical reflection, Glitch Cartographies adds to the debate on how imperfection, ambiguity, and participatory processes reshape digital heritage practices and enhance the potential of experimental virtual environments to contribute to cultural sustainability. Future developments aim to extend this artistic approach to other communities and contexts, encouraging broader adoption of glitch aesthetics as a tool for memory, identity, and sustainable digital heritage. This work was developed within the Master's in Multimedia Art (Interactive Arts) at FBAUL during the classes of Project I and Virtual and Augmented Reality.

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Beyond Technology: Proposing A Contextual Classification Framework for Media Art in Chinese Urban Space Through Its Social Potential

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Abstract

This paper introduces a novel framework for classifying urban media art, one that reorients the analytical lens from technology-driven taxonomies toward a model grounded in the cultural, spatial, and institutional dynamics specific to contemporary China. Based on extensive site-specific fieldwork, curator interviews, and comparative case analyses across multiple Chinese cities, the framework maps urban media artworks across three interdependent axes. The first considers the artwork's primary social function, ranging from aesthetic articulation and civic communication to cultural enrichment, affective modulation, and ecological critique. The second axis addresses the mode of urban activation, encompassing a spectrum from permanent installations to ephemeral, mobile, or networked interventions. The third examines the audience's experiential mode, whether passive, interactive, or participatory. By adopting this multi-dimensional structure, the model underscores how urban media art in China operates not merely as artistic expression but as a vehicle for aesthetic governance, emotional regulation, and symbolic infrastructure, deeply entwined with the state–market–culture nexus. While grounded in China's distinct media ecology, the framework holds relevance for cross-cultural analysis and comparative classification practices more broadly. Hence, by foregrounding the territorial, cultural, and infrastructural contingencies of media art, this study offers a methodologically flexible and globally resonant contribution to the evolving discourse on media art in public space.

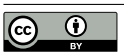
CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Media Art, Urban Space, Contemporary China, Classification, Social Potential

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1 Introduction

Over the past few decades, urban media art has become a defining feature of Chinese cityscapes, incorporating digital screens, projection mapping, and light-based installations into commercial hubs, cultural landmarks, and civic spaces. In contrast to many Euro-American contexts, where such practices are often framed as grassroots interventions or participatory placemaking initiatives [1], media art in China is predominantly shaped by top-down mechanisms of urban planning, aesthetic governance, and symbolic curation [2, 3]. Whether integrated into smart city infrastructures or embedded within developer-driven public plazas, these works frequently transcend the realm of artistic experimentation to fulfill roles in cultural branding, emotional modulation, and urban image construction. Tanya Toft conceptualizes urban media art as a form of mediation that operates across the spatial, aesthetic, and social dimensions of the city [4]. However, within the utilitarian and centrally managed urban environment of contemporary China, such works often resist alignment with Western paradigms of art that privilege autonomy, critique, or subversion. Instead of standing apart from institutional structures, they function within a coordinated system of urban expression, mobilizing spectacle to align public emotion with dominant institutional narratives.

Prevailing classification models for media architecture and digital art remain largely anchored in formal and technical criteria. For instance, M.H. Haeusler's five-category schema organizes works according to their structural configurations, such as projection surfaces or voxel façades [5], while subsequent frameworks have incorporated interactive and hybrid modalities [6, 7]. These typologies, while valuable in earlier stages of media façade development, offer limited insight into the social and symbolic functions media artworks perform today. Moreover, such approaches often overlook the specific cultural, political, and affective logics that shape the production and reception of media art within the Chinese context, where its articulation is often shaped by local constraints and imperatives. Civic engagement is often pre-scripted, cultural motifs are harmonized with national imagery, and interactivity is bounded by curated design. This leads to the central research question: How can urban media art in China be classified beyond technological typologies, in ways that reflect its social, cultural, and spatial functions? To address this question, this study develops a context-sensitive framework that treats urban media art not only as an



Figure 1: Classification of media facades. Photograph by M.H. Haeusler, Media Facades: History, Technology, Content.

artistic display but also as an apparatus of symbolic mediation and affective governance. It first reviews technology-centric typologies and demonstrates their limits in accounting for symbolic, institutional, and affective roles, then details the qualitative, case-based design conducted across multiple cities and practitioner interviews. Building on these materials, a three-axis model is advanced that distinguishes an artwork's primary social role, its mode of urban activation, and the audience's manner of engagement. The model is subsequently applied to representative works, and the resulting patterns are synthesized. Finally, the paper concludes by outlining implications for comparative research, acknowledging limitations, and indicating directions for future work. The result is a localized analytical tool with clear portability for broader comparative analysis.

2 Literature Review

Scholarship on media architecture and urban media art remains largely anchored in technology-oriented typologies, classifying works by surface, hardware, and architectural integration. In the Chinese context, systematic project surveys are comparatively scarce despite extensive implementation, constraining historical continuity and cross-case comparison. Concurrently, a growing body of research foregrounds the symbolic, cultural, and political roles of urban screens as instruments of mediation, branding, and affective governance. Consolidating these strands, the review identifies gaps in China-focused documentation and context-sensitive analysis, thereby motivating the inquiry that follows.

2.1 Emphasis on technology in existing classification methods

In early studies, classification models were primarily technology-driven. Scholars in urban planning, architecture, public art, and media studies employed terms such as media architecture, media facades, and urban media art to describe this emerging hybrid domain. One of the most influential typologies was introduced by M.H. Haeusler in his *Media Facades: History, Technology, Content* [5], which categorized 32 projects into five types based on their technical attributes: projection facades, illuminant facades, display facades, voxel facades, and customized technology facades (Figure 1).

This format-driven framework, grounded in the formal affordances of media surfaces, has since become a foundational reference point, frequently adopted and extended in subsequent scholarship. For instance, Xiongquan later added interactive installations and VR spaces [6], while Yuan Qian proposed "new building material" facades as a sixth category [7]. These models were appropriate in an earlier stage of media facade development, when architectural integration and technological novelty were the primary concerns. However, as media art has evolved from technological ornament to social agent, this classification logic has become increasingly inadequate. While precise in terms of hardware, technological descriptors often overlook the cultural, emotional, and political functions these works perform within specific urban contexts. Moreover, the accelerating emergence of new media formats, such as AR, VR, generative AI, drones, and data-responsive systems, further complicates strictly technical classifications. The rapid evolution of media technologies has outpaced the adaptability of fixed typological models. This limitation is particularly pronounced in the Chinese context, where media art is often entangled within multifaceted institutional frameworks encompassing urban branding, ideological communication, and aesthetic governance. In these settings, the function and meaning of a media artwork are not solely determined by its technological form, but are also shaped by policy imperatives, spatial regimes, and affective strategies.

2.2 Toward context-sensitive classification

In 2012, Haeusler expanded his work by publishing *New Media Facades: A Global Survey*, which included 35 additional projects from various continents [8], including installations in mainland China such as the *State Grid Pavilion* and the *Danish Pavilion* at the Shanghai Expo. However, the ephemeral, technological, and cross-disciplinary nature of these installations significantly hinders their systematic documentation within Chinese art and architecture disciplines. Contrary to a substantial number of practical implementations, there is a notable scarcity of research specifically examining media art project surveys in China's urban space. This disparity poses the risk of urban media art installations becoming increasingly fragmented and losing their historical continuity. Although it is beyond the scope of this article to provide an exhaustive catalog of installations throughout China, a task that would merit a

dedicated monograph, this research endeavors to examine selected projects to offer an analytical perspective that substantiates the proposed classification framework. Furthermore, it seeks to provide a general overview of the current state of urban media art in China.

Several scholars have pointed toward the need to rethink media art classification beyond technological categories. As early as 2006, Struppek called attention to the social potential of urban screens as sites for participatory and civic engagement [9]. Tanya Toft further developed this direction by examining how urban media art can intervene in memory, narrative, and temporality [4]. In the Chinese context, Chang Zhigang highlighted media art's capacity to enhance economic vitality, cultural symbolism, and urban identity [10]. These studies collectively suggest that media art should not be reduced to its format or interface, but understood as a relational medium embedded in cultural, institutional, and spatial systems. Yet despite these valuable contributions, there remains a notable absence of systematic classification models that foreground contextual function over technical form. This gap is particularly salient in the Chinese context, where media art projects are frequently co-produced by municipal authorities, real estate developers, and media artists. In such collaborations, the social, symbolic, and spatial purposes of the installations warrant deeper analytical scrutiny. What is needed is a classification framework attuned to these territorial logics, one that yields categories meaningful not only for scholarly analysis, but also for curatorial practice, urban policy, and transnational comparison. This paper addresses this need by proposing a multidimensional classification model that shifts the analytical focus from the technologies employed to the sociocultural and spatial roles that media artworks perform within the urban fabric. The following section outlines the methodology used to construct this framework.

3 Methodology

This study adopts a qualitative, case-based approach to develop a contextual classification framework for urban media art in China. Fieldwork was conducted across five Chinese cities, including Shanghai, Chongqing, Shenzhen, Hangzhou, and Chengdu, where twelve representative projects were selected for their diversity in site typology, thematic focus, and audience engagement. These cases were documented through on-site observation, photography, and the collection of curatorial and public materials. The study also draws on insights from a broader doctoral research project, which includes semi-structured interviews with ten curators and cultural practitioners involved in media art production and exhibition. While the full interview dataset informs the dissertation, this paper selectively incorporates a subset of those conversations to elucidate programming rationales, affective design strategies, and institutional framings. The analysis focuses on individual artworks and curated initiatives as situated interventions, examined through three interrelated axes: social function, mode of urban activation, and audience experience. This method thus enables a nuanced reading of how media art functions not only aesthetically, but also symbolically and politically within China's evolving urban landscape.

4 Model A Contextual Classification Framework for Urban Media Art

Drawing on insights from urban media theory [4, 11], spatial semiotics [12], and cultural policy studies, alongside field-based interviews, this study advances a three-axis classification model that shifts the analytical focus from technical format to the social function, spatial configuration, and audience engagement of media artworks.

4.1 Primary social role: What does the artwork do in the urban imaginary?

The first analytical axis categorizes media artworks according to their prevailing social function. This framework draws inspiration from Tanya Toft's conception of urban media art as a form of mediation, where artworks act as dynamic interfaces between institutional narratives and lived urban experience [4], as well as from Chinese theoretical perspectives on symbolic communication in public space, particularly Chang Zhigang's articulation of lighting design as bearing symbolic responsibility [10]. Within this interpretive lens, functionality is understood relationally, embedded within broader socio-spatial configurations rather than derived from individual artistic intent. Each artwork is thus examined in relation to the role it occupies within China's apparatuses of cultural governance. Along this axis, five principal social functions are delineated:

1. Aesthetic enhancement: Beautifying or animating the urban environment through visual or kinetic interventions.
2. Civic messaging: Conveying collective memory, civic values, or policy-oriented narratives often aligned with institutional agendas.
3. Cultural reflection: Referencing local heritage, mythology, traditional symbols, or vernacular aesthetics to evoke shared identity.
4. Environmental awareness: Visualizing ecological processes, climate data, or sustainability themes to promote environmental consciousness.
5. Affective Engagement: Generating emotional, commemorative, or romantic atmospheres, often through interactive or immersive design.

While these roles are not mutually exclusive, classification emphasizes the work's primary intent and perceived reception. As several local artists (interviewee C, July 8, 2024; interviewee B, July 19, 2024) noted in interviews, their objectives were "not purely aesthetic," but aimed at "making people feel part of something" or "bringing cultural codes into digital language." These reflections underscore the extent to which affective resonance, cultural articulation, and modes of governance converge in the practice of urban media art.

4.2 Urban activation mode: How does the artwork occupy time and space?

The second analytical axis focuses on the spatio-temporal activation of media artworks. Drawing on Henri Lefebvre's theorization of space as a socially produced construct [12], shaped by institutional rhythms rather than existing as a neutral container, and on Chris

Berry's insights into spatial regulation in contemporary China [13], where urban expression is governed by regimes of visibility, temporality, and authorization, this axis interrogates how media works are situated and timed within the urban environment. In contrast to the spontaneous or guerrilla-style interventions frequently emphasized in Western discourse, media art in Chinese cities is more often programmed, branded, and embedded within ritualized circuits of civic display, commercial spectacle, or state-endorsed cultural production. Within this framework, four distinct modes of activation are identified:

1. Permanent: Integrated directly into architectural façades or civic infrastructure as enduring visual or symbolic features.
2. Temporary: Installed for a fixed duration, often tied to festivals, national holidays, or seasonal marketing campaigns.
3. Ephemeral/ Pop-up: Short-term or mobile installations that operate outside fixed infrastructures, offering fleeting or nomadic experiences.
4. Networked/ Cross-city: Curated across multiple urban sites simultaneously, or distributed serially across cities, including transnational collaborations.

Curatorial interviews (interviewee A, September 1, 2023; interviewee G, August 23, 2024) highlighted that "screen access is institutionalized," and that many projects unfold within "controlled temporal cycles," such as municipal festivals or content blocks managed by platform operators. These insights indicate how temporality in Chinese screen space is often event-driven, reinforcing programmed rhythms rather than spontaneous emergence.

4.3 Audience experience mode: How does the artwork engage the viewer?

The third axis evaluates the degree and nature of audience engagement, treating it not as a technical interface but as an affective and spatial relation among viewer, artwork, and environment. Drawing on Debord's critique of the spectacle [14], which clarifies how visual mediation organizes perception and can induce passivity, and on Bourriaud's relational aesthetics [15], which reframes interactivity as engineered sociality, the axis distinguishes forms of participation by their intended relational effects. In the Chinese context, this lens helps assess whether participation operates as genuine co-creation or as curated affective alignment within programmed environments. On this basis, three engagement modes are identified:

1. Passive reception: Spectators observe the content without any direct interaction or feedback loop.
2. Reactive interaction: Limited stimulus–response mechanisms, often pre-scripted or surface-level (e.g., motion-triggered visuals or sensor-based effects).
3. Participatory input: Audience members contribute data, content, or behavior that meaningfully shapes or co-produces the outcome of the work.

Rather than treating interactivity as a technical affordance alone, this model interprets it as a carefully designed relational structure, often engineered to elicit particular emotional responses or to reinforce the ideological and symbolic messages embedded in the work.

5 Case study analysis: applying the contextual framework

To evaluate the applicability and utility of the proposed classification model, this section applies it to a selection of media artworks drawn from diverse Chinese urban contexts. By analyzing each example across the three axes of social role, urban activation mode, and audience engagement, the framework demonstrates how urban media art in China is embedded within a layered matrix of symbolic, affective, and spatial logics.

5.1 Aesthetic enhancement

Early examples such as the *Moon Project* (2008) and *Creative Tree* (2016) illustrate how media installations beautify the urban landscape while also encoding regional identity. The *Moon Project*, located in the China International Park Expo area in Xiamen, represents one of the earliest instances of free-standing media sculptures in China [5]. *Creative Tree*, designed by the studio d'strict and installed in Yinchuan's historical district, employed 38 curved LEDs to deliver immersive visual narratives rooted in the city's cultural landscape. Both installations are classified under the following axes: Primary role - Aesthetic enhancement; Activation mode - Permanent; Audience experience - Passive reception.

The *Luban Lock Cube* (2023), installed at Shanghai's Turing Square, blends visual spectacle with cultural symbolism [16]. Inspired by the traditional Chinese Luban Lock, a wooden puzzle attributed to the legendary carpenter Lu Ban, the structure evokes themes of craftsmanship, ingenuity, and cultural continuity (Figure 2). Its mirrored structure engages viewers in the daytime through reflection and becomes an LED-based display at night. Although this installation reflects cultural heritage, its primary urban function aligns with spatial beautification and brand identity. It is thus still classified as: Primary role - Aesthetic enhancement; Activation mode - Permanent; Audience Experience - Passive reception.

These works demonstrate how aesthetic enhancement in the Chinese context is rarely neutral or incidental. As a media curator (interviewee G, August 23, 2024) based in Hangzhou commented, "Visual design is always a negotiation between the need to appear modern and the responsibility to maintain a sense of cultural continuity." In contrast to many Western public art models that may embrace abstraction, disruption, or irony, Chinese media artworks, particularly those situated in high-traffic commercial and civic spaces, are more frequently tasked with producing visual coherence, symbolic elegance, and continuity with state or corporate branding. This imperative is further reinforced by the spatial logic that governs their placement. The permanence and visibility of such installations are closely tied to China's top-down planning regimes. Rather than arising from grassroots initiatives or community engagement, these works are typically commissioned by municipal governments or major real estate developers and function as components of symbolic infrastructure. Their sustained presence within the urban landscape serves both as a visual anchor and a mechanism of emotional regulation, providing consistency, legibility, and a photogenic identity in districts undergoing accelerated transformation. What is at stake here is not merely visual embellishment but the deployment of aesthetics as a soft instrument of governance. This dynamic aligns with Berlant's insight that



Figure 2: Media sculpture. From left to right: Moon Project, Creative Tree, and Luban Lock Cube. Photograph by Raiden_INST, via MANA[1]



Figure 3: Projection mapping works Homogeneity (left) and Algorithms Guessing in Chongqing (right). Photograph by Much More, via MANA[2]

public aesthetics function as affective architectures, pre-structuring emotional atmospheres and facilitating a sense of shared belonging through curated visual forms [17]. In this light, while the formal language of these works may resonate with global trends in media sculpture or immersive animation, their socio-political function remains territorially specific. They do not simply beautify public space but enact governance through aesthetics, embedding normative ideals such as cultural continuity, innovation, and urban stability into the city's visual code.

5.2 Civic Messaging

Two projection-based installations featured in the 2023 Chongqing International Light Art Festival, *Homogeneity* and *Algorithm Guessing Chongqing*, operate as visual critiques embedded within the cityscape [18]. *Homogeneity* interrogates the pressures of conformity engendered by algorithmic systems, while *Algorithm Guessing Chongqing* employs GAN-generated imagery to reflect on the growing entanglement between artificial intelligence and urban planning. Both works appropriate public architectural surfaces as dynamic canvases, foregrounding the ideological dimension of technological urbanism (Figure 3). In terms of classification: Primary role - Civic messaging; Activation mode - Temporary; Audience experience - Passive reception.

While these works may initially appear critical or reflective, their integration into institutional frameworks situates them within a tightly managed civic discourse. As one seasoned curator (Interviewee A, September 1, 2023) remarked, "We're invited to reflect, but not to resist. The message is framed, poetic, and bounded." These projection mappings resonate with what Tanya Toft [4] has described as "urban media mediation". Yet, in the Chinese context, such mediation tends to occur within a narrow bandwidth of sanctioned reflection, rather than through open-ended public debate. Thematically, the installations gesture toward concerns around data surveillance and technological acceleration. However, their inclusion in officially endorsed festivals positions them less as activist interventions and more as symbolic acknowledgments of ambient urban anxieties. Their aesthetic ambiguity, rooted in metaphor, visual abstraction, and emotional distance, serves to absorb critical tension while simultaneously reinforcing institutional legitimacy. As the same curator aptly noted, they function as forms of "safe critique." In contrast to civic messaging in Western projection works, which often emerge from grassroots initiatives or enact direct protest, these examples reflect a ritualized mode of expression, where critique is stylized, abstracted, and meticulously curated. The use of poetic imagery and the absence of overt confrontation enable these works to engage public sentiment while remaining securely within the bounds of state-sanctioned cultural programming. The screen does not serve as a site of dissent, but rather as a medium of managed civic affect, where reflection is invited, but consensus is gently orchestrated.

[1] https://shorturl.at/AQvO8
[2] https://tinyurl.com/bdhpz7nu

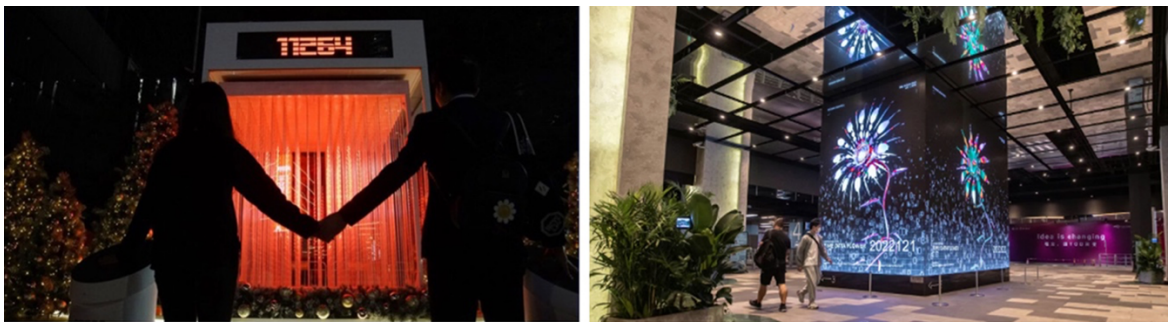


Figure 4: Interactive installations Heartbeat (left) and Time, Data, Flower (right). Photograph by Geeksart, via Geeksart website[3]

5.3 Affective Engagement

Geeksart's *Heartbeat* (2017) activated a large LED heart via hand-touch sensors, pulsing in response to couples holding hands on either side [19]. Similarly, *Time, Data, Flower* (2022), installed on the TODTIME pillar in Shanghai, invited users to generate personalized floral animations by inputting their birth date via QR code [20]. Both works foster affective intimacy through interactive design while operating within curated public infrastructures (Figure 4). They are thus categorized as: Primary role - Affective engagement; Activation mode – Pop-up (*Heartbeat*)/ Temporary (*Time, Data, Flower*); Audience experience -Reactive (*Heartbeat)* /Participatory (*Time, Data, Flower*).

These two projects illustrate how emotional scripting in Chinese urban media art is achieved not through open-ended interaction but through carefully designed and constrained forms of engagement. As an artist (Interviewee E, July 16, 2024) based in Shanghai remarked, "The goal is to give people a sense of presence and intimacy, but within a framework we control. It should be personal, but never chaotic." Such a statement highlights the underlying logic of affective design: to elicit emotion within boundaries that uphold social legibility and institutional coherence. Different from interactive media art in some global contexts, where interactivity may serve experimental, disruptive, or subversive ends, Chinese examples often employ controlled interfaces to ensure emotional containment. Touch sensors typically respond to simple gestures, and user input (such as birthdates) is pre-selected to generate socially desirable or aesthetically pleasing outcomes. The emphasis is not on co-creation, but on guided personalization, producing a sense of emotional proximity without relinquishing institutional control. In this context, media art functions not merely as a form of expression but as an apparatus of affective management, channeling emotion toward curated experiences of public harmony and social cohesion.

5.4 Cultural Reflection

The *Panda Greetings* video, developed by Flint Walk and the China Conservation and Research Center for Giant Panda, represents a clear example of cultural symbolism [21]. By projecting panda-themed 3D animations on urban screens, it reflects China's national identity and promotes ecological harmony. Its sister work, *Spring is Awakened by the Lion*, extends this reflection into diasporic spaces with cross-city deployments in Chengdu, New York, and Seoul (Figure 5). These works are classified as: Primary role - Cultural Reflection; Activation mode - Temporary/ Networked; Audience experience - Passive reception.

These works are emblematic of China's cultural diplomacy logic, where urban screens are not only aesthetic platforms but carriers of symbolic soft power. As the interviewee G described, "We want to show the world something elegant, ancient, and joyful but not old-fashioned." By translating iconic symbols such as pandas and lion dances into animated, cosmopolitan formats, these works serve both internal identity reinforcement and external image projection. Still, unlike many global examples of cultural reflection in media art, which may center on marginal voices, counter-memory, or sub-cultural aesthetics, these Chinese cases tend to emphasize unifying, officially embraced narratives. They celebrate harmony, ecological virtue, and cross-cultural friendship in stylized, non-controversial ways. Their deployment across multiple cities and nations reflects a strategy of diasporic visibility that aligns with state ambitions for international cultural leadership. Moreover, the integration of these works into both commercial and public screen infrastructures shows how culture is not presented as oppositional or avant-garde, but as part of a cohesive branding strategy. In this way, cultural reflection in Chinese urban media art is less about pluralism and more about projecting a harmonized national image. These works operate not only as cultural memory but as symbolic consensus machines that stage identity through immersive spectacle rather than contested narration.

5.5 Environmental Interaction

The *Greenpix* media facade (2008), constructed with photovoltaic cells, was one of China's earliest examples of sustainable media architecture [22]. It featured commissioned video art powered by solar energy collected during daylight hours, positioning environmental sustainability as both form and function. More recently, *Cloud Walk* (2023) by Wang Tianxin visualized real-time environmental data from Dishui Lake through a dynamic LED "cloud sea" responsive to local temperature, wind, and light conditions [16]. Both installations foreground ecological awareness, though through distinct temporalities and modes of interaction (Figure 6). They are classified as: Primary role - Environmental awareness; Activation

[3]http://geeks-art.com



Figure 5: Screen projects. From left to right: Panda Greetings, New Year Picture, and Spring is Awakened by the Lion. Photograph by Flint Walk, via Flint Walk website[4]

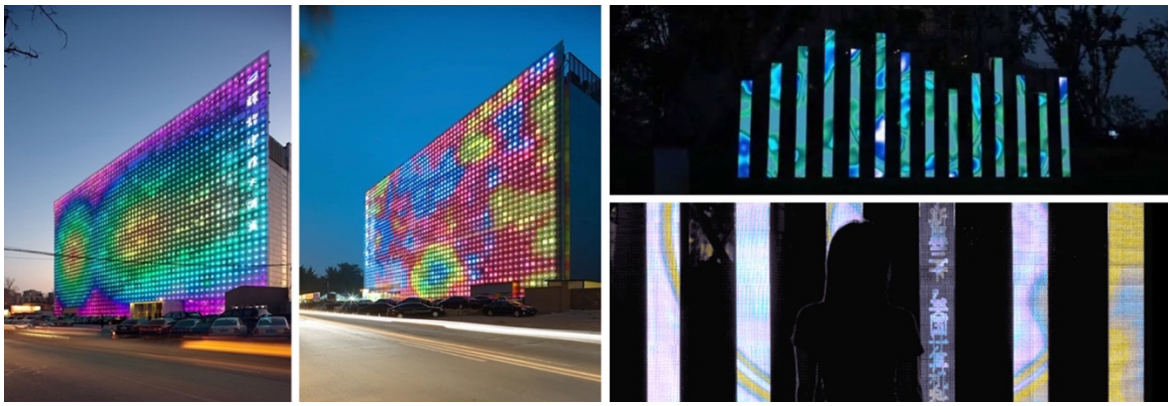


Figure 6: Greenpix (left) and Cloud Walk (right). Photograph by Raiden_INST, via MANA[5]

mode - Permanent (*Greenpix*)/ Temporary (*Cloud Walk*); Audience engagement - Passive (*Greenpix*)/ Reactive (*Cloud Walk*).

These works illustrate how environmental discourse in Chinese media art is often articulated through a technological sublime, where ecological themes are interwoven with visual languages of innovation, serenity, and spectacle. Both *Greenpix* and *Cloud Walk* prioritize data harmony and atmospheric resonance over disruption, aligning environmental awareness with state narratives of modernization, sustainability, and digital integration. *Greenpix*, with its solar-powered infrastructure, performs a symbolic alignment with green policy without deploying explicit environmental messaging. *Cloud Walk* similarly translates real-time weather data into tranquil visualizations, fostering a sensory connection to nature that reinforces emotional calm and civic optimism. These strategies reflect a broader tendency to frame environmental awareness as an aesthetic infrastructure of soft governance. Instead of prompting behavioral change through confrontation or urgency, such works visualize natural systems as ordered, beautiful, and benign, encouraging emotional attunement to environmental themes embedded within futurist, state-aligned narratives. In this context, ecological media art is less a form of activism and more a mode of affective modulation, cultivating awareness through curated aesthetics of flow, balance, and digital serenity.

[4]https://flintwalk.com
[5]https://tinyurl.com/yjj8xaup

These projects are positioned by their primary social function while allowing for secondary roles. For instance, *Cloud Walk* contributes to visual enrichment, yet its dominant classification rests on environmental interaction. The scheme registers both overarching purposes and distinguishing characteristics (Table 1). Additionally, its flexibility allows for expansions as new forms emerge, ensuring its continued applicability.

Note. This classification reflects each work's predominant intent and presentation context rather than technical forms or strict categorical boundaries.

In sum, these case studies demonstrate the model's capacity to clarify the multifaceted roles of urban media art in China. Rather than reproducing technology- or style-based taxonomies, the framework foregrounds the situated logics through which these works operate: as aesthetic infrastructure, symbolic mediation, affective interface, and, at times, policy instrument, each embedded within wider systems of urban governance and cultural production.

6 Conclusion

This paper proposed a new classification framework for urban media art in China, shifting attention from technical format to social function, spatial logic, and audience experience. Based on fieldwork, interviews, and case studies, the model introduces three axes: social role, urban activation mode, and audience engagement,

Table 1: Mapping Chinese urban media artworks within the three-axis contextual classification model

Project/ Artwork	Social Role	Urban Activation Mode	Audience Experience Mode
Moon Project (2008, Xiamen)	Aesthetic Enhancement	Permanent	Passive Reception
Creative Tree (2016, Yinchuan)	Aesthetic Enhancement	Permanent	Passive Reception
Luban Lock Cube (2023, Shanghai)	Aesthetic Enhancement	Permanent	Passive Reception
Homogeneity (2023, Chongqing)	Civic Messaging	Temporary	Passive Reception
Algorithm Guessing Chongqing (2023, Chongqing)	Civic Messaging	Temporary	Passive Reception
Heartbeat (2017, Shenzhen)	Affective Engagement	Pop-up	Reactive Interaction
Time, Data, Flower (2022, Shanghai)	Affective Engagement	Temporary	Participatory Input
Panda Greetings (2024, Chengdu)	Cultural Reflection	Temporary	Passive Reception
Spring is Awakened by the Lion (2024, Chengdu / Seoul / NYC)	Cultural Reflection	Networked/ Temporary	Passive Reception
Greenpix (2008, Beijing)	Environmental Awareness	Permanent	Passive Reception
Cloud Walk (2023, Shanghai)	Environmental Awareness	Temporary	Reactive Interaction

to interpret how media artworks operate within Chinese cities. Instead of enabling spontaneous or grassroots interventions, Chinese urban media art often reflects programmed aesthetics and symbolic curation, shaped by institutional collaboration among governments, developers, and media studios. These works are embedded in top-down infrastructures, aligned with civic narratives, commercial goals, and soft power strategies. The framework captures key variations in function, scale, and interactivity, showing how artworks beautify space, promote national imagery, foster emotional resonance, and visualize data. As both artistic expression and urban technology, media art in China illustrates a hybrid logic of aesthetic governance. While rooted in the Chinese context, the model also offers comparative value for other regions shaped by institutional media infrastructures, especially across East Asia and global smart-city initiatives. It encourages further refinement to address emerging practices. Overall, by anchoring urban media art within its political, spatial, and cultural conditions, this study challenges universalist taxonomies and supports a more pluralistic and context-sensitive discourse, one that acknowledges the diverse ways in which cities across the globe produce public meaning through media technologies.

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Between Light and Screen in David Hockney: the Rearticulation of the Pictorial Gesture in Digital Media

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Abstract

This paper examines David Hockney's digital oeuvre not as a departure from traditional modes of image-making but as a radical extension of them. While Hockney's early experiments with Polaroids and photocopiers already implied an instinct for temporal layering and mechanical mediation, his adoption of the iPad marked a decisive reconfiguration of the pictorial act. The screen, backlit and portable, does not replace the canvas – it reframes it. In tracing Hockney's engagement with mobile applications such as Brushes, this study exposes how digital tools can recover and intensify classical concerns: the registration of light, the elasticity of space, and the fluid syntax of colour. More than a case of technological appropriation, Hockney's method reveals a recursive interplay between materiality and dematerialization. His workflow – sketching in situ, revising in the studio, printing on archival paper – disrupts binaries like virtual/real or process/object. What emerges is not a hybrid aesthetic, but an unstable zone where the image resists closure. By mapping the tension between continuity and rupture in Hockney's digital practice, the paper proposes a critical framework to address how digital images – far from dissolving artistic authorship – may instead intensify its visibility. The analysis situates Hockney not only within the lineage of British modernism or post-Impressionism, but within the speculative terrain where human agency, machine mediation, and visual experience intersect. This paper examines David Hockney's digital oeuvre not as a departure from traditional modes of image-making but as a radical extension of them. While Hockney's early experiments with Polaroids and photocopiers already implied an instinct for temporal layering and mechanical mediation, his adoption of the iPad marked a decisive reconfiguration of the pictorial act. The screen, backlit and portable, does not replace the canvas – it reframes it. In tracing Hockney's engagement with mobile applications such as Brushes, this study exposes how digital tools can recover and intensify classical concerns: the registration of light, the elasticity of space, and the fluid syntax of colour.

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CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Fine Arts**; • **Media Arts**; • **Human-centered computing**; • **Interaction design**; • **Interaction design theory, concepts and paradigms**;

Keywords

Digital drawing, IPad, Reproducibility, Digital aesthetics, Art and technology

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1 INTRODUCTION

Artist David Hockney exemplifies the successful combination of tradition and technological innovation. With a career spanning more than six decades, Hockney shows constant adaptation and intellectual curiosity. Always willing to explore new forms of artistic expression, he has incorporated various technologies into his artistic practice. The arrival of the iPhone and later the iPad marked a turning point in his artistic production, allowing him new possibilities for visual expression. Through the use of applications, Hockney has explored the potential of digital creation, works that challenge traditional notions of art. The new phase began with a series of drawings executed in the Brushes app, which quickly revealed the potential of mobile technologies as an artistic tool. This phase defined the recurring themes in the digital work: the capture of light, the use of colour and the reinterpretation of landscape and portraiture with a new language. Hockney's rise in digital art coincided with a growing acceptance of technology as a legitimate means of creation. Although he shared with other digital artists a focus on technical innovation, he stood out for combining the traditions of painting and drawing with the possibilities offered by technology.

2 TECHNICAL EXPERIMENTATION AND MEDIA IN HOCKNEY'S WORK

2.1 From Analog to Digital: The Construction of an Expanded Language

David Hockney was born in 1937 in Bradford, England and studied at the Bradford School of Art and the Royal College of Art in London. In the 1960s, he established himself as one of the most influential British artists. From an early age, Hockney demonstrated an ongoing commitment to exploring new languages, media and experimental processes. In the 1980s, he began experimenting with collages. Using Polaroids and conventional photographs, he created compositions that brought a new approach to traditional photography, raising new questions about how to capture space and time in an image. He has never settled on a single form of expression. From oil to acrylic, lithography to aquatint, the artist explores and creates with a variety of artistic techniques. Over time, he has incorporated digital into his work, such as C-type printing, digital photography and photomontage. In each phase, Hockney has maintained a constant dialog with the history of art: he draws inspiration from classical masters like Monet as well as modern innovators like Picasso. The fusion of the classical and the modern is, moreover, one of the defining features of his work.

A central theme in Hockney's work is portraiture, especially of close people. His parents and friends are often depicted in his paintings. These portraits go beyond technique: the act of drawing and painting also serves as a visual diary of intimate moments and the evolution of personal and artistic relationships. In the 1990s, Hockney further expanded his technical resources by using the fax machine, laser printer and computer, which raised new questions about originality and reproduction in art. In 1997, he returned to landscape painting, creating monumental works such as the Grand Canyon series. In these works, he continued to investigate the way we perceive the world around us, always interested in the representation of space and in the very act of creating art. His approach to art is both intellectual and visually accessible; while Hockney reflects on the history of art and the philosophical implications of visual representation[1], he maintains a simplicity that engages in an immediate and universal dialogue with the public.

2.2 Fusion of the Traditional and the Digital

A significant part of Hockney's creative process consists of painting directly outdoors[2]. Hockney often travels to pictures locations – such as the Yorkshire countryside in England or the luminous hills of California – where he sets up his easel and paints directly what he observes[3]. The artist believes that this approach allows him to capture the living essence of the landscape, including the subtle changes in light and colour that occur throughout the day. Years later, he innovated by incorporating technology into this outdoor process, so as to create digital sketches on the spot. This extension of traditional practice into the digital medium reflects Hockney's view that a painting should be experienced up close, according to the perception of the human eye [1].

The photocopier may have been Hockney's first foray into incorporating contemporary technology into his artistic explorations. "I'm not a tech-obsessed person", Hockney remarked, "but anything visual appeals to me" [2]. This tool allowed him to take direct control of the entire printing process, which reduced the need for technical assistants. "In fact, this is the closest experience I've ever had in printmaking to what it's like to paint: I can put something in, evaluate it, change it, revise it, all in a matter of seconds" [2], he explained. After his experiences with the photocopier, Hockney also explored the fax machine as a means of artistic creation and distribution. He appreciates the aesthetic qualities generated by the fax, as well as its potential for distribution and accessibility. He has adapted his output to the medium's capabilities, evolving from single-page works to monumental compositions of up to 144 pages assembled together. "I love the idea of being able to send images to people, and the images having no material value, because we dematerialize them in order to send them. All they do is bring pleasure to the eye and the mind, and that appeals deeply to the bohemian side of my artistic nature" [2] he said, revealing an almost visionary view of the dematerialization of art – something that decades later would be seen in the digital domain.

3 DIGITAL DESIGN AS CONTINUITY AND RUPTURE

3.1 Hockney's Digital Creative Process

David Hockney began experimenting with digital devices in 2010. He started drawing on an iPhone and then moved on to the iPad, using the Brushes app[4]. However, this change is not limited to a technological leap; it also reflects a dialog with historical instruments of projection and visual control, such as the camera obscura[5].

[1] David Hockney says: "I learned about the Chinese attitude to painting. They say you need three things to paint: your hand, your eye and your heart. Two are not enough. A good eye and heart are not enough; neither is a good hand and eye" [3].

[2] Practice known as *en plein air*, a French expression meaning "in the open air". In painting, it refers to the practice of painting directly outdoors, rather than working in ateliers. The approach became particularly significant in the 19th century, especially among Impressionist painters. This method emphasized direct observation of natural light, colour, atmosphere, and movement. By painting on-site, artists sought to capture the transient effects of light and weather conditions with immediacy and spontaneity. The development of portable painting equipment – such as the box easel and premixed paint in tubes – facilitated this practice. Historically, plein air painting marked a shift from idealized, composed landscapes toward more empirical and perceptual representations of nature.

[3] "The change in contemporary painting refers not only to the stylized change in the appearance of the images, but also to the change in the way of observing" [1].

[4] Brushes was a digital painting application originally created for the iPhone, launched in 2009 by Steve Sprang. It was one of the first applications to offer a fluid and responsive drawing experience on the iPhone and later on the iPad. The app provided a range of customizable brushes, layers, colour palettes, and undo/redo functions, offering a simplified yet effective toolset for artists. Despite the absence of pressure sensitivity in early iPad models, Brushes enabled expressive mark-making through clever software design. It also included a playback feature that recorded each brushstroke, allowing users to export a time-lapse of their process. Brushes became particularly notable when artist Jorge Colombo used it to create a cover for The New Yorker in 2009, entirely drawn on an iPhone. Its popularity among illustrators and designers contributed to the broader acceptance of tablets as legitimate creative tools in digital art practice.

[5] The camera obscura is an optical device that predates the invention of photography. It consists of a darkened room or box with a small hole or lens on one side. When light passes through this aperture, it projects an inverted image of the external scene onto the opposite surface inside the enclosure. Historically, the camera obscura was used as a drawing aid by artists, especially during the Renaissance and Enlightenment periods. It allowed them to trace the projected image and achieve accurate perspectives. Over time, the device evolved in complexity, incorporating lenses and mirrors to improve image clarity and orientation. The principle underlying the camera obscura is the same as that of the modern photographic camera, making it a precursor to photographic technology.



Figure 1: David Hockney drawing on Ipad, *Bigger Christmas Trees,* 2023. Photo credit: Jonathan Wilkinson. Source: https://www.apple.com/uk/newsroom/2023/12/artist-david-hockney-brings-christmas-cheer-to-battersea-power-station (reproduced for academic purposes only, not for commercial use)

Just as this optical device projected inverted images to facilitate precise strokes, the iPad, in a way, harks back to this historical instrument; it operates with digital layers: a fixed image is in the background, while the stroke occurs, separately, on a distinct layer. This arrangement does not imitate the classical method, but transfers it to a digital logic. The integrated light and the separation of levels allow for a distinct interaction between the precision of the line and the freedom of experimentation. Just as the camera obscura offered a technical aid to capture reality more immediately, the iPad extends direct observation into the digital environment, without suppressing Hockney's habit of creating outdoors. In fact, the artist's digital creative process resembles his traditional practice in many ways: he works in direct contact with nature to capture small changes in real time. His digital creative process mirrors traditional practice in many ways: he works outdoors to capture the small changes in nature in real time. For him, the capabilities of the digital medium are important – such as the possibility of immediate revisions without the need to wait for the paint to dry. Furthermore, the iPad's backlit screen allows him to work at night – something impossible with traditional outdoor painting methods. An interesting aspect of his method is the constant iteration: Hockney periodically prints out the digital works to examine them in the studio, and makes adjustments as necessary. This method – combining working outdoors with subsequent fine-tuning in the studio – results in dynamic and elaborate compositions.

Hockney has also incorporated animation into his digital work. He has produced time-lapse videos that reveal the development of the work over time, records that offer a unique perspective on his creative process. In fact, they allow us to observe the layers and transformations made throughout the work. By adopting the iPad, Hockney has continued his search for new forms of expression and demonstrated how technology can be integrated with traditional artistic techniques: his approach combines the speed of painting and drawing outdoors with the capabilities of digital manipulation. The possibility of quickly evaluating and modifying works results in creations that are both contemporary and rooted in classical tradition. As Hockney states, quoted by Robyn Farrell, "in art, new ways of perceiving mean new ways of feeling, you can't separate the two, as we now understand, you can't have time without space and space without time" [4].

The very use of the iPad in Hockney's creative process symbolizes a union between traditional art and digital tools. This combination allows him to push the boundaries of artistic expression and find new ways of observing and representing nature. Over the years, he has refined his digital technique, experimenting with a greater variety of virtual brushes, textures and layers. The works became even more complex and detailed – revealing how technology can expand and transform artistic practice without sacrificing personal vision.

According to Hockney, drawing is not just a process of tracing lines with a tool; it is fundamentally creating a two-dimensional image of a three-dimensional space – a principle that holds true when creating and altering a work by collaging photographic images [5]. Hockney's digital drawings stand out for the inherent luminosity provided by the devices' backlighting, which intensifies his characteristic palette of vibrant colours[6]. This element is particularly appealing to Hockney, as it allows him to evoke the effects of light and colour similar to those achieved by the Impressionists – a group of artists he has always admired.

[6]"The synthetic image is a totally new species of the sensible; with it a true and proper mutation breaks out in the domain of images and in the history of aesthetic experience" [6].



Figure 2: David Hockney, *Bigger & Closer (not smaller & further away),* London's Lightroom, 2023. Photo credit: Dom Pates. Source: https://www.flickr.com/photos/globalismpictures/52972049382/in/photostream (reproduced for academic purposes only, not for commercial use)

Hockney's technique with digital platforms expresses a fluidity between the traditional and the contemporary[7]. He has incorporated traditional artistic techniques – such as pointillism, atmospheric perspective and the calculated use of the vanishing point – into digital compositions, which have a pictorial quality comparable to those he created on canvas. Exhibitions of digital works have adapted to the unique characteristics of this new medium. For example, in the David Hockney: A Bigger Picture exhibition at the Louisiana Museum of Modern Art in 2011, he used projectors to enlarge the scenes created on the iPad. In 2022, the Bigger & Closer (not smaller & further away) exhibition at the Lightroom in London used video mapping[8] technology with large-scale projections and animations, creating an immersive experience for visitors. In contrast, other exhibitions presented digital drawings printed and framed, bringing them closer to traditional art exhibitions. In this way, Hockney's ability to explore the potential of digital art has pushed the boundaries of his own practice and influenced the way digital art is perceived and exhibited. The ease of reproduction and flexibility of the digital medium makes it possible for works to be seen in several places simultaneously, which expands access to art in a democratic way. Hockney's stance serves as an inspiration to new generations of artists; it demonstrates how essential it is to embrace new technologies without giving up the essence of artistic creation [8].

[7]Digital tools have allowed Hockney to revisit and reinterpret recurring themes in his work. For example, the drawing Montcalm Interior (2010) on the iPad is a digital variation of his 1988 painting Montcalm Interior with Two Dogs, which demonstrates how the artist adapts familiar themes to new means of expression [7].

[8]Video mapping is a technique that projects images or videos onto three-dimensional, dynamic surfaces. This technology has been widely used in artistic performances, exhibitions and cultural events, standing out for its ability to create optical illusions and alter the perception of physical space. Unlike traditional flat-screen projection, video mapping uses specialized software to align imagery precisely with the geometry of the physical surface, accounting for its contours, depth, and spatial orientation. In the context of Hockney's works, video mapping allows visual explorations to be amplified, offering new layers of depth and movement to the compositions.

3.2 Digital Tools and Techniques

Using the Brushes app on the iPad has provided Hockney with a range of digital tools that simulate traditional drawing and painting techniques, allowing him to retain the essence of his signature style while exploring new aesthetic forms. The possibility of undoing, redoing and experimenting without fear of "messing up" encourages a bolder, more experimental approach to the creative process.

In 2011, with a new iPad model equipped with a larger screen, Hockney had even more digital tools at his disposal: more brushes, textures, colours and layers. It was in this context that he created the series The Arrival of Spring, made up of 116 works, all created on the iPad and then printed on high-quality paper using 12 different types of ink. These prints are framed without glass, which allows for a more direct visual experience for the viewer [4].

The ability to work in layers, undo actions and experiment with a vast digital colour palette[9] has expanded his visual vocabulary. Interestingly, this period of intense digital production coincided with the first months of the COVID-19 pandemic. Hockney spent his isolation in communion with nature in the countryside surrounding his home and studio, capturing the small changes in the same tree, the variations in light across a field, and the slow – and sometimes sudden – blossoming of colours [2]. In this way, like the Impressionists, Hockney emphasizes direct observation and immediate response to the visible world, now transposed to a technologically mediated environment.

[9]By capturing this luminosity, the artist uses colour in a unique way. Colour-light, a fundamental characteristic of the device, is different in nature from colour-pigment. We can see the characteristics of the digital screen as a means of enhancing visual art; more than an exhibition space, the tablet's digital screen is a fundamental element from its conception [9].



Figure 3: David Hockney, *Bigger & Closer (not smaller & further away),* London's Lightroom, 2023. Photo credit: Dom Pates. Source: https://www.flickr.com/photos/globalismpictures/52973103253/in/photostream (reproduced for academic purposes only; not for commercial use)

4 MATERIALITY AND CIRCULATION OF THE DIGITAL WORK

4.1 Digital Art in the Contemporary Market

An important aspect of Hockney's process with digital art is the transition from the virtual to the physical medium through printing. This phase is not merely technical, but an integral part of his artistic vision. Hockney collaborates with specialist printers to ensure that the vividness and brilliance of the digital drawings are faithfully reproduced on paper. This work requires meticulous colour calibration and a careful choice of the highest quality inks and papers. Printing digital works raises interesting questions about authenticity and reproducibility in contemporary art. Hockney addresses this issue with the limited-edition digital prints, treating each one as a unique, signed work of art.

Hockney's process with digital art also reflects a shift in the temporality of artistic creation. While traditional drawing often captures a specific moment, Hockney's digital works can be continually revisited and modified, resulting in a more fluid and iterative process in which the work can evolve over time before its final print: the act of drawing digitally becomes a more constant flow of creation. The transition from digital art to the physical medium has changed the artistic community significantly. Many artists, by adopting these new tools, have inspired others to explore the potential of digital resources. Devices such as the iPad and digital drawing applications have become legitimate options for artistic creation, and the art market has followed this transformation. One example was the million-dollar sale of The Arrival of Spring in Woldgate, East Yorkshire in 2011, auctioned by Sotheby's in 2019. The growing appreciation of digital art on the traditional scene shows that the use of digital media does not prevent the artistic or financial recognition of a work [10]. Concerns about reproducibility, once seen as an obstacle to the appreciation of digital art, have lost strength. Recent technologies such as blockchain[10] and NFTs[11] make it possible to guarantee authenticity, ownership and exclusivity in the digital environment – qualities previously associated only with physical art. In this way, technology facilitates new forms of expression and creates unprecedented paradigms of value and commercialization [10].

Hockney's digital work shows how contemporary art adapts to and welcomes technological change. The ability to maintain a distinct artistic identity while using digital tools reveals that the value of art ultimately lies in the artist's vision and execution, regardless of the medium used. Digital work also contributes to new forms of accessibility and democratization of art: the immaterial nature of the digital medium allows for a wider and more immediate dissemination of works, potentially altering the traditional dynamic between artist, gallery and audience [10].

[10]Blockchain is a distributed and decentralised digital ledger composed of blocks of data linked chronologically and cryptographically. Once a block is added to the chain (after validation by network consensus), the data is considered immutable and tamper-proof. It is the technology underlying cryptocurrencies such as Bitcoin.

[11]NFT (Non-Fungible Token) is a unique and irreplaceable digital asset recorded on a blockchain. In its application to digital art, the NFT serves as a certificate of authenticity and proof of ownership for a digital item (image, video, audio, etc.). This cryptographic token ensures the traceability and provenance of the work, conferring upon it the characteristics of digital scarcity and market value, despite the inherent reproducibility of digital files.



Figure 4: David Hockney, *Do remember they can't cancel the Spring,* 2025. Photo credit: Jean-Pierre Dalbéra. Source: https://www.flickr.com/photos/dalbera/54641280624 (reproduced for academic purposes only; not for commercial use)

4.2 Translating Digital Works into Physical Media

A particularly notable aspect of Hockney's productive increase with digital drawing is evidenced in his self-portraits. In 2012, he revisited a 1983 project in which he drew self-portraits every day for several weeks. The original versions, done in charcoal, took longer to complete, while the digital version allowed for faster execution and a broader exploration of styles and expressions, resulting in a more extensive and diverse series. Although artistic productivity has increased with the use of digital media, this has not resulted in less quality or depth. On the contrary: digital technology has acted as a catalyst for a more intense and varied exploration of recurring themes - such as landscapes, portraits and the passage of time. The transition from the internal luminosity of the screen to the reflective qualities of paper requires a reinterpretation of visual syntax. On the iPad, colour is generated through additive synthesis - light emitted in RGB combinations. On paper, it results from the subtractive mixing of inks and pigments. Hockney's awareness of this chromatic inversion influences his approach to composition and tonal balance. The printed image acquires a subtle opacity, a material density that contrasts with the evanescent clarity of the screen. This oscillation between transparency and materiality evokes earlier transitions in the history of image-making, such as the shift from fresco to oil painting or from photography to photogravure. Each technological change requires a recalibration of the relationship between image and medium, and Hockney's digital prints continue this lineage of technical adaptation.

The physical translation of the digital file reconfigures the temporality of the work. The printed version represents a momentary crystallisation of a process that, in principle, could continue indefinitely. The "final" print is therefore a negotiated pause within a potentially infinite sequence of digital iterations. This concept of provisional finality introduces a new temporality into the ontology of the image - one that combines the instantaneity of digital production with the permanence traditionally associated with printing. Hockney's limited editions function not as replicas, but as material instances of this temporal decision. From an institutional perspective, exhibiting printed digital works also meets the material expectations of the art world. Galleries and museums are still structurally oriented towards objects that can be displayed, stored and traded. By translating his digital drawings into large-format prints, Hockney ensures his participation in this established system, while maintaining a conceptual awareness of its dual nature. The printed iPad drawings, displayed without glass and with visible texture, oscillate between image and object; they retain the immediacy of the screen, but invite the slow contemplation traditionally associated with painting.

The technical reproducibility of digital works also introduces new dynamics of circulation and authorship. Hockney's insistence on being directly involved in the printing phase serves as a counterpoint to the automated logic of digital dissemination. Each print incorporates a deliberate act of authorial control-a reaffirmation of the artist's presence in an era of algorithmic production. In this context, printing becomes both a verification of authorship and a gesture of resistance to the infinite replicability of digital data. By treating printing not as reproduction but as translation, Hockney situates his practice in a continuum that connects the tactile gesture of drawing with the immaterial architectures of data. The printed digital image becomes a place where two modes of vision -

luminous and reflective - coexist. It is in this dual condition that the contemporary meaning of drawing emerges: not as a static category linked to a medium, but as a cognitive operation capable of moving freely between substrates, devices, and temporalities.

5 CONCLUSION

David Hockney's body of work – initially received with some scepticism in more traditional artistic circles - has generated a critical debate about artistic creation in the digital age. The production of digital works, potentially reproducible without limit, has also raised questions about value, originality and uniqueness in contemporary art. His approach to classic themes – landscapes, portraits, still life – using modern technology, has led the public and critics to reconsider notions of "authentic art".

Hockney's creative process, characterized by fluid interaction with technology, stands out for generating works that break with expectations and incite critical discussion. The ease with which he moves between digital and traditional media allows him to fully explore the potential of each format; he overcomes the apparent limitations of digital drawing without losing the essence of drawing as an artistic discipline. From his first experiments with drawings on the iPhone to his elaborate landscapes on the iPad, Hockney has shown an ongoing interest in themes such as visual perception, representation and the transformation of reality through the image in the digital age.

In his working environment – which now includes mobile devices as his main tools - Hockney favours spontaneity and capturing fleeting moments. This method results in a diverse body of work, but one that maintains a stylistic and conceptual coherence. Rather than relentlessly pursuing new technologies, Hockney explores the conceptual depth of those he has already adopted, as evidenced in the increasing sophistication of his digital creations. Hockney's digital practice, seen as a natural extension of his traditional art, illustrates the constant evolution of his work and challenges established ideas about originality and reproducibility. He has consolidated his position as an influential figure in the contemporary digital age, and his legacy continues to provoke and redefine the boundaries of artistic practice and design. With the growth and evolution of digital production, Hockney remains a central figure for both inspiration and critical debate – affirming his importance in art history as a pioneer of digital art. Hockney's adoption of digital drawing has had a strong impact on the contemporary art scene. His innovative and enthusiastic stance has helped to legitimize and reinforce the prestige of digital art, influencing other artists and the perception of what is considered "serious art" in the 21st century. Hockney's foray into digital drawing paved the way for a re-evaluation of this medium, transforming technology into a tool for creative renewal and the deepening of classic themes in drawing and painting. In this way, he consolidated digital as a relevant and legitimized artistic form.

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Towards Relationality: Sociocultural Embodiment and Interpersonal Interaction

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Abstract

This paper revisits the concept of interaction in interactive art through the lens of sociocultural embodiment and interpersonal dynamics, leaning toward the discourse of relationality. Drawing from phenomenology, post-phenomenology, and embodied interaction theory, the analytical focus shifts from human–machine interaction to artwork-mediated interactions among audience members. After reviewing existing taxonomies of interactive art, the study proposes the concept of audience–artwork–audience interaction to highlight the sociocultural dimensions of interactivity. A curated analysis of Ars Electronica award-winning works categorizes interaction into multi-audience and interpersonal forms. The findings reveal a paradigm shift from technological interactivity to sociocultural relationality, positioning interactive art as a medium of collective, interpersonal, and potentially interspecific experience. The paper concludes by advocating for future interactive art to expand beyond binary interaction models, embracing broader modes of relational interactions.

Keywords

Interactive Art, Relationality, Sociocultural Body, Sociocultural Embodiment, Interpersonality, Embodiment, Embodied Interaction, Interpersonal Interaction

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1 Introduction

Maurice Merleau-Ponty famously states that "the body is our general medium for having a world" [24]. This phenomenological insight situates the body not as a passive object but as the active, lived site through which the world is perceived, acted upon, and made meaningful. Within this framework, embodiment is not merely biological or mechanical but fundamentally intentional—embedded in perceptual experience and situated action. Building on this, Don Ihde extends phenomenology into a technological context in his seminal work *Bodies in Technology* [14]. Drawing on Merleau-Ponty's notion of the "body-subject," Ihde explores how our embodied existence is increasingly mediated by technological instruments, arguing that our being is "inextricably entangled with the world" through this mediation. Meanwhile, the technological mediation has long been a key feature of interactive art [1]. This trajectory, from classical phenomenology to post-phenomenology and beyond, offers a compelling foundation for rethinking embodiment in the context of interactive art, where bodily experience, technological interface, and sociocultural context converge.

While interactive art has long been associated with technological mediation and audience participation, the role of the body, particularly in its sociocultural and relational dimensions, remains underexplored. This paper shifts the focus from viewing interaction as a system of inputs and outputs between human and machine, toward understanding it as a situated, embodied, and relational experience among audience members. Grounded in phenomenology and post-phenomenology [14, 24], and drawing on Dourish's notion of embodied interaction especially social computing [6, 7], this paper critically reviews existing taxonomies of interactive art [4, 5, 8, 11, 12, 16, 19, 22, 31, 33] in Sec. 3 and introduces a new conceptual perspective centered on sociocultural embodiment and artwork-mediated audience–audience interaction in Sec. 4. Through the new conceptual lens and interaction model, Sec. 5 and Sec. 6 examine the Ars Electronica awarded artworks and highlight how interactive artworks can serve as more than bodily interfaces for audience-artwork dynamics, but as relational mediation that fosters interpersonal and collective experience among audience members. In the end, Sec. 7 and Sec. 8 discuss and conclude this study and provide insight into the previously addressed discourse.

2 Contexturalization

To deepen the shift from interactivity and narrowed embodied interaction to embodied and relational perspectives, it is necessary to further examine how embodiment has been theorized in relation to technology within sociocultural dimensions. The following section



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[1] It has been widely agreed to name artworks that use no digital technology as participatory art and those that do as interactive art [21, p.4].

Table 1: Summarized Ihde's *Bodies in Technology* [26].

Body	Definition	Descriptive Name
Body 01	Experience ourselves as "motile, perceptual, and emotive beings-in-the-world."	Phenomenal Body
Body 02	Be engendered and constructed within the context of social and cultural definitional interplay.	Sociocultural Body
Body 03	Traverses body one and body two, placing the body in relation to technology through some mediating form of technological artifact.	Techno-Phenomenal / Techno-Sociocultural Body

builds on foundational post-phenomenological thought to distinguish between the techno phenomenal body and the sociocultural body, leading towards relationality in interactive art.

2.1 Sociocultural versus Phenomenal Body

Ihde elaborates on the primordial relationship between the body and the world by introducing additional dimensions. Beyond the phenomenal body, he identifies a second dimension: the socially and culturally constructed body, which emerges from the interactions of the phenomenal body with other "body-subjects." A third dimension appears at the intersection of the phenomenal and social bodies with technology [29]. Ihde suggests that experiencing the world through technology fosters a utopia that transcends human limitations and creates "techno fantasies," extending the phenomenal body's capabilities and reach in the world [18]. Nappi further encapsulates this concept by describing it as an "ontological triangulation of our experiences of our bodies in relation to technology," outlining three distinct embodying experiences: (1) as motile, perceptual, and emotive beings-in-the-world; (2) as entities shaped by social and cultural interactions; and (3) as entities that navigate through technology, linking the first two dimensions with technological mediations [26]. These can be succinctly described as the Phenomenal Body, the Sociocultural Body, and the Techno Phenomenal and Techno Sociocultural Body.

Ihde articulates that the multidimensionality of bodies is crucial for re-embodiment through technology. Frequent interactions with technologies diminish the unease and perceived distance between the body and the technological device, which Ihde refers to as an "instrument." This process allows the human somatosensory system to seamlessly integrate technological objects into our embodied self-experience. Specifically, in the context of interactive art, the continuous detection of human behavior through technological devices, while simultaneously overlooking moments that might emphasize the separation between user and the "instruments," enhances the transparency of the interaction. This dynamic is particularly evident in how audience-artwork interactions in interactive art can transcend the mere physicality of the encounter. Overall, Ihde's post-phenomenological perspective incorporates both "extended mind" theories and bio-semiotic principles, which together highlight the evolutionary development of cognitive systems and underscore the complex interplay of bodily processes that shape our embodied identity.

2.2 Tangible versus Social Computing

Paul Dourish coined the term "embodied interaction" in human-computer interaction in his ground-breaking book [7] and presented "a more coherent understanding of our interaction (intersection) with machines ... involve consideration of human mental activity as embedded in a wider physical context" [29]. Rooted his ideas in deeper philosophical subsoil, Dourish took a "whirlwind tour"[7, p.124] through phenomenological thoughts of Husserl, Heidegger, Merleau-Ponty, and Wittgenstein to show how they represent a tradition in Western thought concerned with the human agent as situated in, and active within, a pre-organized world of physical demands and possibilities.

Accordingly, the mind is embodied in the physical presence of the body rather than separate from it; similarly, the body is rooted in the extended domain of the "real world" (naturally, socially, and culturally) of objects and events. Dourish's "embodied interaction" proceeds from two foundational ideas describing how we interact with technology, i.e., tangible and social computing, in which he emphasized not only the role of the body in the experience of being but the presence of the broader-defined natural, social, and cultural environment as well [6]. His general idea argues that "the history of interaction is a gradual expansion of the range of human skills and abilities that can be incorporated into interacting with computers" [7, p.17].

"Tangible computing" branches HCI research to seek to move beyond the desktop metaphor towards more distributed and tactile environments, naturally emphasizing the roles of the physical apparatus and body involvement in interaction. "Social computing" draws attention to the sociological, cultural, and historical context within which we use technology. The point for Dourish is that "social action is embedded" [7, p.96] rather than free-floating and abstracted. Dourish draws on sociological research, in particular the "ethnomethodological" work of Harold Garfinkel and the "situated action" studies of Lucy Suchman, and characteristically rejects the formalized, abstracted assumptions in favor of a concrete, "action oriented" evaluation of real practice and behavior. For Dourish, the theme of this research is to show a concern with "the mundane aspects of social life, the background of taken-for-granted everyday action" [7, p.96].

3 Review of Interaction Models

Since the 1960s, active audience participation and interaction with artworks have garnered significant interest among artists and researchers alike [30]. Roy Ascott emphasized the centrality of "participation and interaction between audience and artwork" in his seminal work, *Behaviourist Art and the Cybernetic Vision* [15]. Similarly, Ernest Edmonds, a prominent figure in interactive art research, posited that the art experience is inherently interactive, involving the dynamic interplay among the environment, perception, and the audience's generation of meaning [25].

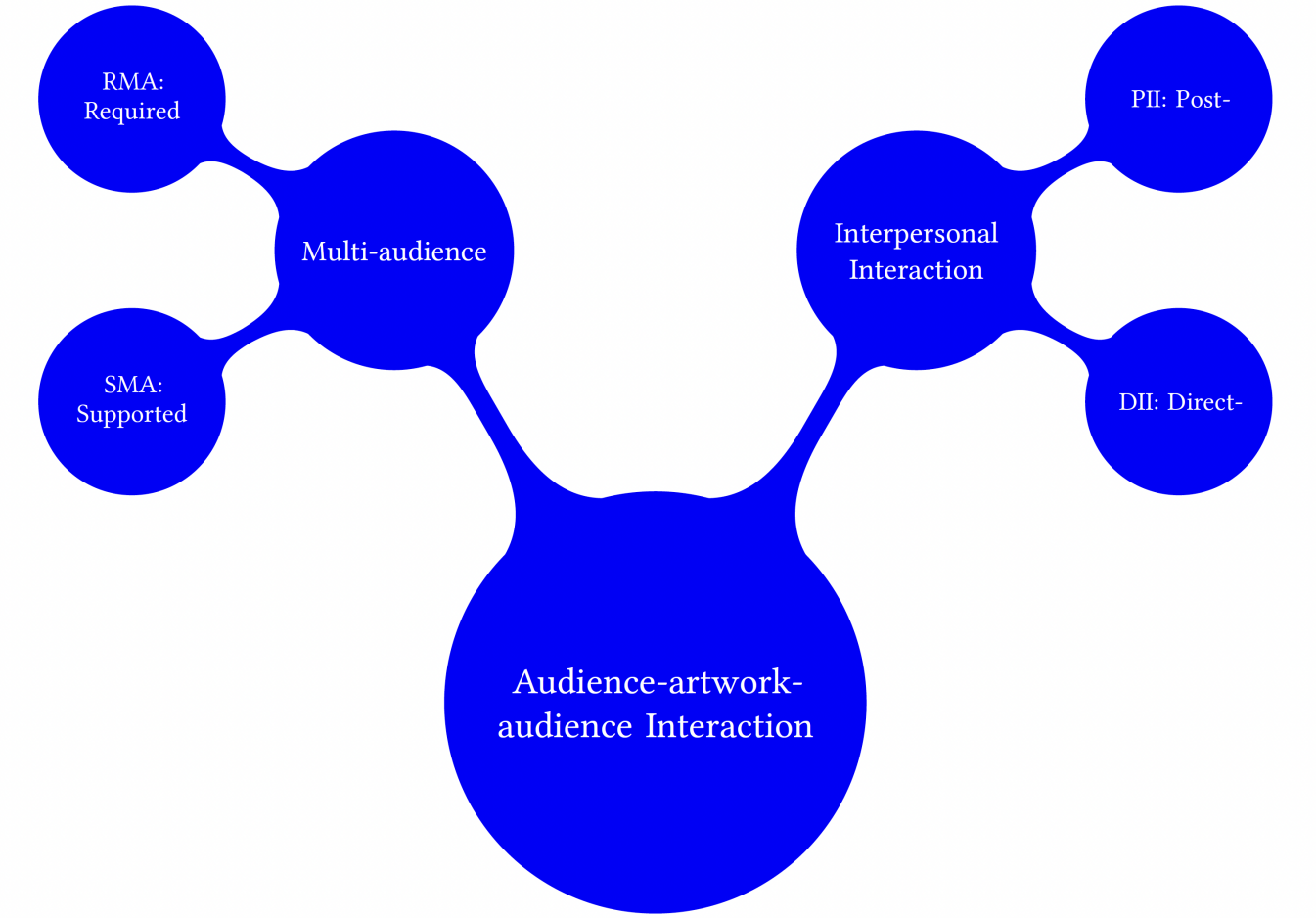


Figure 1: Audience-artwork-audience Interactions: It highlights the social dimensions of the interactive art experience with a focus on how audience members interact with each other through their Sociocultural Body and how the artwork mediates interactions between audience members.

Edmonds subsequently developed various models to categorize interactive art focused on system-oriented perspectives, reflecting this comprehensive understanding. Cornock and Edmonds proposed a framework of static, dynamic-passive, and dynamic-interactive systems [3], which was later extended by Edmonds [9]. Sparacino et al. added classifications such as scripted, responsive, behavioral, learning, and intentional [32]. Trifonova et al. introduced interaction rules, triggering parameters, and content origin as key variables [34], though their model emphasized how artworks respond to input rather than how they shape audience experience. Nardelli added a three-dimensional framework of content provider, processing dynamics, and processing contributors [27], but similarly treated interactive art largely as software systems, often overlooking bi-directional and embodied audience-artwork relationships [31].

Shifting the focus from interactive systems to audeince experience, scholars like Stern critiqued earlier models for neglecting how audience members interact with art, not just how the art is interactive [33]. Edmonds introduced a "critical language" rooted in HCI and experience design [8], and with Costello et al., developed an "embodied experience" model involving response, control, contemplation, belonging, and disengagement [4]. Sommerer and Mignonneau advocated for nonlinear, multilayered interactivity [11], while Dixon proposed a taxonomy with four interaction depths: navigation, participation, conversation, and collaboration [5]. Hannington and Reed added the notions of passive, interactive, and adaptive engagement in multimedia, which informed later frameworks such as V2_'s interaction levels, observational to intercommunication [12, 31].

The V2_ Institute and Ars Electronica have developed descriptive models to categorize interactive art across dimensions such as time flexibility, interaction location, audience size, interaction level, and sensory mode [10]. Kwastek and the Ludwig Boltzmann Institute introduced an action-based framework analyzing what the performer (visitor) and the artwork (project) do, based on Ars Electronica entries and archives [16, 19, 22]. These models are valuable for classifying interaction attributes, but they lack consideration of

embodiment and omit nuanced aspects like sensory modalities and reciprocal audience-artwork dynamics.

4 Audience-artwork-audience Interaction

"Audience-artwork Interaction" is often conceptualized as "Input versus Output" in previous interactive models, particularly those with system-oriented perspectives. Extending on the literature, we position our interest in embodied interaction and highlight the post-phenomenology perspective and technological definitions of embodiment, i.e., the (techno) sociocultural embodiment in interactive art [2]. It aligns with the idea of social computing versus tangible computing in "embodied interaction" by Paul Dourish, returning to interaction's etymological root [3].

This paper re-centers the interpersonal interaction within interactive art and uses the term "audience-artwork-audience interaction" to denote the interpersonal and relational dynamics. This highlights the social dimensions of the interactive art experience beyond the narrowed human-artwork or human-computer interactions, emphasizing the interpersonal interactions among audiences facilitated by or occurring within the artwork. Fig. 1 shows its further division into "multi-audience" and "interpersonal interaction." The "multi-audience" category includes scenarios where the artwork supports multiple audience engagement or requires multiple audience members to function without requiring direct interaction between them. Artworks in the "interpersonal interaction" category foster interaction among audience members and are subdivided into "post-interpersonal interaction" and "direct-interpersonal interaction." "Post-interpersonal interaction" refers to situations where audiences do not directly interact with each other but engage in collective, competitive, or other non-real-time interactions. "Direct-interpersonal interaction," on the other hand, involves real-time interactions among audience members.

5 Ars Electronica Awarded Artworks

Due to its significant authority and longstanding reputation, we choose to review the Prix Ars Electronica archive over the years to establish our research corpus [4]. We prioritize our analysis of audience-audience interaction as a key aspect of the overall interactive experience and select the case studies accordingly. Our definition of Techno Sociocultural body is primarily drawn from Don Ihde's philosophy of bodies in technology. In other contexts, this has been termed "co-located interaction," referring to interactions occurring among two or more co-located audiences [35].

We further divide this interaction into "multi-audience" and "interpersonal interaction." The "multi-audience" category includes scenarios where the artwork supports engagement from multiple audience members without requiring direct interaction between them, or where the artwork necessitates the presence of multiple audience members to function. The "interpersonal interaction" category is subdivided into "post-interpersonal interaction" and "direct-interpersonal interaction." "Post-interpersonal interaction" refers to situations where audiences do not directly interact with each other but engage in collective, competitive, or other non-real-time interactions. "Direct-interpersonal interaction," on the other hand, involves real-time interactions among audience members.



(a) *AHORA* (2013) by Hernán Kerlleñevich & Mene Savasta Alsina. ©Kerlleñevich and Alsina / Courtesy Ars Electronica. Licensed under CC BY-NC-ND 4.0 via Europeana.



(b) *TUNNEL* (2011) by Rejane Cantoni and Leonardo Crescenti. ©Cantoni and Crescenti / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.

Figure 2: Supported Multi-audience (SMA): Artworks supporting multi-user participation and interaction.

5.1 Supported Multi-audience

Many artworks support single and multiple audiences participating simultaneously; those without noticeable differences in interactive experience across these modes are not included in this study. In *AHORA* by Kerllenevich and Alsina, the audience triggers and alters sounds mapped to spatial coordinates through their movement, creating a personal auditory experience. In *TUNNEL* by Cantoni and Crescenti, the arrangement of 92 porticos changes based on the audience's location and body weight. Movement to one side causes the floor to tilt slightly, prompting nearby porticos to rotate and

[2] As interactive art is predominantly technology-mediated, we refer to "techno-sociocultural body" directly as sociocultural embodiment in this discussion.

[3] Georg Simmel was believed first to apply the term "Wechselwirkung," i.e., interaction, to describe interpersonal relationships [20, p.16].

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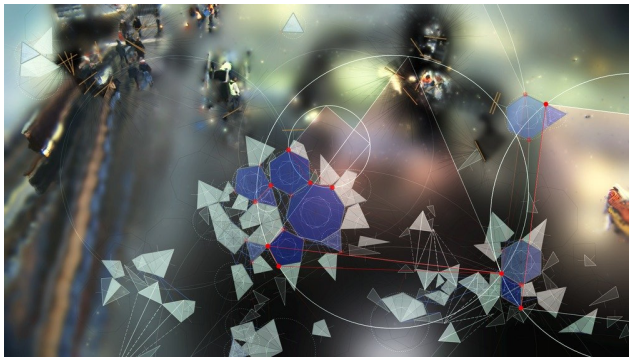
generating waves across the installation, creating dynamic optical effects visible to external observers. *COMPRESSION CRADLE* by Lucy McRae simulates human touch using aerated volumes that gently squeeze the body, mimicking the sensation of being held. *MOBILE CRASH* by Lucas Bambozzi allows participants to trigger audiovisual sequences by pointing to any of the four projection screens.

5.2 Required Multi-audience

This type of artwork requires more than one audience member to function. *PENDULUM CHOIR* by Decosterd and Decosterd features nine a cappella singers on tilting platforms controlled by 18 hydraulic jacks, where the collective vocal expressions and movements are influenced by the platform's tilting. In *INFERNO* by Demers and Vorn, the audience is fitted with robotic exoskeletons, becoming active participants in a performance that explores the dynamics of control and human-machine interaction. *TURNSTILE* by Ursula Damm transforms pedestrian movements into dynamic visual patterns on an LED wall, responding to the flow of people in the traffic station. *AI DJ PROJECT* by Shoya Dozono et al. features a live performance influenced by the audience's movements, analyzed through motion tracking.

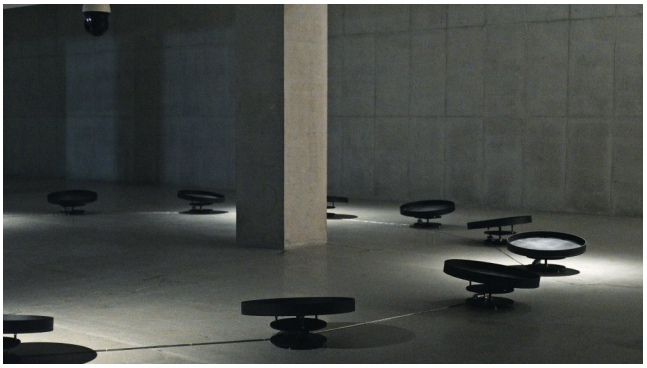


(a) *PENDULUM CHOIR* (2013) by André Decosterd and Michel Decosterd. ©Decosterd and Decosterd / Courtesy Ars Electronica. Licensed under CC BY-NC-ND 4.0 via Europeana.



(b) *TURNSTILE* (2018) by Ursula Damm. ©Ursula Damm / Courtesy Ars Electronica. Licensed under CC BY-NC-ND 4.0 via Europeana.

Figure 3: Required Multi-audience (RMA): Artworks requiring multi-user participation and interaction.



(a) *MIND* (2020) by Shinseung Kimyonghun©Shinseung Kimyonghun / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(b) *VOICE ARRAY* (2013) by Rafael Lozano-Hemmer.©afael Lozano-Hemmer / Courtesy Ars Electronica. Licensed under CC BY-NC-ND 4.0 via Europeana.

Figure 4: Post-Interpersonal Interaction (PII): Artworks facilitating "post" rather than real-time interaction among audience members.

5.3 Post-Interpersonal Interaction

In this category, the artworks facilitate "post" rather than real-time interaction among audience members. *MIND* by artist duo Shinseungback Kimyonghun involves a central rotating camera that captures participants' facial expressions to modulate sea-like sounds from mechanical ocean drums, reflecting the collective emotions of the last 100 visitors. *ECHO* by Pinn and Rossi uses facial capture technology in a booth where participants interact with a virtual mirror, choosing another person's face to hear their life story, as interaction with the previous audience. *VOICE ARRAY* by Rafael Lozano-Hemmer translates participants' voices into unique flashing light patterns. Each new voice recording is shown in the first light of an array, pushing older recordings from the earlier audience down the line. *SPORTS TIME MACHINE* by Ando and Inukai allows runners to race against past performances projected onto a wall.

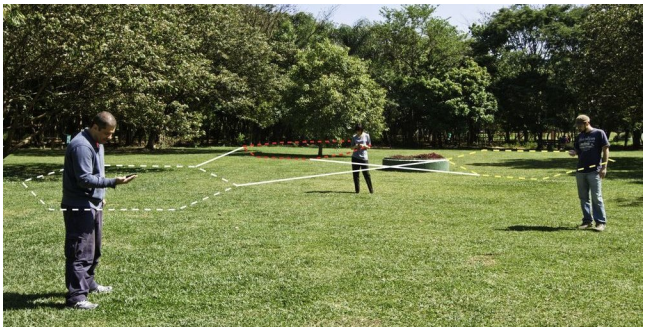


(a) *CROSS COORDINATES (MX-US)* (2012) by Iván Abreu. ©Iván Abreu / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(b) *ISHIN-DEN-SHIN* (2013) by Disney Research Pittsburgh, Olivier Bau, Yuri Suzuki, and Ivan Poupyrev. ©Artists / Courtesy Ars Electronica. Used with permission.

Figure 5: Direct-Interpersonal Interaction (DII) (Duo): Artworks involving real-time interaction among audience members in pairs.



(a) *REDES VESTÍVEIS / WEARABLE NETS* (2010) by Rejane Cantoni and Leonardo Crescenti. ©Cantoni and Crescenti / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.



(b) *BI0FILM.NET: RESIST LIKE BACTERIA* (2022) by Jung Hsu and Natalia Rivera. ©Jung Hsu and Natalia Rivera / Courtesy Ars Electronica. Used with permission from the Ars Electronica Archive.

Figure 6: Direct-Interpersonal Interaction (DII) (Crowd): Artworks involving real-time interaction among audience members in crowds.

5.4 Direct-Interpersonal Interaction

This type of work involves real-time interaction among audience members in pairs or groups. In *SENSITIVE TO PLEASURE*, the audience engages with a naked human within an ambisonic cube, experiencing physical sensations that echo the artist's controversial relationship with the work. In *FUTURE KISS* by Lenka Klimesova, participants wear masks with vibration chips and kiss detectors, seeking connections by finding and kissing their "other half." *CROSS COORDINATES (MX-US)* by Iván Abreu involves participants from the US-Mexico border area in a cooperative game to balance a carpenter's level, with efforts logged as meters, aiming to exceed the length of the border. *ISHIN-DEN-SHIN* by Olivier Bau et al. uses the body to transmit sound, where recorded sounds become audible when touching someone's ear, allowing intimate messages to be shared directly.

BI0FILM.NET: RESIST LIKE BACTERIA by Hsu and Rivera transforms yellow umbrellas into parabolic WiFi antennas, enhancing communication for demonstrators by creating a decentralized network for chatting, file sharing, and storage. *THE KURAMOTO MODEL (1,000 FIREFLIES)* by David Allan Rueter features 1,000 custom bike lights equipped with radio transceivers that synchronize their blinking patterns with nearby devices, fostering a citywide self-organizing system among cyclists. *REDES VESTÍVEIS / WEARABLE NETS* by Claudio Bueno is a collective performance using a virtual elastic net visualized on mobile phones through a geolocalized app. Both works utilize technology to create dynamic, participatory relationships, emphasizing movement and collaboration among physical bodies.

6 Analysis

Alongside the growing interest in artworks with sociocultural body embodiment, more than half of them focus on interpersonal relationships in diverse forms. These artworks' role as an interactive system is fading back, and technology resumes its mediating function; artworks become and act as mediators among the audience members.

6.1 Direct-Interpersonal Interaction (DII)

Some artworks facilitate direct sensation transmission between people, such as tactile sensations in *SENSITIVE TO PLEASURE* and auditory sensations in *ISHIN-DEN-SHIN*. Others visualize interconnectedness, as seen in *THE KURAMOTO MODEL (1,000 FIREFLIES)* and *REDES VESTÍVEIS / WEARABLE NETS*. *FUTURE KISS* uses the act of kissing to identify "the other half," illustrating how these

works bridge interpersonal gaps. Additionally, some pieces connect people across geographical, social, and political divides in challenging scenarios, such as *CROSS COORDINATES (MX-US)*, and *BI0FILM.NET: RESIST LIKE BACTERIA*.

These interactive artworks embody the audience's sociocultural body and foster direct interpersonal interaction, demonstrating an interest beyond mere interactivity and human-machine interactions, but embracing interpersonal interactions. It aligns with the sociological origins of how "interaction;" was invented, calling for an etymological return to relationality of interaction in interactive art.

6.2 Post-Interpersonal Interaction (PII)

When examining artworks with Post-Interpersonal Interaction, the interaction between the audience members goes beyond real-time and on-site engagements. If looking at it from the current participant's perspective, they are interacting with another audience not currently onsite or present, i.e., the post audience; thus, the interaction is real-time. If understanding it from the post audience's perspective, their interaction and participation are passive and maybe even unaware to themselves. Huhtamo suggested several terms, such as "passive interaction," "meta-interaction," and "unaware participant," for similar scenarios [13]; we term it as post-interpersonal interaction (PII) in the study.

In *MIND*, only the last 100 participants' facial expressions are collectively used to control the mechanical "drums" and sounds; when the audience member joins in, they push out the previous participants out of the sequence. Similarly, when *VOICE ARRAY* translates participants' voices into light patterns, the new voice recording of the current participant pushes older recordings from the earlier audience down the line. While in *SPORTS TIME MACHINE* and *ECHO*, the current audience interacts with the previous recorded ones. These artworks extend the sociocultural embodiment and interpersonal dynamics beyond the real-time and physical presence, opening new possibilities for interactive experiences.

7 Discussion

The analysis corroborates our earlier statements on shifting interest within interactive art from audience-artwork interactions towards audience-artwork-audience interactions, i.e., artwork-mediated interpersonal interactions. In the broader scope of contemporary art, the fascination with the relationship between audience and artwork and interpersonal ones is not exclusive to interactive art. Claire Bishop looks at audience participation from the social dimension in her book *Participation* [1]; according to Bishop, participation represents a social mode of audience engagement and is distinct from interactivity, which involves direct human-artwork connections. However, as Christiane Paul points out, Bishop is ignorant of new media and interactive art, although she applies similar terminology as interactive art [28]. Similarly, Nicolas Bourriaud introduces the concept of "relational aesthetic" to highlight the significance of interpersonal relations in contemporary art within its social contexts [2]. Fig. 7 shows this shift from emphasizing techno phenomenal body and human-artwork interactions to sociocultural body and interpersonal interactions could be characterized as a transition from interactivity to interpersonality and eventually relationality.

This observed pattern or shift of paradigm aligns with the evolving idea of interactive art at the Prix Ars Electronica. When commenting on *PENDULUM CHOIR* by *Cod.Act* et. al, the Golden Nica award in the interactive art category in 2013, the jury stated that "...interactivity should no longer be defined by a specific formal language prescribed by the vocabulary of the 1990s. Today, it is a set of strategies that can be situated in multiple contexts, within the art world and outside of it [23, P.156]. This also aligns with the fact that Ars Electronica renamed the Interactive Art category to "Interactive Art +" to include a broader range of artworks in 2016. The jury stated that "the language of interaction in the realm of art has matured to the extent that it can now occupy spaces outside the artists' laboratory and beyond the confines of the screen", and "in the hyper-connected era, interaction is the most pervasive medium that allows art to create a dialogue with every form of human activity" [17].

We share the opinion of those jury members at the Prix Ars Electronica, and regard the expanding, yet increasingly undefined, scope of interactive art as a sign of its maturity rather than a crisis. Just as "digital" is no longer a necessary adjective in front of "media art," the term "interactive" as human-machine or technology-mediated interaction could also fade into the background. Interaction should not only be constrained within the dualism of human versus artwork but can be widely expanded to include interpersonal interaction, returning to its etymological and sociological origins.

8 Conclusion

This paper investigates interactive art through the lens of sociocultural embodiment and interpersonal interaction, offering a shift in focus from interactivity to relationality. First, it contextualizes interaction and embodied experiences within the sociocultural domain through engaging with post-phenomenology and HCI research. Then, drawing on post-phenomenological and social computing perspectives, it introduced the concept of audience-artwork-audience interaction as a framework for examining interpersonal engagement within interactive art experiences. Through a curated analysis of Ars Electronica award-winning works, the study categorized various modes of multi-audience and interpersonal interaction. These findings were further analyzed to reveal a shifting paradigm in interactive art from system-oriented interactivity toward socially situated relationality, culminating in a broader discussion on future directions and implications for interactive art.

This study suggests that interactive art should move beyond binary notions of interactivity to embrace a more expansive view of relationality centered on interpersonal dynamics through sociocultural embodiment. Rather than treating the audience as isolated agents interfacing with a system, future practices should recognize the role of interactive artworks as mediators of interpersonal, social, and cultural exchange. Future directions should build on this insight to further engage relationality. We look forward to future developments of this work to (1) further emphasize the social dimension of interactive art to bridge with broader contemporary art explorations; and (2) to expand the relationality to engage with nonhuman entities and interspecific interactions.

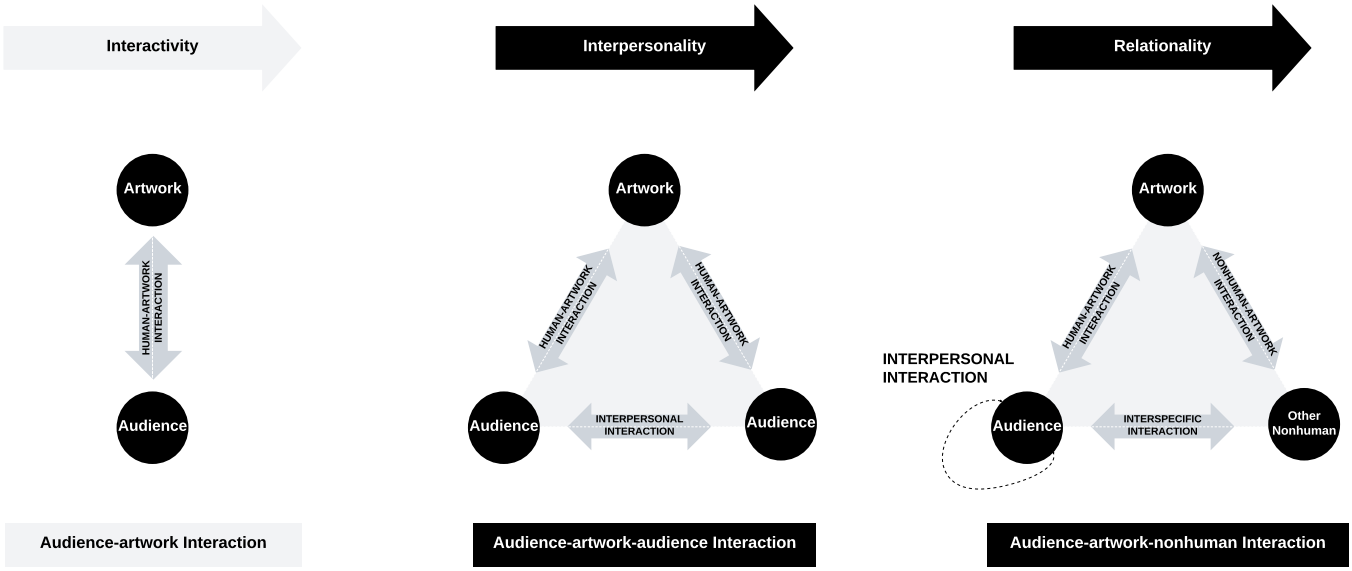


Figure 7: Interactivity vs. Interpersonality vs. Relationality (new triangle) ©Aven-Le Zhou.

9 Limitation and Future Work

While the current work's focus on interpersonality represents a shift away from traditional human-machine interaction, it still largely centers on the individual's engagement with the artwork or other participants. This limitation reflects the ongoing challenge of positioning interactive art as interpersonal and a medium for engaging with larger social and political contexts. The integration of broader social engagements, where the artwork serves as a tool, container, and platform for connecting individuals to societal structures, power dynamics, and collective action, remains largely unexplored. The next steps for this work should aim to explore further how interactive art can facilitate conversations around societal or ecological issues through broader systemic engagement, enabling more collective and politically engaged interactions.

On the other hand, the artworks in the selected corpus and the analytic perspective of this study are largely anthropocentric. The concept of interspecific interaction, which explores the role of non-human agents such as animals, machines, and ecological systems, remains an area for future exploration. The introduction of audience-artwork-audience interaction within this chapter has opened the potential for non-anthropocentric perspectives in interactive art; Fig. 7 shows the evolving paradigm from interpersonal interaction between audience members to interspecific interaction between human and nonhuman entities.

Future work should consider how interactive art can incorporate non-human agents into the interaction process, whether by including environmental elements, animals, or non-human technologies. Such explorations could open new dimensions of meaning-making, creating richer and more complex dialogues between human and non-human participants within or mediated by the interactive artwork.

Acknowledgments

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Glitch Art based on Digital Games

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Abstract

We are exploring glitch art, which is based on the destructive manipulation of data. In this research, we propose a fusion of glitch art and digital games, with the goal of making the process of creating glitch art enjoyable as if it were a game. Specifically, we will make it possible to create glitch art using digital images through fighting and shooting games. While the goals of these digital games and glitch art are entirely different, both share the commonality of involving destructive manipulation or actions. This research sublimates the destructive act of meaningless data in the process of creating glitch art into gameplay, and also sublimates the monotonous attacking gameplay into art creation. It is a unique attempt to seamlessly combine art and games. In this research, we have also developed a prototype system. Specifically, we have implemented a simple fighting game using Unity and a glitch art generation program using Processing. By linking them, we have developed a prototype system that generates glitch art in PNG format images. In this prototype system, a strike in the fighting game is used as a trigger to perform destructive operations on the target image data, generating glitches. Although the prototype system is merely a simple implementation, the glitch art generation program has been implemented as an independent module, and can be reused in future implementations of shooting games.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Glitch art, Digital games, Fighting game, Shooting game

ACM Reference Format:
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1 Introduction

Glitch art is art that uses errors (glitches) in images, videos, and sounds that are intentionally created by destroying digital data or physically manipulating electronic devices. This type of glitch art was born with the emergence of new media. It began with works that used glitches in televisions and video games, and gradually developed into a musical genre called glitch music. Glitch art, which expresses unpredictable beauty, has a charm that is not found in the beauty of pre-determined harmony. It is thought to be the reason why it attracts so many people. Glitch art pursues beauty that emerges by deliberately disrupting harmonious beauty. This brings about a different perspective from classical art, which seeks harmonious beauty.

We are exploring the methods and effects of creating glitch art. In this research, we propose a fusion of glitch art and digital games, with the goal of making the process of creating glitch art enjoyable in a game-like way. Specifically, we will make it possible to create glitch art using digital images through fighting games and shooting games. While the goals of these digital games and glitch art are entirely different, both share the commonality of involving destructive manipulation or actions. This research sublimates the destructive act of meaningless data in the process of creating glitch art into gameplay, and also sublimates the monotonous attacking gameplay into art creation. It is a unique attempt to seamlessly combine art and games.

In this research, we have also developed a prototype system. Specifically, we have implemented a simple fighting game using the Unity [1] game development environment and a glitch art generation program using the Processing language [2], and by linking them, we have developed a prototype system that generates glitch art as PNG (Portable Network Graphics) [3] format images. In this prototype system, a strike in the fighting game is used as a trigger to perform destructive operations on the target image data, generating glitches. Although the prototype system is merely a simple implementation, the glitch art generation program has been implemented as an independent module, and can be reused in future implementations of shooting games.

This paper is structured as follows: Section 2 describes glitch art as the background of this research. Based on that, Section 3 describes the goal and basic approach of this research. Section 4 describes the experiments conducted in this research and a discussion of their results, and Section 5 describes related research. Finally, Section 6 concludes this paper.

2 Research Background

2.1 Glitch Art

A glitch is an error (problem) in images, videos, and sounds that occurs when digital data is destroyed or a television or game console malfunctions. The beauty of glitches has a charm not found in the beauty of pre-established harmony. Over the years, pioneers have used glitches in art, leading to their adoption as glitch art. One of the pioneering works of glitch art is Nam June Paik's "Magnet TV," a work in which the distortion of a television image is changed by moving a powerful magnet placed on top of the television [4]. The video work "Digital TV Dinner," created by Jamie Fenton and



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Figure 1: An Example of Glitch Art

Raoul Zaritsky in 1978, is a video record of glitches created by manipulating the Bally Astrocade, a video game console made by Bally Manufacturing [5].

Glitch art is no longer limited to works that use glitches from televisions and video games; it has developed into a music genre called glitch music. The German electronic music group OVAL [6] is considered to be the pioneer of glitch music, and a music festival named after GLITCH [7] has been held annually since 2014.

Theoretical research has also been conducted on glitch art. Rosa Menkman has proposed using information theory to understand glitch art as a specific genre of contemporary art [8]. In 2010, Rosa Menkman and others organized the international conference GLI.T/CH on glitch [9]. Research on glitch art has also been presented at the international conference Evomusart, which has been held annually since 2011 [10].

There are many tutorials available online on how to create glitch art [11, 12]. Michael Betancourt categorizes the techniques used to create glitch art as follows [13]:

- Data Manipulation: Modify file data and create glitches
- Misalignment: Opening a file from one application in another application
- Hardware Failure: Causes a malfunction in the machine, generating sound or images
- Misregistration: Physical noise of analog media
- Distortion: Creating physical distortion using magnets, etc.

It is important to note that these techniques do not always work effectively. For example, when data is destroyed through data manipulation, the result may or may not be a glitch. There is no doubt that this unpredictability is what makes glitch art so appealing, but the glitches in glitch art are necessarily limited to those that can be perceived by human sensory organs, such as sight and hearing.

Figure 1 is an example of glitch art in PNG format. The image on the left is the original image, and the image on the right is the glitch art image. This glitch art was created in our previous research [14]. Specifically, it was created by converting a PNG image into a RAW (Raw Image Format) [15] image, loading it into the audio processing software Audacity [16], and then performing audio processing. However, this kind of glitch art is, so to speak, the result of trial and error. By repeating experiments and gaining knowledge, it is possible to predict to some extent the glitch art that will be obtained in advance, but fundamentally, it is difficult to predict in advance what to do, how to do it, and where and what kind of glitch will appear as a result of that action. While this is one of the attractions of glitch art, it often results in the worst-case scenario (the image is not displayed), and it often feels more like a treasure hunt than the act of creating a work of art.

In previous research, we have focused on methods for creating glitch art [14, 17]. In the study in reference [14], glitch art was created by applying audio processing to images, and in the study

in reference [17], glitch sound was created by applying image processing to music files. These examples aimed to eliminate ad hoc methods for creating glitch art and to develop unified and meaningful methods for creating it. However, applying audio processing to images or image processing to music files is not necessarily meaningful.

2.2 Digital Games: Fighting Game and Shooting Game

Fighting games and shooting games are both classified as action games in the broad sense, and in both games, the outcome is decided by attacking and defeating an opponent (whether human or not). The difference between the two is that fighting games primarily use martial arts techniques as a means of attack and are generally one-on-one battles. In contrast, shooting games primarily use missiles and laser beams as means of attack and often involve one-on-many opponents.

However, even in fighting games, there are few games in which the only means of attack are pure martial arts techniques, and many games have attack methods such as projectiles and light beams. While the goals of such fighting action games and glitch art are entirely different, both share the commonality of involving destructive manipulation or actions.

These types of competitive action games are often criticized for being violent and aggressive, and for having a negative influence on young people. In fact, a study by Anderson et al. [18] showed results that support this claim. However, comprehensive research on this issue has been conducted by Przybylski et al. [19, 20]. These studies concluded that there is no significant correlation between the violence and aggressiveness of the games and the violent and aggressive behavior of young people who play them. Nevertheless, these games are often not considered intellectual, as they involve repeatedly pressing buttons on a controller. Furthermore, as long as these types of games have no objective other than attacking enemies, opinions on them are likely to remain divided.

2.3 Issue

As mentioned above, the production techniques for glitch art can be broadly divided into five categories, but in none of them does the act of creation itself have any special meaning. In other words, the only purpose is to create beauty, and the act itself has no other meaning. Moreover, it is not even certain that beauty will emerge as a result.

For example, when creating glitch art using a PNG image like the one in Figure 1, it is impossible to know in advance what kind of glitch will appear if you change the image data in some way. In fact, if you do it poorly, the image itself may not be displayed at all.

On the other hand, the same can be said about fighting games and shooters. Pressing buttons to unleash techniques and light beams can be a monotonous task.

By combining the two, we can avoid this situation. In other words, by creating art as if enjoying a game, and by linking the creation of artwork to gameplay, we can change the monotony of gameplay, where the only objective is to win the game. This is the starting point of this research.

3 Research Goals and Basic Approaches

3.1 Research Goals

The goal of this research is to fuse glitch art with digital games. This will achieve the following:

- Sublimating the destructiveness of meaningless data into gameplay
- Sublimating monotonous attacking gameplay into art

In other words, this research aims not only to make the process of art-making enjoyable, but also to ensure that digital games do not end up being merely monotonous gameplay.

3.2 Basic Approaches

The basic principles of this research are as follows:

- The target art is a digital image (PNG format).
- The digital games used are fighting games and shooting games.
- The data is actually destroyed by gameplay.
- The glitch art is displayed in real time.
- The game elements are preserved.

First, the target of this research is to turn digital images into glitch art. The digital games used will be fighting and shooting games. The most important point is that the digital data is actually destroyed by playing the game. This means that glitches are not simulated. Another important point is that the production process of glitch art must be able to be displayed in real time. This is because it is uncommon for the production of glitch art using digital images to be able to display the state of the production process in real time. Furthermore, game elements, such as winning or losing in a game and the points gained, will be retained. We will not aim for a technique that is so focused solely on the production of glitch art that it cannot be enjoyed as a game.

There is a reason why we decided to use PNG format for the digital images we are targeting. Before we explain that, let us first list the features of PNG.

- File format that compresses and records image data
- Compressible without degradation
- Compression encoding of bitmap images
- Lossless compression and decompression
- Pre-filtering to improve compression efficiency by using image characteristics

Among the features of PNG, we focused on filter processing. PNG has the following five filter processes:

- None: Do nothing
- Sub: Subtracts the byte to the left
- Up: Differentiate from the byte directly above
- Average: Differes from the average of the bytes directly above and to the left
- Paeth: Calculates the Paeth value from the left neighbor, directly above, and above the left byte, and subtracts the difference

In this way, PNG filtering processes data in a regular manner. We chose digital images in PNG format because we thought that if we manipulate glitches while taking this filtering process into account, we might be able to realize glitches with regularity that

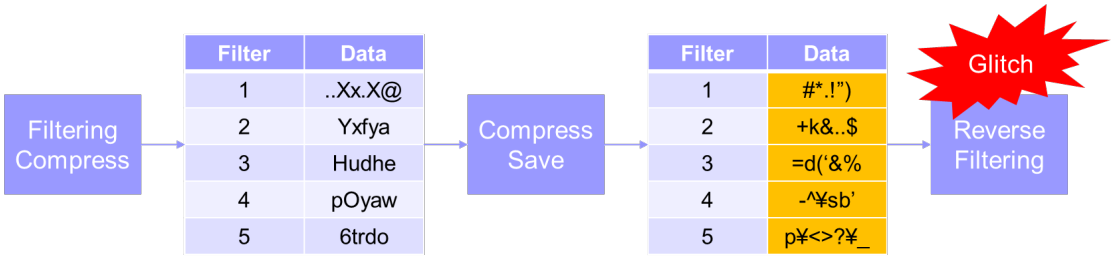


Figure 2: Basic Mechanism of Glitch

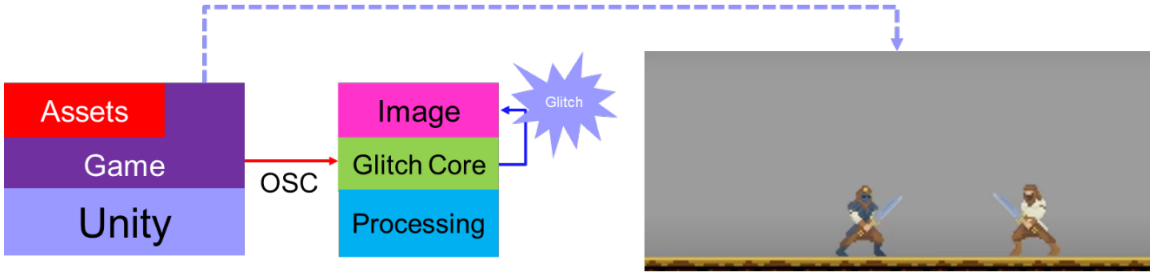


Figure 3: Prototype Implementation

correspond to the processing of each filter. Figure 2 shows the basic mechanism of glitch manipulation in this research.

In this research, we adopt a technique that generates glitches when displaying PNG images. This is based on the basic mechanism of PNG. Before ZIP compression processing, PNG uses the characteristics of the image to perform a filter process that improves compression efficiency. The process is as described above. Then, when displaying the PNG image, the inverse process (inverse filtering) corresponding to each filter is performed.

There is one thing that must be taken care of when creating glitches in PNG images. That is, to avoid destroying the PNG format. In other words, randomly destroying a PNG file will result in the image itself being completely undisplayable. For this reason, in this research, we read the PNG image, apply simple compression to only the data portion without destroying the format, and then save it again. The key to this is skipping the filtering process. This causes glitches to occur when inverse filtering is performed. Despite skipping the filtering process, glitches are still generated by performing the inverse filtering process. In other words, the glitch art in this research is based on the data manipulation and misalignment described in Section 2.1.

The glitch mechanism that focuses on the above PNG filtering process makes it possible to create glitches with regularity, as shown below.

- Sub filter action: causes horizontal glitching
- Up filter action: causes vertical glitching
- Average filter action: causes diagonal glitching
- Paeth filter action: causes complex glitches

We will associate these glitch operations with gameplay. The basic idea is to perform destructive operations on data when an attack is received in the game. There are some points that need to be considered, but we will discuss these later as a future topic.

4 Prototype Implementation and Discussion

4.1 Prototype Implementation

We are currently investigating the functions and mechanisms of a fighting game for creating glitch art, and are designing a prototype system and experimentally implementing it.

The software configuration of the prototype system is shown in Figure 3. The game portion uses Unity, but the glitch art portion is a unique module implemented in Processing. This was done to keep in mind the flexibility and reusability of the system by separating and making the glitch art portion independent. It is possible to implement the logic related to glitch art in Unity, but since it is possible to use a game environment other than Unity, we have chosen to implement it using Processing. We use OSC (Open Sound Control) [21] for communication between Unity and Processing. OSC is an easy-to-use communication protocol, and we chose it for the prototype because we prioritized simple implementation.

Figure 4 shows the prototype system currently being implemented. The image of the woman is a PNG file, prepared solely for the purpose of the experiment. The prototype system implements a simple mechanism that reflects the gameplay of the fighting game on this image, turning it into glitch art in real time.

Figure 5, 6, 7, 8 show examples of glitch art created by the prototype system. All four examples are created based on attacks from fighting games. Specifically, glitch art like that shown in Figure 5, 6, 7, 8 are created by applying special operations to the filter processing of PNG images based on attacks inflicted by the game player on the enemy, causing glitches. Specifically, we see a vertical glitch in Figure 5 because it is based on the Up filter of the PNG process. Similarly, a horizontal glitch in Figure 6 based on the Sub filter, a diagonal glitch in Figure 7 based on the Average filter, and a complex glitch based on Figure 8. Note that attacks in gameplay are

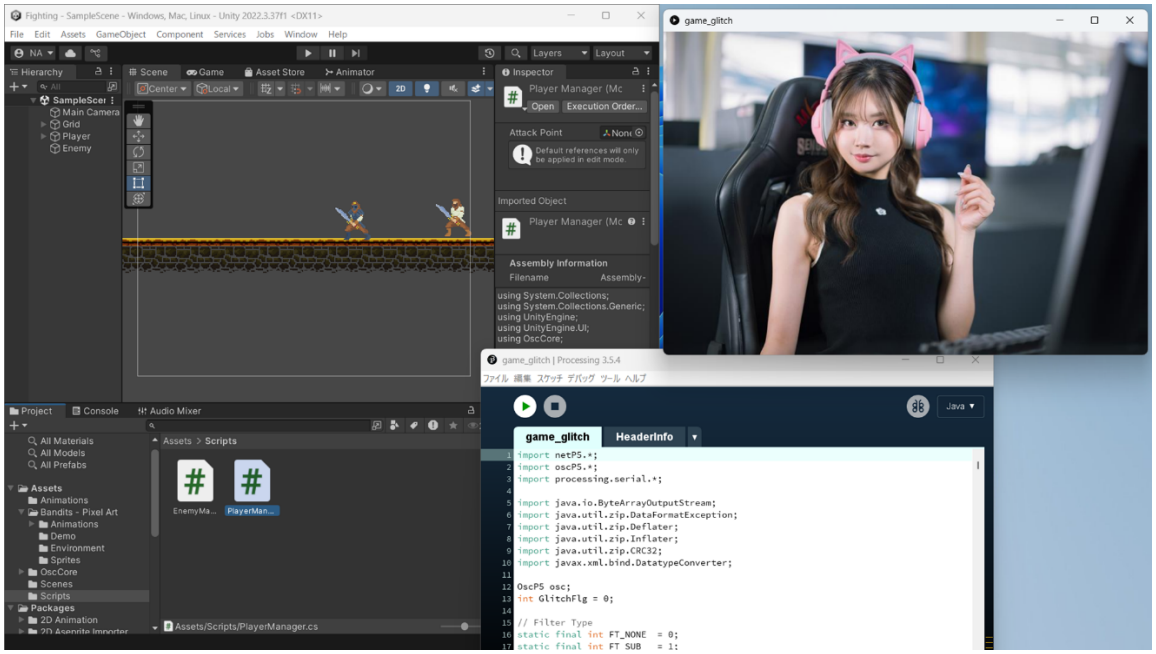


Figure 4: Capture Image of Prototype Implementation

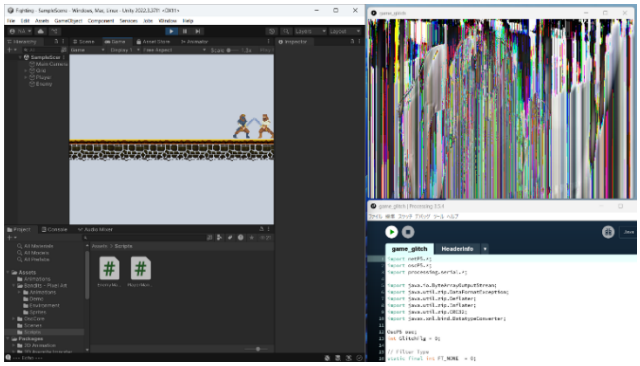


Figure 5: Glitch Art based on Up Filtering

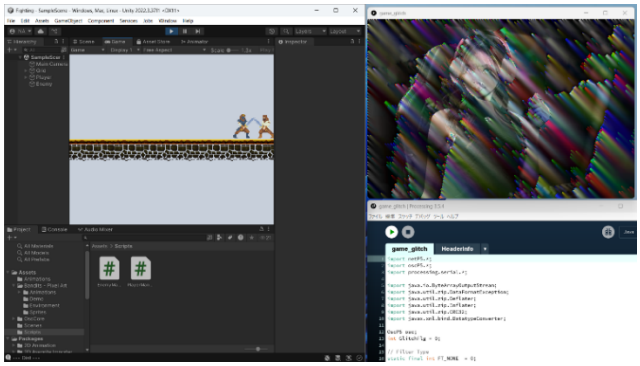


Figure 7: Glitch Art based on Average Filtering

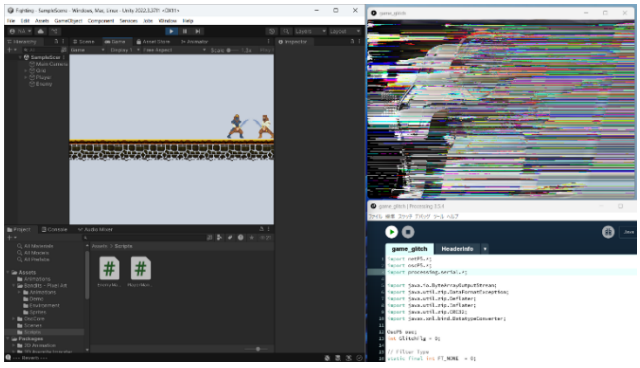


Figure 6: Glitch Art based on Sub Filtering

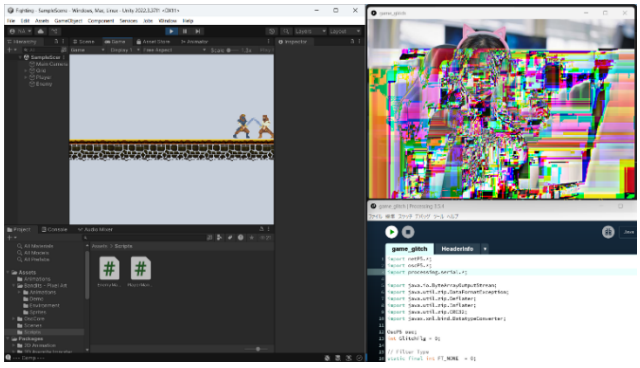


Figure 8: Glitch Art based on Paeth Filtering

detected as simple slashing attacks, and if a hit occurs, a random number is generated, and the glitch art created changes depending on the value of the random number.

4.2 Discussion

Glitches are closely related to digital games, and glitches have been found in many digital games to date. However, in the field of digital games, a glitch is any technique that deliberately takes advantage of a software defect (bug) to gain an advantage in the game. If you happen to encounter a bug while playing a game, it is not called a glitch. Also, a term similar to a glitch is cheating. Cheating involves using an external tool to tamper with game data, causing behavior that cannot be reproduced through legitimate play, and is considered to be cheating.

The glitches and cheats in digital games and the glitch art in this research have different purposes and methods. However, cheating techniques and external tools may be useful for this research, and we are considering conducting a more detailed investigation of them in the future [22]. This research takes the stance of using digital games as a tool for creating glitch art, and we will not consider creating glitches in the games themselves. This is because glitches in the game itself could interfere with gameplay and ruin the enjoyment of the game.

- Matching gameplay and glitch controls
- Attack type: Glitch type (select Sub/Up/Average/Paeth filtering depending on the type of attack)
- Attack strength: Glitch degree/range (Change the degree and range of the glitch depending on the strength of the attack)
- Attack location: Glitch part/range (change part and range of the glitch depending on the part of the attack)
- Glitch control
- Complete control of glitches (full control over the type, degree, range, and part of glitches): pre-established beauty

First, it is necessary to match gameplay with glitch operations. There are many different types of attacks in fighting games and shooters, so how do you match them with glitch operations? The damage dealt by the same attack varies depending on its strength and the location of the attack (such as which part of the opponent it hits).

Another important point is how to control the glitch. In the experimental implementation of the prototype, the glitch operation was applied to the entire original image. But this is too simple and uninteresting, and there are problems with the finished product and the appeal as an artistic work. It is desirable to generate glitches according to the part of the image that is hit by the attack. But this is not so easy, and complete control of the glitches may result in losing the essence of glitch art, which is unpredictable beauty.

There is also room for consideration in classifying glitches with a view to games. The current prototype implementation performs glitch operations on a single image. But in a competitive game, it is thought that preparing two images and performing glitch operations on the opponent's image for each attack would have a higher affinity with the game. If gameplay is considered a collaborative artistic production, then the current prototype implementation can also be considered a meaningful method.

5 Related Work

As mentioned in Section 4.2, there is a strong relationship between glitches and digital games, but the focus has been on creating glitches in the game itself and using these in gameplay. This research does not create glitches in the digital game itself, but rather creates glitches in images separate from the game through gameplay, and so has a completely different purpose and perspective.

It is fair to say that glitch is already recognized as a form of artistic expression. Some artists have published comprehensive works using glitches in PNG, which were also used as a reference in this research [23]. There is also a technique called datamoshing, which creates errors when playing videos, and research is being conducted into its effects and techniques [24]. A glitch installation work using live coding [25] has also been created. This work is very interesting as it includes glitches made by physical devices as well as sounds and images. There are also attempts to combine contemporary dance with glitch art [26]. They have proposed a method of creating glitch art that uses errors (glitches) in sensors that capture dance motion in mixed reality images.

In the previous research, we proposed a method for creating glitch art based on audio processing operations [14], a method for creating glitch sound based on image processing operations [17], and a live coding system for creating glitch art [27]. Our research on glitch art based on audio processing [14] involves loading image files into audio processing software and applying audio processing to the image data. Specifically, we apply audio processing such as echo, reverb, fade-in, and fade-out to the image data to create glitches in the image. This is one of our solutions to the glitch art production method, which is based on the random destructive actions of data, but applying audio processing to image data is not necessarily meaningful. Our research on glitch sound, based on image processing [17], involves loading music files into image processing software and applying image processing to the music data. Specifically, we apply image processing such as cut-and-paste and gradients to the music data to create glitches in the music. At first glance, this may seem like a completely opposite approach, but it is the same as our research on glitch art based on audio processing [14] in that it is based on our negative stance against the random, destructive actions of data.

Research into live coding systems for creating glitch art [27] uses Sonic Pi [28], a music-based live coding system, to create glitch art triggered by musical performance. This research has many similarities to the present study, which uses attacks from fighting games as triggers. In fact, the objects of the glitch art are set to PNG format images, and the same algorithms are used to create the glitch art. However, it must be said that it is difficult to relate musical performance to the creation of glitches. Specifically, glitch art is created using sound effects such as echo and reverb from live coding as triggers, but there is no need to use sound effects as triggers for creating glitch art.

The essential difference between this research and those studies is the interactive meaning attached to glitch creation and gameplay. In other words, because glitch creation and gameplay are two sides of the same coin, they are meaningful from both perspectives. Playing a game is both the act of playing the game and the act of creating glitch art, and the act of creating glitch art is also the act of playing

the game (gameplay). There is no meaningless action here, such as applying audio processing to an image, as is the case with glitch art based on audio processing. Furthermore, from the perspective of games, this research is also highly significant. In other words, playing a game, which was previously seen as violent, aggressive, and harmful, can now also be an act of artmaking, resulting in the creation of beautiful artwork. This completely changes how we view and evaluate competitive action games.

Most research and production related to glitch art focuses only on the creation of glitch art. This research aims to make the otherwise boring process of creating glitch art enjoyable as if it were a game, and to elevate the monotonous gameplay into the creation of art. In this respect, this research is different from previous related research and production.

6 Conclusion

In this research, we aimed to make the process of creating glitch art enjoyable in a game-like way, so we proposed a fusion of glitch art and games and experimentally implemented a prototype system. Specifically, we made it possible to create glitch art by performing destructive operations on a target PNG image using an attacking play in a fighting game as a trigger. This research has just begun, and we have the following planned future developments:

- Matching gameplay and glitch operations (type, degree, and part of attacks: effect and range of glitches)
- Creating glitch art using shooting games
- Subject evaluation of the developed system

The first challenge is how to generate localized glitches that correspond to attacking plays. In the prototype implementation, glitch operations are performed on the entire image with a single attack, but this is too simple an implementation, and we are considering improving it. What is desired is to generate localized glitches according to the type, strength, and range of the attack. To achieve this, we need to get into the details of the game. Close cooperation between the game and glitch art production is required, including determining the type of attack and matching the location of the attack with the degree of the glitch. Although this appears to be quite difficult to solve, it is an issue that we definitely want to overcome when developing a tool for creating glitch art. Generating localized glitches means that multiple glitches are scattered in one image, which is thought to lead to more interesting glitch art. We would also like to attempt creating glitch art using shooting games. Even though they are both fighting games, the gameplay of fighting games, which primarily feature one-on-one battles, and shooting games, which primarily feature one-on-many battles, is naturally different. For that reason, we expect that it will be possible to create glitch art that is different from that of fighting game glitch art. Finally, we would like to have subjects evaluate the system we have developed.

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Experimental Machinimas: Avant-Garde and Hacktivism

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Abstract

Machinima, or the form of 3D game-based filmmaking, has evolved over the last thirty years from an amateur activity within the enclosed community of hard-core gamers into a novel experimental film genre. Contrary to early machinima "fan mods" that were replicating the traditional narrative style of video games, the contemporary artists' or experimental machinimas subvert the normative gameplay through diverse hacking and editing techniques. Following the technocritical lineage of early avant-garde and experimental cinema of the 1960s and onwards, experimental machinima makers challenge the dominant technocapitalist paradigm by exposing the glitches in its seamlessly optimal technological apparatus.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Information systems** → Information systems applications; Multimedia information systems; Information systems applications; Multimedia information systems; Multimedia content creation; Information systems applications; Collaborative and social computing systems and tools; Asynchronous editors.

Keywords

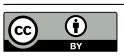
Machinima, Experimental Film, Hacktivism

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1 Introduction

Portmanteau of "machine" and "cinema", machinima is commonly defined as the art of making "animated films within a real-time virtual 3D environment" [9], and has been hailed as a new audiovisual, "hybrid" form which aspires to "become a medium itself" [12]. Since its development and proliferation from the early hacker and gamer scene in the mid-1990s to the mass-produced genre which it is today, a number of books have been dedicated to this new art form, primarily focused on its oral history and production techniques. Furthermore, as Eli Horwatt notices, these studies have been centered around the analysis of narrative machinimas, with little to no consideration of their experimental and non-narrative forms [3]. This, however, shouldn't come as a surprise, given that the first machinimas were almost exclusively fan-based amateur works made as an insider-joke within the enclosed circle of hard-core gamers [7]. To this should be added the fact that the visual language of computer gamers was largely based on the "cinematic grammar of Hollywood", as highlighted already in 2001 by Lev Manovich: "The area of computer culture where cinematic interface is being transformed into a cultural interface most aggressively is computer gamers. By the 1990s, game designers have moved from two to three dimensions and have begun to incorporate cinematic language in an increasingly systematic fashion. […] Regardless of game's genre – action/adventure, fighting, flight simulator, first-person action, racing or simulation — they came to rely on cinematography techniques borrowed from traditional cinema, including the expressive use of camera angles and depth of field, and dramatic lighting of 3D computer generated sets to create mood and atmosphere" [8]. This traditional cinematic style was hence incorporated by gamers-amateur filmmakers whose films only created new stories within the same visual regime of the computer game. The practice spread in the 2000s, namely with the introduction of the record button in the famous game franchise *The Sims 2*, which made it easy for anyone with a basic video editor to customize sets and characters. Given that the game was popular within the female gamer community, new machinima genres emerged such as romance and drama [5], again, following the script of traditional narrative filmmaking.

In parallel to the history of machinima "fan mods" created by the gaming community, there is a history of machinima "art mods" made primarily by artists, which has largely been left off the radar of machinima specialists in new media and digital arts studies [12]. Among the few who tackled the artists' machinimas was Eli Horwatt, who aligned their non-narrative, abstract and collage aesthetic, DIY ethics and political approach with the history of radical video art and avant-garde film movements [3]. Much like cheap Super 8 and video cameras allowed outsider filmmakers and artivists to critically engage with mainstream cinema and television, Horwatt claims that the introduction of affordable PCs had the same democratizing effect, positing machinimas as an example of "grass-roots media resistance movement". He proceeds then to the categorization and description of genres which engage critically with the politics and the ideology of video game culture: "avant-garde machinima" made by acclaimed experimental filmmakers such as Peggy Ahwesh and Phil Solomon; "outsider experimental machinima" made by gamers, programmers, hackers that combine fictional and experimental film forms, "political machinima" (usually left-wing) and "machinima documentary", which usually incorporates the style of a mockumentary. Horwatt's article presented in this sense a valuable foundation for further study into the relations between machinimas and a wider history of critical art forms.



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This technocritical and subversive aspect of machinimas was further explored by film programmers and researchers Dmitry Frolov and Vladimir Nadein. In 2023 they curated a Theme programme within the 69th International Short Film Festival in Oberhausen titled *Against Gravity. The Art of Machinima.* The programme gathered 35 films divided into six sections, giving an important historical overview of diverse machinima practices spanning over three decades. In their curatorial statement they follow Horwatt's reasoning claiming that "it is interesting to think of the early machinima makers as avant-garde artists who developed new visual language and esthetic codes", describing machinimas furthermore as "contemporary art practice which can be diverse and pursue different goals, but remains experimental by its nature" [2]. Focusing mainly on their counter-cultural properties, Frolov and Nadein consider contemporary experimental machinimas as successors of net art and glitch art practices, referencing the gaming hacks of Cory Arcangel and JODI from the late 1990s as some of the earliest forms of experimental machinimas. Early machinima "fan mods" and more classical, narrative gameplays were not included in the programme as, per the curators, they have lost relevance and originality with their mass proliferation on video hosting platforms (namely, playthroughs accompanied by players' voiceover).

Although contemporary experimental filmmakers are increasingly engaging with the visual language and political dimensions of video games – as exemplified by the significant number of works made over the past decade in the Oberhausen Theme programme – scholarly interest in machinima has experienced a pronounced decline since its initial proliferation during the early 2000s. This has left an important research gap during the years of the unprecedented technological and cultural shift towards a digital paradigm, a turning point which also saw the gaming industry overtaking the market size and revenue of the film industry [11]. Amid abundant visual stimuli in the contemporary digital media landscape, more and more filmmakers have turned to recycling practices instead of producing their own images, reviving the tradition of experimental *found footage* films. They have appropriated images that circulate on the internet and on social networks to critically examine their political, ethical, and aesthetic implications. Soon new genres of digital filmmaking emerged, notably *desktop films*, which use screen capture technology to record the artist's activities on the computer screen. Accordingly, machinimas may be seen as a hybrid genre that synthesizes the methodology of found footage (via appropriation of video game imagery) and desktop filmmaking (via screen capture of gameplay).

In the following section I will propose a theoretical framework for analyzing contemporary experimental machinimas, situating them within their historical lineage linked to avant-garde cinema and hacker (counter-)culture. The analysis will be supported by practical examples, with a particular focus on recent works by the Austrian art collective Total Refusal and the American artist Grayson Earle.

2 Theorizing experimental machinimas

Machinima was the subject of several studies in the 2000s and early 2010s, such as *3-D Game Based Filmmaking* (2004), *The Machinima Reader* (2011), *Machinima: The Art and Practice of Virtual Filmmaking* (2012), *Understanding Machinima* (2013). Since it was a young medium, the majority of these studies were focused on the issues of defining and discerning its unique properties, as well as on the question of its artistic legitimacy. Much like cinema in its early days, video games were and still are widely considered as a product of lower cultural value, a cheap entertainment for the masses. This might explain why the majority of machinima research is conducted by new media and game studies scholars, with very few articles coming from art and film scholars. The exclusion could also be due to the fact that much of machinima works in the early days circulated outside of the art and film industries. They were created and distributed within predominantly online communities of gamers and machinima fans, who launched dedicated websites, channels on video hosting platforms, as well as machinima film festivals [2]. It's not until recent years that machinimas have started to gain their place in art and film festival circles, as a result of a growing number of new media artists and experimental filmmakers who began to challenge conventional, narrative-based gameplay in favor of more conceptual and critical approaches that inquired into issues like ideology, representation, and player agency in gaming. Artists not only engage in different gameplay, they are making radical interventions in the game itself, be it through editing of the recorded game material or through various hacking techniques that alter the elements within the game.

Historically, hacking practices formed the core of machinima in its early days, since game developers in the 1990s until early 2000s did not offer tools for modifying games as they do today. Pioneers needed a high degree of technical and programming skills to create machinima tools, treating it not only as a fun community activity but also as a hacking challenge. As noted by Kelland:

> "To create new settings, the filmmaker needs to create new 3D models and associated animations, and then must find a way to incorporate them into the game. These highly specialized skills, particularly the ability to add new assets to an existing game or change its behavior, are skills that are well established in the game development and game 'mod' community but are uncommon outside those small groups" [5].

This idea was enhanced in the 2000s, in the advent of the computer games that incorporated filmmaking tools in the gameplay and enabled anyone with a simple video editing tool to create machinimas. A clash within the community emerged:

> "[…] many people in the pre-2004 machinima community refused to accept movies made in The Sims 2 or The Movies as real machinima. Many veteran machinimators felt that the essence of machinima was to show prowess at pushing a game engine beyond the limits intended by its developers, and games like *The Sims 2* and *The Movies* simply made it too easy" [5].

A very similar DIY and hacker discourse that appeals to artists to take the means of production into their own hands and subvert the normative use of commercial technology is present in the community of glitch artists. They intentionally seek and produce errors in analog and digital media as a form of hacktivist practice against

the technocapitalist ideology of progress and perfection. Some of the members of this community, like Clint Enns and Sabato Visconti, also made machinimas, notably by hacking the early analog consoles such as Game Boy and Atari to produce visual glitches in the gameplay. The same ethics of audiovisual disruption can be found among members of the growing community of artists who seek to preserve and renew photochemical film practice in the age of its commercial decline. The artists collect, repair, recycle and repurpose abandoned film equipment, make their own tools (e.g., new developing formulas, hand-made emulsions), and process their films themselves. During the last decade, these labs have produced numerous experimental films which embrace the so-called "aesthetic of contact" [6], characterized by imperfections and visible traces of artists' hands-on approach and interventions on the surface of the film strip.

In his recent study *The Aesthetic of Signal*[1] Bidhan Jacobs [4] noted a surge of artivist collectives since the 1990s who creatively appropriate technology in order to deconstruct its ideology and functioning. The goal of their audiovisual works is, more precisely, to "make the tools and machines legible" (to question their transparency and study their conduct), to "emancipate artistic practices from the prescribed history of technologies" (to challenge the discourse of historical evolution imposed by technical industries) and to "liberate tools or create free tools" (to fight for the right of access to internal mechanisms of technologies, to misuse the technology and exploit its bugs). He further claims that this artistic approach is closely related to the equally expanding technocritical academic research that contests neoliberal, vertical power structures and progress-oriented technological paradigms, emphasizing instead the complex socio-political nature of technology. The act of hacking plays a central role here, not only as an innovative, art activity[2] (as per Richard Stallman [14]), but also as a political and liberating practice that "disconnects us from consumerism, [...] favorizes permanent learning and puts at our disposition all old and recent technologies to test, recycle, rethink, and subvert them from their prescribed usage". The hacker collectives and ethics of knowledge sharing are henceforth important because they demystify the functioning of technologies and emancipate its users. They help to "eradicate the last inhibitions that dwell within us – consequences of the internalization of a feeling of inaccessibility to technical knowledge, desired and induced by technical industries and corporations through the idea of powerful and almost magical 'high technologies,' in order to confine us to the sole status of consumer and user". His examples of technocritical and hacktivist films not only include recent works of glitch artists (where the films of Jacques Perconte are given considerable space), but stretch as far as to the avant-garde pioneers (Jean Epstein, René Clair), to further connect them with the vision of structuralist filmmakers of the 1960s (Stan Brakhage, Paul Sharits, Malcolm Le Grice), video artists (Bill Viola) and contemporary photochemical filmmakers with hands-on approaches (Peter Tscherkassky, Jürgen Reble). Machinima makers, curiously, are left out of Jacobs' monumental study, even though their filmic practice by all means belongs to this large counter-history of "technical disobedience" [1] in the audiovisual field.

Among the groups that stand out in the contemporary experimental machinima scene is the Austrian artivist collective Total Refusal, whose practice involves counter gaming to expose the ideological subtext of the mainstream computer gamers. Self-described as "Pseudo Marxist Media Guerilla", its artistic strategy is already conveyed by its name "Total Refusal", a military term referring to the practice of military disobedience as popularized in 1968 [15]. With members coming from different academic backgrounds (anthropology, media studies, political science, arts, philosophy), the group's films are a product of meticulous research that incorporates Marxist and leftist thought to deconstruct the clichés and capitalist agenda in mainstream media content. Hence the reason they "semi-kiddingly" refer to their work as *Agitainment* or *Machinifesto* [15]. Even though they are all gamers in their free time, they are nevertheless aware that "the video game is the child and poster boy of late capitalism, reproducing its meritocratic narratives, patriarchal patterns and reactionary hero tropes to the same extent as the most conservative mainstream films", as explains Michael Stumpf, one of the core members. And since it is a medium that acts as a "formative social space for so many people", the collective found it necessary to apply the critical standpoint [13].

In the award-winning machinima essay *Hardly Working* (2022), the collective focuses on the lives of NPCs (non-playable characters, the extras within the video game who serve as a background for the main action) in the Western shooter *Red Dead Redemption 2*. Structured as an observational documentary within the gameplay (the collective did not make modifications within the game), the narrator in voiceover describes and analyzes the endless, repetitive daily work of four NPCs: a laundress, a stableman, a street sweeper and a handyman. Employing the Marxist critical apparatus, the collective notes that their work "neither results in a product, nor does it change anything about their status quo". It reflects the reality of the capitalist paradigm where "work becomes a pure performance for the sake of appearances to ensure a social order". The NPCs appear as "digital Sisyphus machines" caught in the loop of meaningless labor. The emancipatory potential, however, comes in the form of unexpected algorithmic glitches in the game, when, for example, a street sweeper's broom suddenly disappears from the porch. Having nothing to do, the street sweeper just stands and looks into the distance. In those moments of unplanned idleness, the collective questions whether this has resulted in a loss of meaning for the character or, on the contrary, an opportunity for emancipation. As theorized by glitch artists and researchers, the glitch points to an unexpected disturbance within the technological systems that reveals their inherent fallibility and imperfection [10]. It presents a rupture that questions power structures, uncovers the limits of control, predictability, and seamless efficiency as promised by technocratic ideologies. As such, glitches also present a political act of resistance that highlights the vulnerabilities of technocapitalist infrastructures and "induces the fear that a hitherto unquestioned (political) system might no longer be successful" [13].

[1]The book is originally published in French and has not yet been translated into English. The English translation of the title *Esthétique du signal* and the citations taken from it is provided by the author of this article.

[2]Jacobs reminds that the term *hacking* is not exclusively related to computing and is taking its understanding from Richard Stallman who sees it as practice of "exploring the limits of what is possible, in a spirit of playful cleverness." In the 1980s Stallman introduced the term *cracking* for an unauthorized security breach to destigmatize the practice of hacking.

A similar essayistic approach is undertaken in the experimental machinima by American new media artivist Grayson Earle, *Why Don't the Cops Fight Each Other?* (2021). He carries out a critical investigation into the ostensibly arbitrary restriction embedded within *Grand Theft Auto V*, a game renowned for its vibrant modding community and the virtually limitless possibilities for altering its features through code manipulation. Earle's inquiry is specifically oriented toward the reasons behind the impossibility of programming police characters to engage in combat with one another, despite their proclivity for aggression toward ordinary civilians. The artist's ultimately unsuccessful hacking interventions engender a series of deliberately humorous glitches (e.g., police officers fleeing from one another), which serve to illuminate the exceptional status accorded to law enforcement and the extent to which cultural imaginaries and institutional logics are embedded within the game's algorithmic architecture.

These recent examples indicate a significant departure from the pioneering machinima works, which were primarily based on uncritical reproductions of conventional narrative lines and intended mainly as entertainment for a community of gaming enthusiasts. The new generation of machinima artists, akin to early avant-garde filmmakers, examines, appropriates, repurposes, and hacks mass media production tools to expose and challenge the myths perpetuated by technocapitalist and cultural industries.

3 Conclusion

From its beginnings rooted in gaming and hacker subcultures, machinima has evolved in the last thirty years from amateur and then professional films based on the replication of classical narrative structures prominent in mainstream video games. Thanks to a growing number of new media artists and experimental filmmakers who, in the midst of digital transformation and monetary dominance of gaming culture, recognized in video games a potent subject for critical analysis of its connection with today's dominant technocapitalist paradigm, experimental machinimas are now slowly becoming recognized and legitimized by major art and film festival circles. Akin to traditions of cinematic avant-garde and experimental film and video movements from the 1960s and onwards, the novel aesthetic and political strategy reflected in appropriation, radical subversion, and hijacking of game technology, suggests that experimental machinimas should be studied within the larger counter-history of technocritical experimental film and video. Subjecting computer games to non-conventional gameplay and glitches becomes an activist and emancipatory event that makes visible not only inherent imperfections and instabilities of game technology, but also of a wider technocapitalist political structure.

The outlined technocritical approach enables a theoretical investigation of other hybrid new media artworks within the domain of film studies, still largely invested in narrative forms of filmmaking, or, in the case of experimental film, its established genres. In light of the growing body of research emphasizing the political and material dimensions of digital technologies (especially within studies of artificial intelligence), coupled with the intermediality as a foundational characteristic of contemporary moving image production, it becomes imperative to adopt a wider cultural-political, historical, and interdisciplinary framework for analysis. Such an approach is essential for apprehending the complex evolution of novel art forms and visual languages, which arise not in isolation but as interventions shaped by multifaceted socio-technical and aesthetic forces.

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Machinima Artivista como Crítica Social: O Caso de "City Art – Mimo e a Cidade"

Machinima Artivism as Social Criticism: The Case of

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Abstract

"City Art – Mimo and the City" is a machinima project that utilizes the Grand Theft Auto V engine to explore the condition of the artist in contemporary society. It adopts an a/r/tographical approach that integrates artistic practice, theoretical research, and social critique. The symbolic narrative of Mimo, a marginalized character who transitions between the creative purity of an island and the hostility of a hypercapitalist city, critiques the incommunicability of authentic art within consumerist urban ecosystems. Inspired by a theoretical framework that articulates the works of Debord (Society of the Spectacle), Bauman (Liquid Modernity), Baudrillard (Hyperreality), Jameson (Cultural Logic of Late Capitalism), and Fisher (Capitalist Realism), the project transforms the game"s technical limitations (such as NPC behaviors and unrealistic physics) into visual metaphors for alienation and resistance through a "poetics of the glitch". The methodology involved narrative conceptualization, a detailed technical workflow, and reflexive analysis via a Digital Logbook. The machinima subverts the violent satire of GTA V, proposing a ludic activism that humanizes the digital. Contributing to the fields of Digital Art Cultures and Media Art History, the project highlights the potential of machinima as a tool for social criticism, challenging the marginalization of the artist and fostering reflections on authenticity and vulnerability in contemporary algorithmic culture.

Résumé

"City Art – Mimo e a Cidade" é um projeto de machinima que utiliza o motor de *Grand Theft Auto V* para explorar a condição do artista na sociedade contemporânea, adotando uma abordagem a/r/tográfica que integra prática artística, pesquisa teórica e crítica social. A narrativa simbólica de Mimo, um personagem marginalizado que transita entre a pureza criativa de uma ilha e a hostilidade de uma cidade hipercapitalista, critica a incomunicabilidade da arte autêntica em ecossistemas urbanos consumistas. Inspirado por um quadro teórico que articula as obras de Debord (sociedade do espetáculo), Bauman (modernidade líquida), Baudrillard (hiper-realidade), Jameson (lógica cultural do capitalismo tardio) e Fisher (realismo capitalista), o projeto transforma as limitações técnicas do jogo (como comportamentos de NPC e física irrealista) em metáforas visuais de alienação e resistência, através de uma "poética do *glitch*". A metodologia envolveu conceptualização narrativa, um *workflow* técnico detalhado e análise reflexiva via Diário Digital de Bordo. O *machinima* subverte a sátira violenta de *GTA V*, propondo um ativismo lúdico que humaniza o digital. Contribuindo para os campos de Culturas de Arte Digital e História da Média-Arte, o projeto destaca o potencial do *machinima* como ferramenta de crítica social, desafiando a marginalização do artista e promovendo reflexões sobre autenticidade e vulnerabilidade na cultura algorítmica contemporânea.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Machinima, Computer Game, GTA V, Media Art

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1 Introdução: O Artista na Cidade Algorítmica

Este artigo apresenta o projeto "City Art – Mimo e a Cidade", um *machinima* que investiga a condição precária do artista disruptivo nos ecossistemas urbanos contemporâneos, cada vez mais moldados pela lógica consumista e pela governação algorítmica [1]. Embora as cidades modernas celebrem a diversidade cultural, frequentemente marginalizam expressões artísticas autênticas que não se conformam à lógica da mercantilização [2]. O projeto posiciona-se como uma intervenção de investigação baseada na prática neste problema, utilizando a linguagem da média-arte para explorar a tensão entre a criatividade e o consumismo.

O artefacto central é uma alegoria narrativa que segue a jornada de Mimo, um artista mudo, desde um espaço de pureza criativa (uma ilha isolada) até uma cidade hipercapitalista hostil (a Los Santos de *Grand Theft Auto V*), culminando na sua dissolução existencial no mar. Esta narrativa serve como uma metáfora para a luta do artista pela autenticidade num mundo que valoriza o espetáculo em detrimento da substância [3]. A cidade que Mimo encontra não é apenas um espaço social ou económico, mas um ecossistema algorítmico, governado por regras codificadas que excluem sistematicamente o seu comportamento não utilitário. Esta perspetiva



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Figure 1: Mino na Cidade em "City Art - Mimo e a Cidade". [Domínio Público], via Youtube[1]

reformula a crítica urbana tradicional, focando-se na lógica subjacente que governa tanto os espaços físicos como os digitais no século XXI [4].

A abordagem do projeto é definida como "ativismo lúdico", um conceito que implica a subversão da gramática violenta e satírica de *GTA V* para construir um comentário comovente sobre vulnerabilidade, alienação e resistência. Em resposta a uma necessidade de maior rigor estrutural e aprofundamento teórico, este artigo estabelece os seguintes objetivos: (1) apresentar a metodologia a/r/tográfica que guiou o projeto e detalhar o seu *workflow* técnico de produção; (2) construir um quadro teórico robusto que conecta críticas clássicas e contemporâneas do capitalismo; (3) analisar as estratégias narrativas e estéticas da obra, com foco na "poética do glitch"; e (4) discutir as implicações do projeto para a arte digital e a crítica social. A estrutura do artigo seguirá esta sequência, começando com as fundações teóricas, seguidas pela metodologia, análise do artefacto, uma discussão mais ampla e, por fim, a conclusão.

2 Fundações Teóricas: Espetáculo, Liquidez e o *Sandbox* Neoliberal

A base conceptual do projeto articula o machinima como um meio de prática crítica, contextualizando o "ativismo lúdico" dentro do campo mais vasto do ativismo digital e enquadrando a luta do artista na crítica à sociedade do espetáculo e ao urbanismo neoliberal.

2.1 Machinima como Prática Crítica

O machinima, uma combinação de "máquina" e "cinema", evoluiu de uma subcultura de jogos para um meio reconhecido de *storytelling* digital e expressão artística [5] [6]. A sua principal contribuição para a média-arte foi a democratização da produção de animação, permitindo que criadores independentes produzissem conteúdos de alta qualidade sem os custos proibitivos do cinema tradicional [7] [8]. Esta acessibilidade confundiu as fronteiras entre jogo, cinema e arte, criando um meio híbrido que desafia as noções convencionais de entretenimento [9].

No contexto contemporâneo, marcado pela ascensão da geração de vídeo por IA, o processo de criação de *machinima* assume uma nova relevância. A produção de "City Art" não depende de algoritmos generativos, mas de uma forma de "marionetismo digital" (*digital puppetry*), onde o artista encarna e performa o personagem em tempo real [4]. Este processo pode ser entendido como uma forma de ativismo digital "artesanal", reafirmando a agência humana num contexto de cultura algorítmica crescente [10] [11].

Numa era de criação algorítmica cada vez mais desencarnada, esta abordagem recentraliza o trabalho e a vulnerabilidade, tornando o próprio processo de criação uma crítica às tendências desumanizadoras da tecnologia [12] [13]. A escolha de *Grand Theft Auto V* como plataforma é deliberada, seguindo precedentes como "Finding Fanon II", que utiliza o jogo para comentar sobre raça e imperialismo cultural [14].

2.2 Artivismo Digital e a Ecologia dos Média

O "ativismo lúdico" do projeto insere-se no campo mais amplo do artivismo, a interseção entre arte e ativismo, e especificamente do

[1] https://www.youtube.com/watch?v=APF7SvFfrk4

ativismo digital, que utiliza espaços online para transmitir mensagens políticas e sociais [3]. Contudo, para evitar uma visão tecnologicamente determinista, adota-se uma perspetiva de ecologia dos média, que reconhece que as práticas digitais coexistem com um longo historial de ativismo mediado por tecnologia, numa complexa interação entre média antigos e novos [2]. Esta visão contextualizada permite uma análise mais nuançada, que não celebra a tecnologia de forma acrítica, mas reconhece as suas continuidades e ruturas com práticas anteriores.

É igualmente crucial reconhecer as complexidades do ativismo digital. Fenómenos como o *slacktivism* (ativismo de baixo esforço), a desinformação e a vigilância digital criam um dilema entre os benefícios da mobilização em massa e os riscos da participação superficial, um cenário que Han [15] descreve como a "sociedade do cansaço", onde a ação se torna passiva. "City Art" navega este dilema ao focar-se não na mobilização em massa, mas numa forma íntima e poética de resistência, usando a plataforma digital para uma reflexão existencial em vez de um apelo direto à ação.

2.3 O Artista no Espetáculo Neoliberal

O quadro teórico do projeto articula uma cadeia causal que liga a economia política à experiência cultural e social. A base é o sistema económico do capitalismo tardio, que, segundo Jameson [16], se caracteriza pela mercantilização total da cultura, transformando a própria arte num produto. Este sistema gera uma atmosfera ideológica de realismo capitalista, a noção, descrita por Fisher [17], de que não existe alternativa viável ao capitalismo, o que limita o horizonte do pensável e do possível [18].

Esta conjuntura manifesta-se culturalmente como a "sociedade do espetáculo" de Debord [3], onde as relações sociais autênticas são substituídas por representações mediadas por imagens, e o "ter" suplanta o "ser". Simultaneamente, emerge a "hiper-realidade" de Baudrillard [19], um estado em que os simulacros e os modelos precedem e geram o real, apagando a distinção entre a cópia e o original. Neste cenário, a autenticidade é frequentemente obscurecida pela proliferação de imagens e representações que se tornam mais reais do que a própria realidade [20]. Finalmente, a condição social e psicológica resultante é a "modernidade líquida" de Bauman [21], caracterizada pela fluidez, precariedade e incerteza constantes, que dissolvem os laços humanos e as identidades estáveis.

O mundo de jogo de *GTA V* funciona como um modelo funcional e interativo desta cadeia teórica: um "*sandbox* neoliberal". É um "espaço público" que é propriedade privada (da Rockstar Games), governado por algoritmos rígidos e centrado na acumulação de capital, uma simulação perfeita do sistema descrito por Jameson [16] e Fisher [17]. A luta de Mimo é, portanto, uma interação literal com a lógica codificada deste sistema. A sua arte, não sendo mercantilizável, é rejeitada, e o seu fracasso em integrar-se em Los Santos pode ser lido como uma recusa desta lógica. A sua morte representa uma forma de "retirada ativa", preservando a sua autenticidade ao custo da sua própria existência [20], uma resposta trágica à questão de como resistir num cenário hiperconsumista.

Dado que o enquadramento teórico define o projeto como uma interação direta com a lógica codificada de um "*sandbox* neoliberal", a metodologia escolhida precisava de ser igualmente híbrida. A simples análise teórica seria insuficiente sem a prática criativa, e a prática sem a teoria perderia o seu rigor crítico.

3 A/r/tografia em Prática: A Construção do Vídeo

O projeto foi, por isso, desenvolvido sob o paradigma da a/r/tografia. A metodológica do projeto articula o enquadramento conceptual do processo técnico de produção, e combina a abordagem reflexiva da a/r/tografia com um *workflow* de produção de *machinima* rigoroso e em várias fases.

3.1 Uma Abordagem A/r/tográfica aos Média Digitais

O projeto foi desenvolvido sob o paradigma da a/r/tografia, uma metodologia de investigação baseada na prática que integra sinergicamente os papéis do artista (*ars*), do investigador (*graphia*) e do teórico (*theoria*). Este processo não é linear, mas sim uma "investigação viva" (*living inquiry*), iterativa e reflexiva, que valoriza o conhecimento corporizado e relacional. A sua implementação prática foi centralizada no "Diário Digital de Bordo" (DDB), um documento digital que serviu como espaço para registar decisões criativas, experimentações técnicas e reflexões teóricas ao longo de todo o processo [22]. O DDB garantiu um alinhamento constante entre a prática artística e o enquadramento crítico, permitindo que as descobertas emergentes da criação do machinima informassem a análise teórica e vice-versa, abordando diretamente a necessidade de uma articulação mais clara entre estes domínios.

Como referido anteriormente, a inspiração provem do filme "Machinima Finding Fanon II", de Larry Achiampong e David Blandy, que explora o motor do jogo *GTA V* para fomentar a reflexão sobre temas de mercantilização e imperialismo cultural [14]. Da análise a esta obra tem origem o "gatilho" que impulsionou o projeto "City Art - Mimo e a Cidade".

3.2 O *Pipeline* de Produção do Machinima

A criação de *machinima* em *GTA V* depende de um *workflow* que contorna as limitações do *software* proprietário. Este processo revela uma separação temporal entre as funções de "ator" e "diretor de fotografia", que, embora desempenhadas pela mesma pessoa, ocorrem em fases distintas. Esta metodologia "de cérebro dividido" permite um controlo meticuloso sobre a cinematografia, mas introduz uma desconexão entre a espontaneidade da performance original e a natureza calculada da filmagem final. O *pipeline* de produção foi estruturado em três fases distintas.

- **Fase 1: Pré-Produção:** Esta fase inicial focou-se na tradução dos conceitos teóricos em elementos narrativos e visuais concretos. O guião foi desenvolvido em torno da estrutura de três atos de Mimo, com cenas específicas projetadas para metaforizar a sociedade do espetáculo e a modernidade líquida. Seguiu-se um processo de exploração do mapa de *GTA V* para identificar locais e *game assets* que pudessem servir como cenários simbólicos, como a ilha isolada para representar a pureza e a opulenta *Vinewood* para simbolizar o excesso consumista.

[2] https://www.larryachiampong.co.uk/list-of-artworks/finding-fanon-2



Figure 2: "Finding Fanon Part II". [Domínio Público][2]



Figure 3: Esboço no Diário Digital de Bordo. Fonte: Autor.

- **Fase 2: Produção e Captura de Filmagem:** Nesta fase, as cenas foram encenadas e performadas utilizando o *Director Mode* de *GTA V*. A performance de Mimo foi capturada em tempo real, num processo análogo ao "marionetismo digital". A filmagem bruta foi gravada utilizando a funcionalidade de gravação interna do jogo. Foram capturadas múltiplas tomadas de cada cena para garantir uma variedade de

Table 1: *Workflow* de Produção Técnica para "City Art – Mimo e a Cidade"

Fase	Atividade	Ferramentas Utilizadas	Racional Artístico/Técnico
1. Pré-Produção	Conceptualização Narrativa e Guião	Diário Digital de Bordo, Editor de Texto	Traduzir conceitos teóricos numa estrutura de três atos e cenas acionáveis.
	Prospeção de Locais e *Assets*	Exploração *In-Game* de *GTA V*	Identificar ambientes virtuais que representem visualmente as dicotomias simbólicas centrais.
2. Produção	Performance de Personagem e Encenação	*Director Mode* de *GTA V*	Executar as ações de Mimo através de "marionetismo digital", encenando interações com o ambiente e NPCs.
	Captura de Filmagem Bruta	Gravador In-Game de GTA V, Software de Captura de Ecrã	Gravar múltiplas tomadas para capturar a performance e eventos ambientais imprevisíveis.
3. Pós-Produção	Cinematografia Virtual	Rockstar Editor	Refilmar a performance capturada de múltiplos ângulos usando câmara livre, blends e tracking.
	Exportação de Clips	Captura de Ecrã da Pré-visualização (NVIDIA ShadowPlay)	Exportar planos com a máxima qualidade, contornando a exportação de baixa qualidade do editor.
	Edição Final, Gradação e Desenho de Som	Software NLE (DaVinci Resolve)	Montar os planos, realizar a gradação de cor e adicionar a banda sonora e efeitos sonoros.

opções na pós-produção e para mitigar o comportamento imprevisível dos NPCs (*Non Playable Character*).

- **Fase 3: Pós-Produção:** A pós-produção foi a fase mais intensiva. Primeiro, os *clips* de jogabilidade bruta foram importados para o *Rockstar Editor*. Esta ferramenta foi usada como um poderoso sistema de câmara virtual, onde cada cena foi "refilmada" a partir de múltiplos ângulos, utilizando câmaras livres, movimentos de câmara suaves e efeitos como a profundidade de campo. Crucialmente, a exportação destes *clips* contornou a função nativa do editor, conhecida por produzir ficheiros de baixa qualidade. Em vez disso, foi empregue uma técnica desenvolvida pela comunidade: reproduzir cada *clip* finalizado em pré-visualização de ecrã inteiro e recapturá-lo com um *software* de captura de ecrã externo de alta qualidade, como o *NVIDIA ShadowPlay*. Esta prática representa um "*hack*" ao *pipeline*, um ato de resistência técnica contra as limitações de um sistema fechado para alcançar a visão artística desejada, ecoando as práticas de *modding* e subversão de plataformas [23]. Finalmente, os *clips* de alta qualidade foram importados para um *software* de edição não linear (NLE) profissional para montagem, correção de cor, e adição da banda sonora e efeitos sonoros - *DaVinci Resolve*.

4 Desconstruindo o Artefacto: Narrativa, Alegoria e a Poética do *Glitch*

Analisando criticamente o artefacto, conectamos as escolhas estéticas e narrativas ao enquadramento teórico e metodológico. A análise harmoniza a linguagem poética e científica para desvendar as camadas de significado da obra.

4.1 Alegoria Narrativa e Trajetória Existencial

A narrativa do machinima está estruturada em três atos simbólicos que mapeiam a trajetória existencial de Mimo.

- **Ato I - A Ilha:** Este ato estabelece a ilha como um "útero criativo", um simulacro Baudrillardiano de pureza [21]. O cenário, com as suas texturas simplificadas e vegetação rígida, não pretende ser realista, mas sim hiper-real na sua artificialidade, um *sandbox* de criação pura. O isolamento de Mimo é acentuado pela câmara fixa em terceira pessoa, evocando a solidão do herói romântico.
- **Ato II - A Cidade:** A chegada a Los Santos é uma imersão na sociedade do espetáculo de [3]. A cena crucial da expulsão de Mimo de uma galeria de arte demonstra a lógica neoliberal onde a arte só é valorizada se for consumível. A indiferença dos *NPCs*, com os seus movimentos pré-programados, materializa a "indiferença líquida" de [21], transformando a cidade num antagonista coletivo.
- **Ato III - O Mar:** O clímax trágico ocorre no mar. O regresso à ilha revela-se impossível, pois o passado é irrecuperável. O afogamento de Mimo não é um mero acidente, mas um "suicídio criativo", um ato final de resistência que preserva a sua essência ao recusar-se a adaptar-se a um mundo que não tem espaço para a sua sensibilidade. Esta é uma forma de "retirada ativa", uma recusa em aceitar o absurdo sem resistência [24].

4.2 Subvertendo o Motor de Jogo: A Poética do *Glitch*

A contribuição mais inovadora do projeto reside na sua capacidade de transformar limitações técnicas em recursos poéticos, criando uma "poética do *glitch*". Esta não é apenas uma escolha estética, mas um ato metodológico e político de "ler contra a corrente" do *software*, onde o artista procura e re-significa as falhas do sistema.

A rigidez das animações e dos movimentos dos NPCs, que são robóticos e desprovidos de expressão, não constitui uma falha técnica no design do jogo, mas sim uma escolha deliberada para representar a desumanização inerente à sociedade de consumo. A sua



Figure 4: Os 3 atos em "City Art – Mimo e a Cidade". Fonte: Autor em *GTA V*.

indiferença programada, a forma como interagem de maneira previsível e sem emoção, serve para acentuar o sentimento de alienação e isolamento vivenciado por Mimo, o protagonista, mergulhando o jogador numa atmosfera de desconforto e reflexão sobre a superficialidade das interações humanas na era moderna, sobre forma de falha sistêmica [13].

A maneira como a física irrealista da água é representada em *Grand Theft Auto V*, especificamente a sua "pesada irrealidade" [14], que materializa o caos, desempenha um papel crucial na encenação do naufrágio do Mimo. Esta representação intencionalmente distorcida da física não visa a precisão, mas sim criar um efeito dramático e simbólico. À medida que o barco se inclina e vira de forma lenta e grotesca, a cena é elevada a algo que transcende um mero acidente. Torna-se, de facto, um espetáculo de absurdo existencial, onde a estranheza e a improbabilidade da situação sublinham a natureza caótica e imprevisível da existência, transformando o evento num momento de reflexão sobre a estranheza da realidade simulada e, por extensão, da própria vida.

Glitches e artefactos visuais reforçam a relação do personagem como cenário, assumindo uma dimensão emotiva "real" [4]. O conceito de *camera shake*, que simula a instabilidade da câmara, é empregado de forma expressiva em momentos de profunda angústia, traduzindo visualmente a desorientação existencial da personagem. De igual modo, a noção técnica de *render distance* – a distância máxima a partir da qual os elementos do cenário são visíveis e renderizados no ambiente do jogo – é subtilmente transposta para uma dimensão metafórica. Neste contexto, o *render distance* transforma-se numa representação eloquente do vazio e da incerteza metafísica que Mimo confronta durante a sua jornada pelo vasto e inóspito oceano.

Esta estratégia demonstra uma "retórica processual do fracasso". O conceito de retórica processual argumenta que os videojogos persuadem através das suas regras e sistemas [25]. O motor de *GTA V* está processualmente desenhado para o sucesso através da acumulação de capital e violência. Ao tentar realizar arte não utilitária, Mimo rejeita estes objetivos, e o seu fracasso é o resultado processual lógico da sua incompatibilidade com a lógica do jogo. A crítica, portanto, está profundamente embutida no próprio meio. Além disso, a obra explora o "vale da estranheza da emoção" (*uncanny valley of emotion*) [26]. A dissonância entre a profunda tragédia da narrativa e a face inexpressiva de Mimo amplifica o sentimento de alienação, forçando a audiência a projetar a emoção na personagem.

5 Discussão: Resistência Poética na Cultura Algorítmica

No âmbito do crescente diálogo sobre arte digital e ativismo, este projeto procura examinar o papel multifacetado do artista na sociedade contemporânea, posicionando-se nas interseções destas discussões emergentes.

5.1 Contribuição para as Culturas de Arte Digital e a História da Média-Arte

"City Art – Mimo e a Cidade" contribui para os campos das Culturas de Arte Digital e História da Média-Arte ao recontextualizar o machinima como uma ferramenta de "ativismo lúdico" e crítica social. O projeto alinha-se com debates atuais sobre a criatividade digital, onde a agência humana e a profundidade conceptual são reafirmadas como centrais, mesmo na era da IA generativa, como discutido na teoria dos novos média [27] e da cultura algorítmica [11].

A obra serve como um estudo de caso para a "armazenagem da vulnerabilidade". O mundo de *GTA V* é construído sobre a "armazenagem do poder", onde a agência do jogador se expressa através de armas, veículos e dinheiro. "City Art" inverte esta lógica. As únicas ferramentas de Mimo são os seus gestos e a sua vulnerabilidade. O impacto crítico do projeto advém desta inversão. Ao implantar a vulnerabilidade num espaço desenhado para a agressão, Mimo expõe a brutalidade e o vazio das dinâmicas de poder do jogo, reformulando a narrativa de uma simples história de vitimização para uma forma de resistência ativa, ainda que trágica.

5.2 A Ambivalência das Plataformas Corporativas e a Figura do "*Glitch-Wanderer*"

É fundamental uma autorreflexão crítica sobre o paradoxo de usar um produto de entretenimento corporativo como *GTA V* para uma crítica anticapitalista. Esta prática pode ser enquadrada no conceito de *counter-gaming*, onde jogar um jogo contra os seus propósitos pretendidos se torna um ato político [25]. No entanto, esta abordagem não resolve a contradição inerente: o ato de crítica é realizado dentro do, e é dependente do próprio sistema que está a ser criticado. Isto destaca a posição complexa e frequentemente comprometida do artista digital na cultura algorítmica contemporânea.

Neste contexto, a figura de Mimo transcende o arquétipo do *flâneur* de Walter Benjamin [28], o observador urbano ocioso. O *flâneur* observa e faz parte da malha urbana; Mimo é ativamente rejeitado por ela. A sua deambulação não é de lazer, mas de exclusão, constantemente interrompida pela lógica do jogo. Mimo não é um *flâneur*; ele é um "*Glitch-Wanderer*". A sua jornada não é uma travessia suave do espaço, mas uma navegação gaguejante e fragmentada de um sistema codificado que o lembra constantemente de que ele não pertence. Este conceito atualizado captura a experiência do indivíduo marginalizado numa sociedade digital, onde se está não apenas socialmente, mas sistemicamente "ilegível" para os algoritmos que governam a vida contemporânea [29].

6 Conclusão E FUTURAS PRÁTICAS

"City Art – Mimo e a Cidade" subverte radicalmente a linguagem de *Grand Theft Auto V*, transformando um jogo conhecido pela violência gratuita num manifesto sobre a vulnerabilidade artística. O projeto demonstra que o machinima pode transcender o entretenimento para se tornar uma poderosa ferramenta de artivismo. A sua contribuição mais significativa reside na articulação de uma "poética do *glitch*", onde as limitações técnicas do motor de jogo são reapropriadas como metáforas para a alienação numa sociedade algorítmica. A própria artificialidade do meio torna-se um comentário sobre a impossibilidade de uma comunicação genuína.

Ao falhar em adaptar-se, Mimo revela o preço da não conformidade, ecoando críticas sobre a "ditadura dos códigos técnicos" [29]. Este projeto posiciona-se como uma contribuição crítica para as Culturas de Arte Digital e a História da Média-Arte, provando que as restrições podem gerar poesia e que o ato de brincar com as regras de um sistema pode ser um gesto político profundo.

Para futuras práticas, o projeto sugere a exploração continuada de motores de jogo como locais para práticas artísticas e ativistas híbridas. A investigação futura poderia aprofundar como os meios digitais, com as suas limitações inerentes, podem gerar poéticas inovadoras, ampliando os debates sobre autenticidade, vulnerabilidade e o papel da arte em contextos urbanos contemporâneos.

O verdadeiro ato revolucionário aqui não está no que é dito, mas em como é dito: usar um jogo que satiriza a crueldade do capitalismo para, ironicamente, lamentar as suas vítimas mais silenciosas — aquelas que ainda acreditam na beleza.

O projeto prova, em última análise, que a resistência artística mais profunda na cultura algorítmica não é vencer o sistema, mas forçá-lo a renderizar a sua própria contradição: um glitch de beleza trágica no coração de um mundo programado para a crueldade.

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Autonomous Puppetry - A Preliminary Study on the Puppeteer´s Perspectives of Autonomy in Puppetry Practices

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Abstract

This paper presents the preliminary findings from the initial research phase of a PhD project that explores the relationship between performative arts and technology. This art-based research critically examines concepts of autonomy, control, and theatricality in puppets empowered by autonomous systems. The project is organized into a three-phase methodological framework, of which the first phase involved conducting interviews with professional puppeteers from diverse cultural backgrounds. This methodological framework was designed to address the first of two research questions, which address the dynamics between the puppeteer and the puppet. After the qualitative analysis of the interviews, the overall findings display not only the current use of technological elements and devices in puppetry practices but also the puppeteers´ perspectives on enhancing the puppet autonomy for their performances. Moreover, the results reveal the artists´ concerns about technological applicability, specifically about the role of human presence and its subsequent replacement, and the preservation of puppetry principles. Conclusively, these preliminary results present a framework where the intertwining between puppetry and robotics offers groundbreaking perspectives for mutual growth.

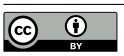
CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts; Arts and humanities; Performing arts; • **Human-centered computing** → Human computer interaction (HCI); Interaction paradigms; Collaborative interaction;

Keywords

Control, Puppetry, Autonomous Systems, Robotic Technology

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1 INTRODUCTION

This paper presents the preliminary findings of the initial research phase of a PhD project investigating the intertwining of performative arts and technology. It examines concepts such as autonomy [1-5], control [6-8] and theatricality [9-16] in contemporary performing arts practices [7, 8, 14, 15, 17-23]. The study approaches traditional and innovative perspectives of puppetry practices, analyzing the impact of robotic technologies and Artificial Intelligence (AI) on autonomous control in puppet theatre [18]. The research methodology employs a mixed-methods design, following a sequential exploratory strategy through a three-phase approach: Research, Prototyping, and Evaluation.

In the Research phase, interviews will embrace the puppeteers´ perspective and receptiveness to robotic technology in terms of control and interaction. In the Prototyping phase, an autonomous robotic puppet will be developed based on the findings from these interviews and tested in a video-recorded live interaction with a professional actor in front of an audience in a short theatre play. Observational reports will help to collect data from the audience to capture the puppet´s effect. In the Evaluation phase, interviews with the participants will help to examine the impact of robotic control not only on the puppeteer's role during the performance, but also on the puppet´s behavior. The collected data will be analyzed through Interpretive Phenomenological Analysis (IPA) to extract in-depth perspectives and nuanced insights into the participants' experiences, thereby contributing to the existing body of knowledge on the intersection of puppetry and robotics.

This paper examines the research phase of the project, which involved conducting interviews with professional puppeteers. This methodological framework was designed to address the first of two research questions, which focuses on the dynamics between the puppeteer and the puppet. The primary objective is to analyze the distinctions in terms of control and the role of the puppeteer between a traditional puppet show and an autonomous puppet performance [23].

This study holds significant value not only for the theatre and puppetry community but also contributes to cultural heritage studies by offering a reliable method for documenting practical knowledge. In addition, it effectively captures authorship and artistic signatures, enabling faithful replication while maintaining the essential human element. Investigating the puppeteers´ perspectives and their level of acceptance regarding technological and robotic elements in their performance practices represents a primordial milestone in developing effective prototyping and for further research work.

To achieve this, the authors developed the following methodological strategy. Professional puppeteers from different nationalities answered semi-structured interviews to unravel their relationship with technological elements associated with puppets. The interviews included both open-ended and closed questions to assess the levels of autonomy, their openness to robotic elements in puppet systems, and the potential impact of these elements on the theatrical context. All the interview participants have filled out and signed an informed consent form, which clarifies to them the purpose and nature of the research. In addition, they also filled out a demographic form with personal and professional data. These forms guarantee the participants´ rights, ensuring confidentiality, respecting voluntary participation, and maintaining privacy. The data collected from the interviews will be kept under the principles of confidentiality, and it will undergo a qualitative analysis to reveal valuable insights.

2 METHODOLOGY

2.1 Human Participants

The methodology for this part of the study consisted of semi-structured direct interviews with puppeteers listed in UNIMA Portugal and UNIMA Brazil - ABTB (Puppetry Theatre Brazilian Association) database according to the Union Internationale de la Marionette (UNIMA Internacional) database [24-26]. In addition to these lists, some puppeteers from the professional authors´ network were included in this study, as same as recommendations by experts, reaching a total of twenty interviewees [27]. However, the sample appears small, especially considering the global diversity of puppetry, qualitative research reaches their meaning saturation between 16 to 24 interviews [28].

The invitations (n=23) were sent by e-mail, phone calls, and written messages through social media and communication apps such as Instagram and WhatsApp, respectively. Unfortunately, it was not possible to invite all the database participants due to the unavailability of contact details (email or telephone numbers on the respective websites). From those invitations, twenty interviews were conducted throughout two months between September 2nd and December 4th, 2024. The interviews had a medium time range of 1 hour and 12 minutes, in which the longest interview lasted 2 hours and 10 minutes and the shortest recorded session lasted approximately 27 minutes. The interview mode varied according to the interviewee´s availability, whether it was face-to-face, online, or asynchronous. 12 interviews were conducted online, 5 in face-to-face mode and 2 asynchronously, and 4 of them were canceled due to unavailability of the schedule. There was no kind of financial support or compensation for the participants.

2.2 Informed consent form

In the context of the interviews included in this study, the authors duly presented the informed consent form to the participants. The form effectively communicated the academic context of the interview as an important step of the research and offered the participants the choice to authorize the mention of their identity, which was authorized by 100% of the participants (n=20). Furthermore, the form prominently featured the authors' professional contact for any necessary clarifications and concluded with the requirement of the participant's signature.

2.3 Demographic data

To collect social-demographic data, the participants were assigned an informative form based on the last Censo Portugal, developed by Statistics Portugal (Instituto Nacional de Estatistica) [29], which asked for personal and professional information. For personal data, the participants had to answer questions about their gender, nationality, date of birth and ethnic-racial identifications. According to professional data, the demographic form enquired about literacy degree, years of professional experience in puppetry, and the puppetry techniques the participants used to work with.

Out of the 20 participants, 70% were "Male" (n=14) and 30% were "Female" (n=6) and 0% self-identified as "Non-Binary" or "Choose not to answer". Considering their nationalities, 55% of the participants were "Portuguese" (n=11), 35% were "Brazilians" (n=7), 5% (n=1) were from Chile and 5% (n=1) were from England. Considering their dates of birth, 45% (n=9) were born in the 1970s, 25% (n=5) were born in the 1960s and also 25% (n=5) were born in the 1980s, just 5% (n=1) were born in 1955. From their ethnic-racial identifications, 80% (n=15) identified as "White, European origins", 5% (n=1) considered as "Black, afro descendent origins", 0% of the participants identified as "Asian, Asiatic origins", "Gypsy, romanic origins" or "American Indigenous origins". On the other hand, 10% (n=2) answered this question as "Other(s)", in which the participant had the opportunity to declare their ethnic-racial identification. The result was equally divided into 2 groups, where 5% (n=1) stated as "Mixed race" and the same percentage for "Brazilian mestizo".

For the literacy degree, the study showed a more divided result. 26,3% (n=5) had a graduation level; 21,1% (n=4) only frequented the secondary school, and on the other hand, the same percentage - 21,1% (n=4) - had a Master's Degree. 10,5% (n=2) of the participants had a PhD and 15,8% (n=3) had post-doctoral studies. Only 5,3% (n=1) had undergraduate degrees. This study identified 13 different theatre companies where 80% (n=16) of the participants worked and 15% (n=3) worked at 3 different universities and 5% (n=1) claimed not to belong to any group at the time of the interview. Considering the years of professional experience in puppetry, the majority of the participants - 40% (n=8) - had between 30-39 years of experience, followed by those with 20-29 years - 35% (n=7). 15% (n=3) had between 10-19 years working in the field and there were only 5% (n=1) each between 0-9 years and 40+ years of professional experience in puppetry.

To collect data about the puppetry techniques the participants used to work with, the demographic form presented an open- ended question, offering the participants to choose the most appropriate terminology to describe their technique. The results for this question were extremely varied, although it was possible to find some duplicates and slight variations. Some terms that came up, such as "Bunraku", "table-top", "adapted Bunraku", and "direct manipulation robots" qualitatively refer to the same technique code further described as "Direct Manipulation". 35% (n=7) of participants described their work in such terms or directly as "direct manipulation". 40% (n=8) of the participants defined their work as "multiple techniques" according to their description of different kinds of puppetry

or even answering “all techniques” or “multiple” or “all kind”. 10% (n=2) had their professional trajectory working with “shadow theatre”. 5% (n=1) established different definitions for their work, coded as “object score”, “glove and object theatre” and “automata”, each.

2.4 The data collection instruments and procedures

In this study, the authors conducted online and face-to-face interviews and adapted the interview protocol described in [30], which included the following components:

- A heading (date, place, interviewer, interviewee)
- Standard procedures to be used from one interview to another
- Ask permission to record the interview (audio and video, in the case of online interviews)
- The ice-breaker questions
- The closed-ended questions followed by open-ended questions to ask the participants to explain their ideas in more detail or to elaborate on what they have said
- A final thank-you statement to acknowledge the time the interviewee spent during the interview

In addition, the authors utilized handwritten notes to augment the recorded data obtained from the interviews. All collected data, including responses from the asynchronous interviews, represents primary material, as it is sourced directly from the individuals or contexts under investigation. Interviews that were canceled were excluded from the study, as they did not take place.

The questions followed a qualitative methodology, developed into semi-structured interviews organized into six closed- ended questions and four open-ended questions. The closed-ended questions were structured as two binary questions (Yes or No), two Likert scales (3-point and 5-point), and two multiple-choice questions. The open-ended questions asked the participants for justifications about their previous answers and/or a reflection about his/her artistic choice. The lack of correspondence with the options provided regarding the closed-ended questions can justify the absence of data in particular interviews.

The questions could be described as follows:

- Do you use or have you used any kind of autonomous system and/or Artificial Intelligence in your artistic processes?
  - Yes, or No?
  - If No, please justify it
- If Yes, for what purpose is it used? Organization of production steps; developing artistic texts; sound, lighting and video mapping control; puppet control; other(s)
  - Explain how it is used
  - Explain the advantages and disadvantages of the system you use
- On a scale where 0 is neutral, 1 is negative and 2 is positive, how do you see the use of autonomous puppets on stage?
  - Justify your answer
- Do you agree with using a fully autonomous puppet on stage? Yes or No?
  - Justify your answer
- On a scale of 0 to 5, where 0 is total human control and 5 is a fully autonomous puppet, how much autonomy would you like to see in a puppet on stage?
  - Justify your answer
- Where do you suggest the autonomous robotic structure should be located? Incorporated into the puppet (internal) and or attached to the puppet’s traditional control mechanism (external)?
- In a complete anthropomorphic puppet, in your opinion, which limb(s) are the most relevant to automate? Eyes; Eyebrows; Mouth; Nose; Hands; Fingers; Arms; Chest; Legs; Feet

The collected data was subsequently transcribed by AI-based transcription software and human-reviewed for further analysis. The university template form supported the visualization and correct statistical data. It also compiled the previously described documents assigned to the participants and distinguished the closed-ended and open-ended answers, titled Form_01 and Form_02, respectively. For this preliminary study, the analyzed data consisted of closed-ended answers from Form_01, sub-questions 1.1 and 1.2 and missing data justifications. The authors focused on presenting statistically descriptive data that can be systematically organized and interpreted at this preliminary stage of the research. Although the open-ended data have been collected and initially reviewed, their analysis is scheduled for subsequent phases of the research, to ensure the integrity and depth of their meaning through a rigorous interpretative framework.

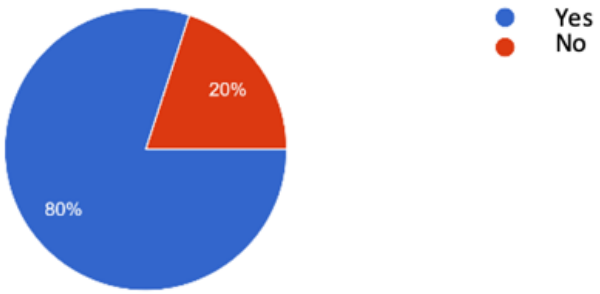


Figure 1: In your artistic processes, do you use or have used any type of autonomous system and/or Artificial Intelligence? 20 answers

3 DATA ANALYSIS AND DESCRIPTIVE STATISTICS

The first question inquired the participants about their previous or current experience with autonomous systems and/or artificial intelligence in their artistic work and their main goal. As shown in Figure 1, 80% (n=16) of the participants have had experience with that kind of system, and 20% (n=4) have not. For those participants who have had experience with it, the next question inquired about their main goal, presented in Figure 2. The findings show a majority to “Others” 43,8% (n=7), followed by “Controlling performative elements such as sound, lighting and video” and “Puppet Control”

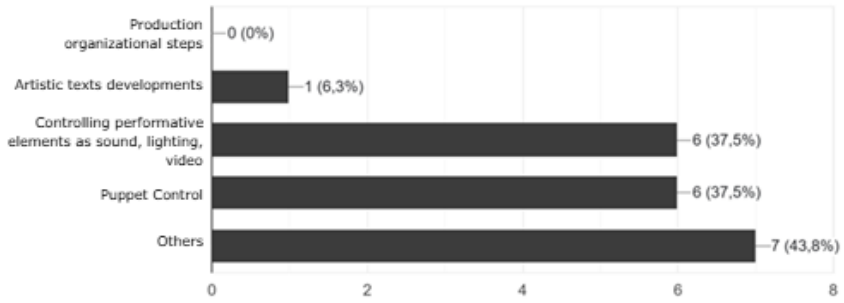


Figure 2: If yes, what is used for? 16 answers

with 37,5% (n=6). In the end, "Artistic texts developments" appears with 6,3% (n=1) and 0% (n=0) for "Production organizational steps". The four missing data in Figure 2 correspond to the number of participants who have not used any type of autonomous systems or artificial intelligence in their work. For these individuals, the justifications included difficulties in communication between the artistic and engineering/robotics fields, unfamiliarity with the required technical knowledge, and a traditional perspective for puppetry.

The following question utilized a three-point scale to assess participants' observations of an autonomous puppet on stage. An ordinal number was determined for each option as 0 for Neutral, 1 for Negative, and 2 for Positive. As shown in Figure 3, 70,6% (n=12) of the participants considered Positive, 17,6% (n=3) Neutral and 11,8% (n=2) chose Negative. The missing data was qualitatively analyzed and consisted of considerations over the artistic proposition.

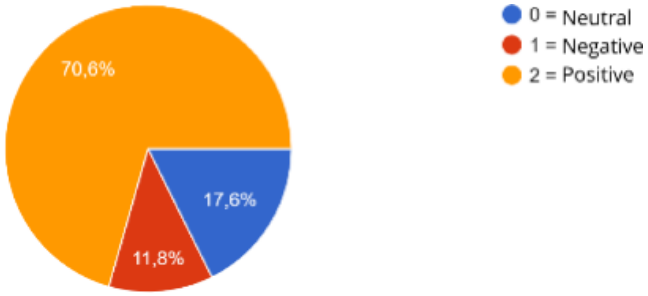


Figure 3: On a scale where 0 is Neutral, 1 is Negative and 2 is Positive, how do you see the use of autonomous puppets on stage? 17 answers

The next question asked the participants if they agreed with the use of a completely autonomous puppet on stage, offering a Yes/No option. Figure 4 shows 78,9% (n=15) answered Yes and 21,1% (n=4) said No. A participant justified not answering this question by arguing that everything on stage has an artistic meaning and the puppet is a feature for artistic communication.

The following question was on a 5-point scale where the participants had to choose degrees of autonomy they would like to see in an autonomous puppet. The scale points were organized from #0 (Null Autonomy) to #5 (Complete Autonomy). Figure 5 presents

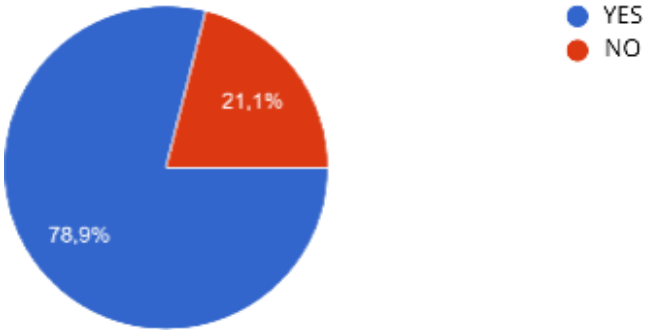


Figure 4: Do you agree with the use of a fully autonomous puppet on stage? 19 answers

that the majority of the participants 66,7% (n=12) answered this question by choosing Complete Autonomy (#5), 22,2% (n=4) chose number #3 Medium Autonomy, and 5,6% (n=1) picked Basic (#1) and Initial Autonomy (#2) each. None of the participants chose Null Autonomy (#0) or Advanced Autonomy (#4). For not answering this question, a participant argued that every level would be acceptable if the communication concepts were not lost, and another one, from a semiotic perspective, affirmed that the selection of the level of autonomy must be aligned with the artistic proposition.



Figure 5: On a scale of 0 to 5, what degree of autonomy would you like to see in a puppet on stage? 18 answers

The following two questions addressed the design aspect of the puppet, specifically its structure and shape. Question 5 asked participants to indicate their preference for positioning the robotic components: embedded within the puppet (internal) or attached externally triggering traditional control methods. Participants had the

option to select either one or both, and the following percentages reflect the accumulated choices made.

As shown in Figure 6, the first alternative was selected by 81.3% (n=13) of participants, while the second received 68.8% (n=11). Out of sixteen responses, 50% (n=8) chose both options, 31.25% (n=5) picked only the internal option, and 18.75% (n=3) chose only the external mode. Four participants did not answer the question presenting different arguments, from challenging the aesthetic limit and the puppetry traditions, threatening the human element on stage, the need to rename it as a different artistic language according to its technological level, the artistic proposition, and the engineer´s obstacles to develop it.

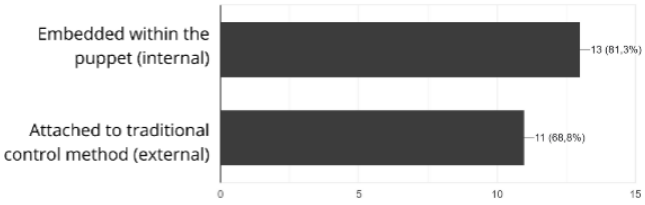


Figure 6: Where do you suggest the autonomous system should be located? 16 answers

Question 6 asked which limbs were most relevant to be automated in a complete human-like puppet, offering the participants ten different body parts: Eyes; Eyebrows; Mouth; Nose; Hands; Fingers; Arms; Chest; Legs and Feet. As same as the previous question, participants were able to select either one or several options and the following percentages reflect the accumulated choices made.

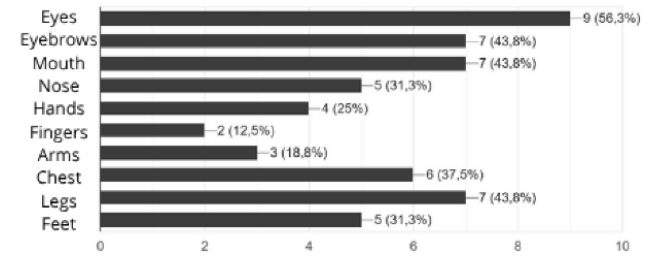


Figure 7: In a humanoid puppet, which limbs are the most relevant to be automated? 16 answers

Illustrated by Figure 7, 56.3% (n=9) of participants selected the Eyes, while 43.8% (n=7) chose the Eyebrows, Mouth, and Feet, each receiving the same number of votes. The Chest was chosen by 37.5% (n=6), followed by the Nose at 31.3% (n=5). Hands, Arms, and Fingers attracted selections from 25% (n=4), 18.8% (n=3), and 12.5% (n=2) of participants, respectively. Among the sixteen responses, 12.5% (n=2) opted for all available options, while the same percentage selected five options. Additionally, 18.75% (n=3) chose four options, and 25% (n=4) selected either one or two options. Excluding those who chose all options, 56.3% (n=9) focused on facial elements, 37.5% (n=6) selected upper limbs, and 31.3% (n=5) opted for lower limb features. As same as the previous question, four participants did not answer by justifying it through artistic propositions, puppetry conventions, the character's physical design, the high risk of toughening the performance through the enlarged response time, and the precise reproduction of human gestures and dynamics in the current state of technology.

4 FINDINGS AND RESULTS

The findings reveal the core of the technological systems the puppeteers use or have used in their work, which focuses on the technical aspects of the performance rather than the puppet´s control. On the other hand, a valuable interest among participants emerged in exploring different levels of autonomy of puppets. From a hybrid perspective, this study reaffirms the value of a multidisciplinary approach to the improvement of both artistic and technological fields [31, 32]

4.1 Previous and current technological experience

The first question´s and sub-questions' findings reflect a technological implementation trajectory into theatrical performances. While some participants have incorporated technological elements in "Puppet Control," the overall results of the first question suggest that the participants prioritized those elements in generative uses and controlling technical elements over actual puppet control.

4.2 Puppet´s autonomy perceptions

Considering the statistical data for the second question, the result shows a positive perspective in increasing the puppet´s autonomy. Even for the participants who considered it "Neutral", the result also showed at least an openness regarding their artistic concerns. While the second question took into account the different degrees of autonomy, the third question focused on a fully autonomous puppet. The findings of this question further emphasize the previously expressed positive perspective of the participants. Those participants who disagree with this approach establish their work under a traditional overview.

The fourth question presented different levels of autonomy, and the overall findings showed genuine curiosity by the majority of the participants. It was mainly justified because they had never seen a fully autonomous puppet before on stage. Those participants who have chosen "Medium Autonomy" strongly believe in a hybrid performance where the robotic and human elements work together to optimize expressiveness and improve the aesthetical experience.

Those with a traditional perspective have selected lower levels of autonomy for the puppets, emphasizing human control over the technological commands. The result of this question shows in a very distinguishable perspective those who were blindly enchanted by technological innovation in contrast to skeptical puppeteers who tend to preserve human control, and in the middle, those who believe that performative power comes through cooperation between humans and machines.

4.3 Puppet´s design

The findings for the fifth question revealed that the embodied alternative was the most selected. In contrast, the participants who had chosen to maintain the traditional controlling mode, despite the robotic structure, argue that the technological elements are

welcome as they offer innovative resources for expressiveness and theatrical effects for the audience. However, they still consider technology a tool subordinate to their artistic proposition and human control.

The sixth question´s findings showed a preference for facial expressions and/or head elements rather than upper or lower limbs. This result reveals a preference for not automating the most expressive body parts responsible for movements and gestures. In that case, the puppeteer would manage the main on-stage actions handling the technological system as secondary moves.

Overall, the findings and results of this preliminary study reveal an introductory integration between the puppeteers and technological systems, firstly in terms of technical aspects. Similarly, they demonstrate an openness toward the applicability of robotic systems for puppetry performances. These results present a framework where puppetry can benefit from technological developments to enhance the performances, and robotics can take over some puppetry principles to improve expressiveness beyond design, envisioning applicability cases, and offering groundbreaking perspectives for new artistic experiences.

5 LIMITATIONS, CHALLENGES AND FUTURE WORK

This preliminary study highlights potential improvements in artistic and technological domains but also notes constraints in the performative context that could hinder the use of robotic systems in puppetry performances. These are limitations in expressiveness and theatrical rhythm, difficulties in technical development, concerns about the role of human presence and its subsequent replacement, and the preservation of fundamental principles of theatre and puppetry.

For future work, the authors highlight the need for an alternative study into robots and autonomy in the cultural context, focused on the technological imaginarium [33, 34], to cross with the puppeteers´ perspective, considering their expertise in artistic expressiveness beyond the puppet´s design. In addition, the authors advocate for the complete analysis of the survey, integrating open-ended data.

An in-depth study holds considerable significance to both the theatre and puppetry communities and the broader field of cultural heritage studies. It offers a reliable methodology for the documentation of practical knowledge. Multidisciplinary framework investigations interlink the artistic and technological domains, illustrating how each field contributes to and enhances the development and advancement of the other.

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Drawing, painting, modelling, mobile phones and video in anamorphic construction.

Analogue and digital processes in the metamorphosis of certain artistic forms.

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Abstract

This paper is developed in the context of our research project focused on the theme of anamorphosis and *trompe l'oeil* representations in specific architectural spaces, with the collaboration of our students from the Drawing degree and Master degree at the Faculty of Fine Arts of the University of Lisbon. The text covers three anamorphic constructions designed and articulated for three specific spaces, one realized individually and two carried out by two groups of students, all of them coordinated and guided by us. In these constructions, as we will see, digital and analogue mediums were used in parallel, where the respective productions involved geometric drawing, analogue drawing, digital drawing, 3D modelling and analogue painting. Digital videos and photographic records were made for the exhibition of these productions, with the aim of them being integrated, shared, disseminated and exhibited in other possible places. The illusion of the metamorphosis of forms in art can also be achieved by including the theme and techniques of anamorphosis and trompe l'oeil construction and there is no doubt that this fact may be very relevant for the creation of more complex future projects. In the first case, we observe the metamorphosis and anamorphosis of the illusory form of a red chair represented in a corner of an architectural space, where the dynamic of the observer leads to the form's legibility and ineligibility, showing its metamorphosis, a bit like shapeless water that turns into an ice cube and vice versa. In another case, it is interesting to observe the playful game of a green square anamorphosis represented inside an inhabited house. In a third case, the project inspired by the painting and scenography of some of Eduard Hopper's works, but relocated in a new context, was completely realized and designed using a computer software 3D modelling program, but with the aim of ultimately completing it in analogue form, using traditional paints and media for the purpose. This theme of anamorphosis is a field of perspective science that is very well displayed through video, because this digital medium allows us to stage and display in any exhibition space the constant mutations that the forms on display provide us with, as a kind of metamorphosis, where the forms and images of them are not exhausted in the change of according to the movement of the viewer and the digital camera that accompanies them. Thus, we show three examples where we verify that the subsequent use of the video tool enhances and emphasises the display of this type of images, which appears distorted and fragmented in countless observation points, where they are only restored from the original reference from a single point of view. The novelty in the articulation of this theme with digital and media arts also emerges here, especially in the first two examples presented: precisely in the application of video as a powerful tool for exhibiting and sharing these types of images, which can be created or constructed digitally or analogically. Another curious aspect of the video recordings of these anamorphic images was the use of this medium from our mobile phones, through the small digital cameras that are incorporated. Mobile phones were also used to project the images of the anamorphic references, using the small flashlights built into them, projecting the drawings made on acetate onto the projection surfaces of architectural spaces. And here we found another good use for mobile phones, although the light sources they emit, which are well polarised, have a limited range, but sufficient to obtain or construct this type of images in some architectural or natural spaces. These student essays that we will see in the text, the first two produced at the beginning and end with the aid of mobile phones, for the projection of images and recording of videos, can be a starting point for more complex future projects, using more sophisticated instruments with greater potential.

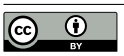
CCS Concepts

• **Applied – Arts and humanities**; • **Applied computing – education**; • **Computing methodologies – computer graphics**;

Keywords

Drawing, painting, video, anamorphosis, 3D modelling

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1 INTRODUCTION

The possibility of illusory representations of shapes and spaces, scenarios, in architectural spaces of various geometries, straight, trihedral, polyhedral, curved and mixed, in today's contemporary

art can involve various ways of constructing them. From traditional tools and methods such as the projection of shadows using light sources, to the use of auxiliary grids and stretched wires, new technologies now also make it possible to rehearse, simulate and construct this type of representation. So, in addition to the classic analogue means and tools, such as a simple pencil, paints and other instruments, today we can rehearse illusory anamorphic constructions using 2D and 3D software and even our own mobile phones, here through the small light camera that allows us to project the images and references, acting as a tool for constructing the anamorphosis, and also with the help of the built-in video camera that allows us to dynamically record the anamorphosis through another vision that is more cyclopean and parallel to our vision. These video recordings of works built or designed for specific spaces have the advantage of being able to be projected later on a large scale with the aid of other computer aids, like projectors. Two groups of our undergraduate students and another Master's student in Drawing, under our guidance and coordination, recently trialled three projects for the Faculty of Fine Arts of the University of Lisbon. The means and instruments used by these students varied and mixed, from the use of more traditional techniques to the use of techniques from the world of computer science technology, in some cases using both digital and analogue tools that complement each other, in other cases using almost exclusively analogue tools and in other cases using exclusively digital tools to test the project, but in the latter case, the aim was to materialise the project with analogue tools. The three proposals presented here, which we will describe below, differ greatly in their effects or language, but what is interesting is that in their respective creative processes, analogue and digital media were used in all three cases, where more traditional media and more technological and digital media intersect. In the text, we present three very different student project proposals, ranging from abstraction to figuration, where the methods used have some differences but also some similarities, establishing a bridge between these two worlds: digital and analogue.

The three examples show us the utilization of old and new technologies and methods, but what surprises us and what we believe to be very relevant is how the final instrument of the video in the three cases, and especially in the first two, can provide the viewer with even more expressive effects, insofar as it records, in and with movement, the constant changes in forms and images, in their legibility, distortion and fragmentation. Furthermore, as video is a monocular record, whose frames show us cyclopean images and moments, it accelerates the expressive effects of geometric perspective, which enriches the viewer's reception of this type of image. As a result, video functions as a new and powerful tool for the construction and reception of these images, with the videos themselves ultimately being regarded as the final works of art shown to the viewer. In the third case, as we shall see, dynamic visualisations with the aid of 3D software allow the best framing to be viewed and designed virtually in order to produce final works completed in analogue form. The use of little mobile phones was crucial in the first two cases, showing how this type of image can be constructed and designed with minimal resources, inspiring the students, authors, to take on more complex challenges in the future, using other more sophisticated instruments such as long-range light projectors that allow them to rehearse and produce anamorphic images located at great distances.

In summary, we find that what is relevant, considering the three essays described in the text, is that there is no doubt that the illusion of metamorphosis of forms in art, and especially in digital art, can be produced, as we see especially in the first two examples, by including the theme and techniques of constructing anamorphosis and *trompe l'oeil* with the great final reinforcement of video as a digital tool that allows you to accelerate, share and boost the desired metamorphic and anamorphic effects anywhere, thus functioning as a powerful medium beyond the other tools and techniques, digital or analogue, that participate in the construction of this type of static and moving images. On the other hand, the third example, constructed with the aid of 3D tools, shows how references from art history, such as Eduard Hopper's analogue painting, can be tested in new environments and contexts and also inserted into these anamorphic and metamorphic games.

2 BETWEEN THE VISIBLE AND THE INVISIBLE. METAMORPHOSIS, ANAMORPHOSIS AND THE FORM CONSTRUCTION AND DECONSTRUCTION

> "From changed forms into new bodies, ingenuity leads me to speak; oh gods, inspire my endeavour (for you have changed it too) and lead my song uninterrupted from the primordial origin of the world to the present day" [1].
>
> 'Nothing remains, but everything flows. Fragment adjusts to fragment and so things grow. Until we know and name them. They merge and are no longer the things we knew' [2].

The terrestrial bodies appearance, whether man-made or not, artistic or non-artistic, always appears in a particular way to the viewer, who already has a subjective reading. These qualities and differences in human beings are also reflected in the history and journey of the forms in the space that comprises them. The anamorphosis, those images that are restored or become legible and identifiable from a certain point of view, the prince's eye, a concept already referred to by the ancients, at the same time starting from other arbitrary points of view that move away from the privileged place of observation, show other unreadable, distorted, apparently transformed or fragmented forms, without however, altering the contour of the initial shape in any way. This kind of apparent mutation of anamorphic forms, resulting from the viewer's wandering visions around anamorphic images or objects, creates new distorted, fragmented, visible, invisible, partially visible and partially invisible, rather enigmatic and misshapen images and forms that are not exhausted by their multiple appearances. They are like Nature's metaphor itself in constant transformation and mutation, sometimes slower, sometimes faster. The anamorphosis thus appears and is compared metaphorically to the metamorphoses and principles that Lavoisier already referred to in his chemistry at the end of the 18th century, where in 1777 he mentioned the famous phrase: "In nature, nothing is created, nothing is lost, everything is transformed" [3]. Hundreds of years earlier, the fascination with

the Metamorphoses them was already part of the classical antiquity imagery, as we can be seen in the work of the Roman poet Ovidius, who wrote about mutations, the transformations of forms and things, as well as in the Lucretius imagery, also a poet and philosopher, who also dwelt on the subject of metamorphoses.

The anamorphosis thus reflect and compare a little to the metamorphic world that Ovidius, Lucretius, Bachelard [4] and other authors have already recorded in their poetry. The forms mutations are matched by the apparent images mutations that never end. Like stones that are transformed by erosion or agglutination over time, acquiring other appearances and new forms, in the artistic representation of anamorphosis there is a parallel phenomenon of transformation, but in this case of the illusory transformation of the contours of their forms, which thus acquire various configurations depending on the position of the viewer contemplating them. The effects of the force of time and nature on objects are thus compared to the effects of the viewer's mobility in reading anamorphic forms. Metamorphoses are in nature, in the universe and in man, and anamorphosis are a kind of metamorphosis of images and objects created by man and conditioned only by the gaze of the spectator who, from various arbitrary points of view, outside the radial occlusion [5], shows this kind of invisibility, deconstruction and mutability of the referents being observed. In order to create these effects of the form legibility and *trompe l'óeil* and at the same time its apparent mutability, construction, deconstruction and distortion, in the artistic sphere we find various ways of conceiving them and one of them is precisely the technical and conceptual application of anamorphic representations. In the artistic sphere and on the contemporary scene, various authors have trialled this type of anamorphic image, often combined with the *trompe l'oeil* technique in proposals and projects with a precise language and/or aesthetic that goes beyond the mere application of the dominant techniques used to conceive this type of image. We've already talked about these techniques and methods elsewhere, of these variations in the application of analogue and digital media and techniques, and even the application of both together, as the techniques often complement each other. In the more traditional techniques and in the analogue way, to project and record this type of image, in addition to more traditional scratching media such as a simple pencil, we can use short and long-range light sources, stretched wires materialising visual rays or light-shadow rays and even grids or square meshes which, once projected, are transformed into trapezoids, but in this case the use of grids and their transformation into trapezoids is only relevant if the artists choose to make the anamorphosis on a single flat support. History shows this with the anamorphosis of some portraits that were realised in the 16th century. For the anamorphosis and *trompe l'oeils* representation on more complex curved and polyhedral surfaces, more mechanical and empirical methods, with fewer geometric calculations, are the quickest option. If we choose between these two paths, using the lines of the aforementioned stretched wires or the shadow light rays from a light source, placed in the exact location of the observation point, we have to check the intersection of these lines with the various points of the image or drawing of the referents until we reach the surfaces where the anamorphosis will be recorded. In modern times, as we can see in the case of artists George Rousse and Felice Varini, among others, the traditional grids, magic lanterns, stretched wires and other more traditional elements have given way to modern digital tools, like far-reaching light projectors, digital drawings, virtual 3D modelling tests, good digital cameras and other tools for creating anamorphic effects [6].

3 SOFTWARE, PHOTOGRAPHY, VIDEO AND LOOP IN THE CONTEXT OF THE ARTISTIC PROJECT WITH ANAMORPHOSIS

Today, in addition to the traditional methods with analogue means and tools, we can rehearse anamorphosis in virtual reality with the help of certain 2D and 3D software such as SketchUp, Rhinoceros or Blender 3D, for example. With this software we can rehearse the anamorphosis and the environments in which they are recorded. In fact, digital tools can even make it possible to build the final work of art by assuming it virtually without later applying it to a real concrete space. On the other hand, the tools of digital photography and video are proving to be very useful in contemporary times for various purposes and also in contemporary art. Indeed, in the case of anamorphosis, the recording and digital dissemination and exhibition of anamorphic and *trompe l'oeil* representations on video makes it possible to create another reality parallel to the first, precisely that of the recording, which can complement and even enrich the real vision we have of the works in their specific spaces, even through augmented reality and the monoscopy of the video image which, unlike our stereoscopic vision, registers the images in cyclopean form, thus accelerating the effects of linear perspective on the stereoscopic observer. Imagining a concrete architectural space where an anamorphosis is represented. Using augmented reality, video and the loop technique, we could include a huge screen in that same space where, at the same time, we could observe the continuous movement of a wandering observer or spectator observing the work, starting by observing it from one or more arbitrary points of view until they reach the ideal place in real space where they observe the anamorphic work without distortions.

This aggregation of augmented and parallel reality, via video, placed in real space and viewable on a huge screen could strengthen and enrich the viewer's immersion in the work as we know it. In this case, we would have a double enjoyment of the work in the same place: in real terms, observing the concrete work; and in digital terms, observing the video of this concrete work, which can enrich the aesthetic message of the work itself. Alternatively, and a bit like George Rousse **(1)**, but in this case with the photography of his anamorphosis [7], artists can rehearse their anamorphosis in certain spaces, in analogue, digital or mixed form, and after this phase, of the real representation in a specific real space, create photographs or a video of that same work and take those photographs or that video as the final piece or work. In other words, the photographs and video recordings in this case become the final work of reception for the viewer. In the specific case of video, if we imagine the videos projected with the aid of a computer using the loop technique on a huge screen or even on a huge wall of a space or gallery, or occupying an entire wall of a gallery, the immersive effects can be significantly intensified by immersing the viewer into the work. In other words, the photographs and video recordings in this case

become the final work of reception for the viewer. This loop, structured or divided into three non-stop interconnected times, would first show the view of the work from arbitrary points of view where we would see the metamorphosis of the distorted and fragmented form into ever different images. In a second moment and following on from the previous one without interruption, we would arrive at the ideal place where we observe the piece without distortions, in the place of the prince's eye where we witness the radial occlusion. And finally, in a third moment, we would observe in the video the observer moving away from the place of the prince's eye, recording other simultaneous views of the anamorphosis, observing again, as at the beginning, the diversity of the forms of the anamorphosis resulting from the movement of the spectator and the video camera. After this outcome, the exhibition video would return to the first moment using the loop technique, a technique that consists of filming that returns to the beginning when it ends, repeating itself constantly. This exhibition strategy shows the importance of video, which can be used to bring the viewer into the work, accelerating the visual effects of the cyclopean perspective, since the projector is monocular, just like the viewer in the classic linear perspective, which brings or can bring about very expressive effects in the viewer. Publicity and companies already exploit this type of display for marketing, but not for artistic purposes, as we can see, for example, in the realization of anamorphic images produced by a company in Vietnam, projected onto trihedrons made up of three half-planes (2).

On the other hand, videos can be produced using our own mobile phones, which incorporate small digital cameras, making them a great working tool, because of their small size and in the case of not using long viewing distances. This also happened with some of our students who worked individually and in groups on a project that we'll talk about in the next section, using their mobile phones not only to record the videos but also to project the images. Digital and analogue media were used in all the examples we'll mention. At the end of their works, almost all of the students recorded a video using the loop technique with the aim of being able to rehearse the immersive effects at another time or in another phase, in other spaces, using projectors and other surfaces in larger projection spaces, thus significantly increasing the scale of reproduction and projection of videos made with small digital cameras, such as those built into their own mobile phones.



Figure 1: On the left, Georges Rousses, anamorphosis photograph from the 'Cercles Levants' series, Bordeaux, 2014. Source: https://www.georgesrousse.com/en/selections/archive/2014/

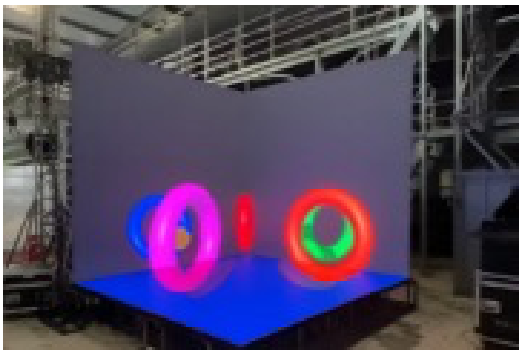


Figure 2: On the right, anamorphic video photo, showing an animation produced in Vietnam, with the aid of Led lights, Tri-planar anamorphic LED display. Source: https://altamedia.vn/anamorphic-illusion technology/?lang=en

4 FROM THE DIVERSITY OF THREE EXAMPLES: BETWEEN ANALOGUE AND DIGITAL

4.1 Around a project

Within the scope of our project *Anamorphosis and Trompe Lœil: geometric methods and conception*, with the collaboration of our students from the Faculty of Fine Arts of the University of Lisbon, the aesthetic choices of the work carried out recently have varied greatly in their diversity and in the means, techniques, methods and tools used [8]. The aim of this project was for the students, individually or in groups, to realise the representation of an anamorphosis associated with the concept of *trompe l'oeil* [9], in a specific space at the Faculty of Fine Arts. The students faced interesting challenges, initially with predictable but still uncertain results. Testing a series of methods we provided in the class, each group tested several methods until they found the ones that best suited their objectives. In two cases, the anamorphic representations were made using almost exclusively analogue methods and tools, with the exception of the use of the mobile phone's light and video camera, which were used to project the images and also to record the final videos. In a third case, the entire project was rehearsed digitally and in virtual reality, using specific 3D modelling software, but with the aim of the final piece being rehearsed using traditional means such as drawing and analogue painting, ultimately using scratching media and acrylic paints for this purpose. The results were expected, but the trial, exploration, and testing of various possible methods sometimes caused some discomfort and anxiety in the working groups, which then found the appropriate options and methods through experience at the exhibition and production sites.

4.2 'The Red Chair'

In one of the projects, carried out by students Leonor Dias, Leonor Costa, Madalena Matos, Pedro Diniz e Vasco Carreira in 2025, the aim was to represent the illusory object of a simple office chair, which they called "The Red Chair". Anamorphosis is perfectly integrated here with the issue of *trompe l'oeil*, since the anamorphic techniques aimed to simulate the illusion of a three-dimensional chair on three plan portions, made up of the floor and two walls of a sector of a space, forming a trihedron. The students began by selecting and taking measurements of the space and a chair that will generate the anamorphosis and the *trompe l'oeil*, then choosing the location of the prince's eye, the place where the chair will later be illusorily observed without deformations. They rehearsed the perspective of this anamorphosis in an analogue way, making a drawing using traces and vanishing points method, considering the real measurements reduced to a certain scale. In a second phase, at the end of the day when the light was low, they projected the chair object itself onto the trihedron formed by the floor and the two walls of the chosen space, with the help of the mobile phone torch, which was placed and fixed at a distance of 1.60cm from the floor and situated in the place of the prince's eye. The mobile phone torch made it possible to record the anamorphic drawing of the chair on the trihedron of the three surfaces through the projected shadows on the floor and on the walls, all three orthogonal to each other. To this end, the students projected the outline of the main lines of the chair using a record of it on a small sheet of transparent acetate that was fixed to a makeshift tripod.

They then used adhesive tape to mark the drawing on the three surfaces. In another phase, in order to avoid damaging the wall surfaces, they used three sheets of tracing paper to decal the projected drawing, which was first recorded using adhesive tape. From these decals on tracing paper, they then transferred these three drawings that form the contours of the chair to three sheets of cardboard, placing them on and fixing them to the three surfaces of the floor and upper walls, taking care to check that the drawings were correct and that there were no misalignments once they were observed from the place of the prince's eye **(**3**)**. The final stage was the inclusion of colour and paint, where studies and tests were carried out, to finally cut out these parts of the designed and painted chair on the three pieces of cardboard, placing and fixing them to the floor and the two upper walls **(**4**)**. The result was very curious and the anamorphic shape of the chair also had quite an impact due to the red colour and the movement of the observer outside and in the place of the ideal viewpoint, showing us the metamorphosis of this curious anamorphosis, given precisely by the various illusory shapes resulting from the view from various arbitrary viewpoints, many of them appearing misshapen until we reach the ideal viewpoint, where we observe the chair without deformations, giving rise to an effect of surprise **(**5**)**. In this example, analogue media dominated the process, with the exception of the new technology of using a mobile phone torch. In the end, the students created a video with the aim of being able to exhibit and share it elsewhere at a later stage, using the loop technique, considering a future immersive enjoyment of the respective presentation and the viewer's reception of the work, which implies an increase in the scale of the projected video, as well as the place where it will be projected. We believe that this digital video resource is of enormous relevance and is an essential tool for conveying the aesthetic and poetic message of this example.

4.3 A green square in an inhabited space

In a second example, realised in 2025 by our student Gabriela Jóia, under our guidance, we saw the representation of a square in an inhabited space. In the process, she used both digital and analogue media. Firstly, she drew a simple square using an iPad and then printed it out on a sheet of transparent acetate. After this stage, she placed and fixed the transparent acetate sheet on a tripod attached to a small frame and then chose the specific place and point where the observer will see the square without deformation, which corresponds at the same time to the place and point where the image of the square is projected. After choosing the exact spot from which to observe the square without deformation, at night, in very little light and with the help of her mobile phone torch, situated in the observer's seat and behind the digital drawing of the square fixed to the tripod, the student projected the drawing through the shadows produced by the lines of the square on the various parts of the house, such as the walls, two doors and the floor. The student, with the help of a second person, marked the drawing of these lines projected by shadows on these surfaces, which she did using adhesive tape. Then, the student measured and recorded to scale the areas and places of the house where the lines of the square projected, obtaining the shape of trapezoids and small irregular triangles. Finally, she filled these areas with green transparent adhesive sheets. The result here is also very curious, because we can see the various shapes of the square, distorted and deformed, from multiple points of view where we can only see the perfect square without deformations from the place that projected it **(**6 and 7**)**.

At the end of the work, the student also made a video with the aim of using it for exhibition purposes and applying it and showing it in various possible public spaces, with the loop technique. Another curious and relevant aspect of this work can be seen in the effective use of transparent green adhesive sheets, which create different shades that reveal a harmony and a palette of tones that are very pleasing to the eye, guided by the geometry of the space, which shows us the anamorphosis and metamorphosis of a square integrated into a classic living space. At the same time, the shape of the green square, seen from the ideal point of view, where we see no distortions or fragments, seems to show us a micro-space or a small surreal world within the real, larger space that encompasses it.

4.4 Modelling software and Eduard Hopper's ghost

In a third example realised individually by another of our students, Vasyl Pauk, digital media were used predominantly to design his work project. The author starts from the memory or ghost of analogue painting and the Edward Hopper's environments, which for him are a reference point, due to the contrasts of light, colour and mystery that the American painter's works evoke **(**8**)**.

For his work, the student chose the corner where two corridors intersect, at the Faculty of Fine Arts of the University of Lisbon,



Figure 3: Drawing of the linear perspective of a chair, using the traces and vanishing points method, recording and marking the drawing chair with adhesive tape after projecting it with the aid of a torch, and the decal drawing chair using tracing paper onto sheets of cardboard. Source by our students Leonor Dias, Leonor Costa, Madalena Matos, Pedro Diniz e Vasco Carreira, kindly provided to the author

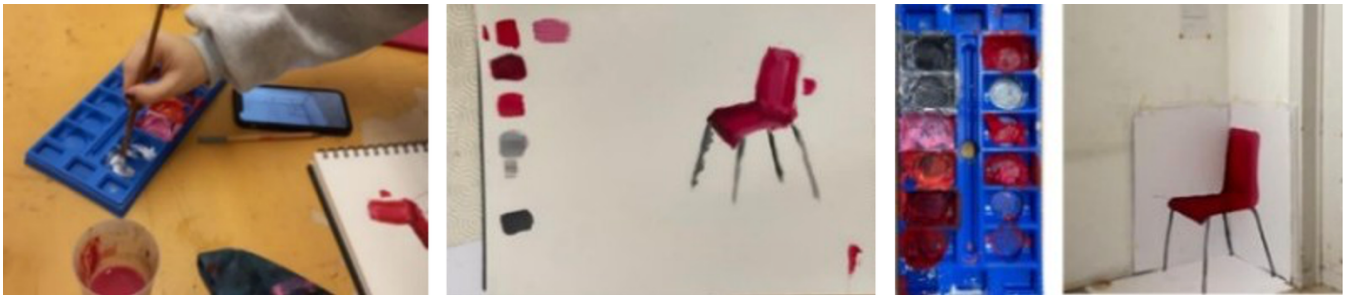


Figure 4: Colour studies of the chair using the watercolour technique. Source by the authors, our students Leonor Dias, Leonor Costa, Madalena Matos, Pedro Diniz e Vasco Carreira, kindly provided to the author

to stage an anamorphic *trompe l'oeil*. The frozen scene of a simple dog observing, reminiscent of Hopper's human figure poses, was exclusively created in virtual and digital form with the help of software, using the Blender 3D modelling programme, but with the aim of ultimately being represented in real space in analogue form and with analogue and traditional means, using paints and brushes.

For the staging and design of this anamorphic *trompe l'oeil*, the student, using Blender 3D software, began by making a 3D scan of the location where the anamorphosis will be represented, also using the Polycam application for this purpose, which is a good mobile application available for iOS and Android devices that allows you to create 3D models of objects and spaces using photos and, on devices



Figure 5: Views of the illusionary chair video from four arbitrary points of view, where we see the chair deformed, and at the place of the prince's eye, where we see the chair without deformations. Source by our students Leonor Dias, Leonor Costa, Madalena Matos, Pedro Diniz e Vasco Carreira, kindly provided to the author



Figure 6: Views from the video loop of the illusionary square from four arbitrary points of view, where we see the square deformed. Source by our student, Gabriela Jóia, kindly provided to the author

with a Lidar sensor, real-time scans. This application also offers tools for editing and exporting 3D models in various file formats. In the model used, the student maintained and considered the real dimensions and textures of the place, facilitating the testing of the artistic object integrated into that space where the extraction and consideration of the respective measurements or coordinates was essential. After that, the student virtually created the illusion of a niche or hole in the walls of the real architecture, which he cut out with an equally illusory frame, inside which he quoted and referred to the light, colour and atmosphere of Eduard Hopper's paintings (9).

Once the work has been staged virtually, in order to materialise this virtual work into a real one , the student then virtually considered a grid with a 1m x 1m square, facilitating the creation and marking of reference points that allow for the extraction of measurements to then pass from the virtual rehearsal to the real walls of the real space (10).

After the grid of orthogonal lines was considered, the student considered various reference points in the virtual and illusory scene represented, which he marked with small red crosses, recording measurements and coordinates that must finally be transported to the real walls where the anamorphic *trompe l'oeil* will be represented. For this last phase, to draw the contours of the shapes on the two corner walls, the measurements were extracted from the virtual scenario, where the student then recorded the analogue drawing on the walls with a simple pencil and adhesive tape. The final part will be the integration of drawing and analogue painting on the two walls, using the virtual model as a guide. The student then chose to cut out two fragments of canvas and attach them to the two walls to avoid damaging them, and he also considered a wooden frame that encompasses the entire scene, just as we see in the virtual model. The final part of the work was completed with analogue painting and acrylic paints on the two canvases fixed on the walls (11).

5 ANALYSIS OF RESULTS AND FINDINGS

In contemporary times, the means and technical options for realising artistic projects oscillate between the analogue and digital worlds. In certain areas, more analogue media are used, in other areas more digital media and in still other areas the two worlds complement each other: analogue and digital. In the three examples shown, we have seen how the illusion of the metamorphosis of forms can be produced with the inclusion of the anamorphosis



Figure 7: View from the video loop of the illusionary square from the ideal point of view, where we see the square without deformation. Source by our student, Gabriela Jóia, kindly provided to the author



Figure 8: Eduard Hopper, *Morning Sun*, oil on canvas, 1952, Columbus Museum of Art. Image source: https://www.columbusmuseum.org/blog/2020/05/12/pocketguide-to-cma-edward-hoppers-morning-sun/

and *trompe l'oeil* theme and techniques, visualising in a distorted and legible way a fixed representation in a specific place, whose appearance is not exhausted, given the mutability and dynamics of the points of view, as we have seen in the case of the examples rehearsed by some of our students in different places in the architectural space of the Faculty of Fine Arts of the University of Lisbon. The design of the three proposals all involved both analogue and digital means, but in one case the conceptual process was more digital through the use of computer-aided modelling software. The possibility of recording, sharing, publicising and including the video made of the anamorphic works, using the loop technique for example, could enrich the aesthetic message for the viewer. It's also interesting to note that these artistic options and essays that include the theme of anamorphosis and *trompe l'oeil*, with or without video, are not exclusive to the artistic sphere and can have other applications in the media world. We also see and emphase that the exclusive use of digital media may not be the best solution at times or on some routes. Nowadays, the two paths - digital and analogue - not only live separately, but also complement each other.

6 CONCLUSIONS

The means are not to be confused with the ends and the use and application of traditional, analogue tools and means, and more technological digital means, drawing and analogue painting and drawing, digital painting and computer-aided modelling or other varied and mixed techniques using diverse materials and technologies, used separately, or complemented, or simultaneously, can bring very satisfactory and surprising results in the world of visual communication and in this case, as we have seen, in the artistic world and in the world of artistic teaching. In artistic representations, the contemporary works of art production, often begins with analogue tools and ends with a totally digital project, but the opposite also happens: digital tests using various software can often be a tool for the final analogue production of artistic works. In other cases, as we've seen, we still see the complementarity and



Figure 9: Vasyl Pauk, virtual and digital rehearsal of anamorphosis and *trompe l'oeil* depicting an interior scene with a dog. Source of Vasyl Pauk, kindly provided to the author.

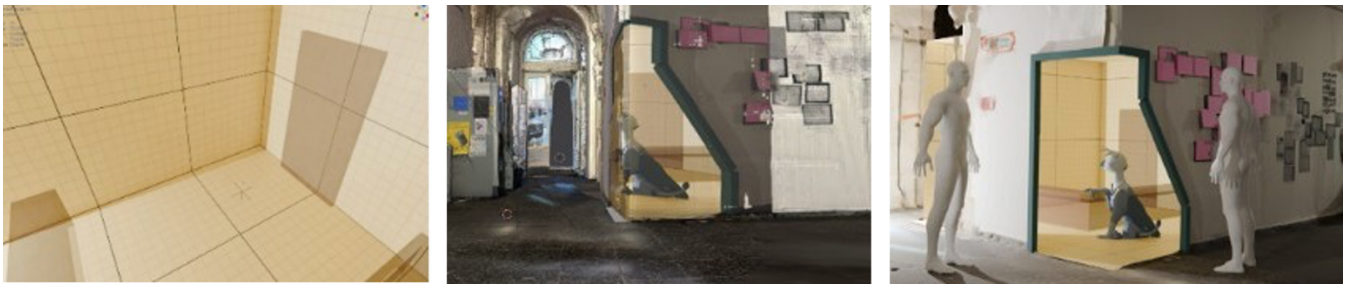


Figure 10: Vasyl Pauk, virtual and digital rehearsal of anamorphosis and *trompe l'oeil* representing an interior scene with a dog, with the marking of a speck or mesh in the illusory virtual space considered. Source of Vasyl Pauk, kindly provided to the author.



Figure 11: Vasyl Pauk, virtual and digital test of anamorphosis and *trompe l'oeil* and the process of transposing the drawing into real space, considering and marking red reference points, to transpose these measurements from virtual reality to real space, as we can see. At the bottom of the picture, we can see the final and expected result, made in the future with analogue and acrylic paint on two pieces of canvas fixed to the wall. Source of Vasyl Pauk, kindly provided to the author.

inclusion of both digital and analogue processes in the exhibition and aesthetic message of works of art.

The theme of anamorphosis, often associated with trompe l'oeil, shows in contemporary times how the techniques and methodological procedures used to create these images, constructed using

traditional and more technological means, can display works that are not only static but also in motion, where the application of certain computer-aided design software, 3D modelling design and digital video allow this theme to be dynamised and transported to new immersive and constructive scenarios. On the other hand, the dynamics of digital video in recording this type of work also allows these metamorphic images, which appear distorted and fragmented in their various possible viewing locations, to be slowly or rapidly exposed, restored in a single place and from a single point of view, precisely that from which the images were projected. The works presented by our students, using minimal resources such as simple flashlights and digital cameras built into their mobile phones, show challenges that were to be expected, but with interesting results that can be enriched in the future with other more sophisticated resources and on a more monumental scale, using long-range projectors or more professional video cameras. In short, digital tools are essential and function as new mediums for the conception of these images, which are simultaneously anamorphic and metamorphic, and in this way, they contribute to and enrich the production and exhibition of this type of art, which has been known since the Renaissance, when more traditional instruments and methods were used.

Acknowledgments

To all my students and my son.

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The Plasticity of Generative Artificial Intelligence in Materialized Artistic Practice. Case Study 'in/visibilidades no feminino 2.0'.

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Abstract

This article offers a critical examination of the convergence between art and technology, exploring how the generative plasticity of Artificial Intelligence reconfigures emerging artistic practices. It analyses the transformations introduced by Generative Artificial Intelligence, which metamorphoses modes of expression, production, and authorship while simultaneously enabling the subversion of hegemonic narratives and the emergence of new digital aesthetics. The analysis focuses on the materialisation of artistic artefacts through generative processes, with particular emphasis on the case study *in/visibilidades no feminino 2.0*, an experimental project that employs GenAI as a device for the symbolic recomposition of female identity, supported by ethnographic imagery and critical mediation strategies. The results demonstrate that GenAI can operate as an agent of co-authorship and interdisciplinary collaboration, fostering the reinscription of gendered subjectivities and opening space for new forms of representativity in contemporary art. Informed by Donna Haraway's posthumanist perspective [1], this reflection problematises the relations between technology, hybridity, and identity construction, highlighting generative plasticity as a field of aesthetic experimentation and sociocultural transformation.

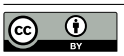
CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Computing methodologies** → Artificial intelligence; • **Social and professional topics** → User characteristics; Gender.

Keywords

KeywordsDigital Media Art, Generative Plasticity, Artivism, Imagetic Ethnography, Female Identity

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1 Introduction

We live in a globalized and polarized society, in which social, cultural and emotional bonds are crossed by fragmented discourses, making it difficult to establish a code of empathy that allows us to understand the world from a more collective, relational and less subject-centred perspective. In this way, technology, as an extension of human evolution, reinforces its intrinsic link to the subject [2].

The concept of *plasticity*, which constitutes the central axis of this research, is understood as the capacity for continuous transformation and recomposition, evolving from its etymological origin linked to the Greek verb *plassein* – to mold – and revisited in the German aesthetic tradition, from a notion of material malleability to a processual and relational dimension. As Ströbele states, plasticity always implies "action and transformation", manifesting both in material and in symbolic or social domains [3]. Building on this conceptual foundation, the study proposes the notion of *generative plasticity* to reflect on the emerging aesthetics of Generative Artificial Intelligence (GenAI) systems. By operating through the algorithmic recombination of visual and cultural archives [4], GenAI transcends a merely instrumental function and acts as an aesthetic agent, producing new configurations of meaning. In this sense, generative plasticity represents a symbolic co-creation process between human and machine that challenges fixed models of identity, authorship, and agency.

In the critical reflection on generative plasticity, a posthumanist approach is adopted – one that questions the centrality of the human subject and reconfigures the relationships between humans and technology. This approach is illustrated by Donna Haraway's figure of the cyborg, which exposes the dissolution of boundaries between nature/technology, body/machine, and mind/matter [1]. This vision challenges traditional binaries and proposes artistic creation as a hybrid, decentralized, and relational practice, in which GenAI assumes an active role in the production of meaning.

This research addresses the central question of how the convergence between GenAI and the interdisciplinary practices of Digital Media Art – namely artivism, ethnography, and cultural mediation – can reconfigure artistic creation and generate new forms of expression that challenge hegemonic norms while contributing to the reinscription of female representational forms. The concept of plasticity is thus revisited from an expanded perspective, understood as an adaptive and transformative capacity that, in a digitally dominated ecosystem, manifests in the continuous recomposition operated by generative neural models. These models stretch and

amplify creative processes, giving rise to new visual and discursive grammars.

The case study *in/visibilidades no feminino 2.0* critically, poetically, and collaboratively integrates GenAI, configuring itself as an artistic artifact with provocative intentionality, exploring issues of female identity, visibility, and invisibility. The work also reveals the dissolution of boundaries between sender/receiver, human/machine, and artwork/process, within the construction of a hybrid and relational artistic practice. This approach aligns with artistic experimentation methods that embrace chance, autonomy, and unpredictability as creative production strategies, akin to John Cage's aleatory music [5].

The practice-based research developed through *in/visibilidades no feminino 2.0* produces materialized knowledge derived from data collection and artistic outcomes as both artist and researcher. The artifact becomes a medium for analysis and reflection, evidencing transformations of the initial concept according to variables such as time, tools, materiality, and inspiration. Within this dynamic, the methodological openness to serendipity and the continuous recording of *in situ* research and observation throughout the creative process prove to be fundamental [6].

Although widely used, GenAI has often been explored from a technicist perspective, leaving under-theorized its plastic potential as a critical tool to reconfigure visual narratives and challenge representational regimes of female identity. Thus, this study examines the critical potential of GenAI within the artistic practice *in/visibilidades no feminino 2.0*, articulating theory and practice through a feminist and posthumanist lens.

1.1 Visibility and Invisibility: Female Identity in the Digital

The dichotomy between visibility and invisibility is central to understanding how female identity is perceived and represented in contemporary digital culture. Historically, women have been portrayed as objects of contemplation, confined within visual stereotypes and cultural labels associated with divinity, motherhood, innocence, and sensuality. For centuries, the female figure was shaped by the male gaze, resulting in a paradox: women remained exposed as images but were systematically silenced as subjects of discourse and action [7]. As Sarzi-Ribeiro states, "women who use their bodies in art and set them in motion through languages associated with technology remove them from the rigid and static posture previously assigned to them. (...) When a woman moves from object to subject, relationships are reversed, and new meanings emerge, including for what is considered feminine" [7].

It is therefore essential to analyse how artistic practice mediated by emerging technologies can challenge regimes of invisibility and contribute to processes of symbolic reinscription. Building on this premise, Section 2 presents the methodology applied to the collaborative intervention between human and GenAI in the creative process; Section 3 explores the concept of convergence between art and technology, as well as the notion of generative plasticity as an expansion of the image-based language mediated by GenAI; Section 4 introduces the case study *in/visibilidades no feminino 2.0*; and finally, Section 5 presents the concluding reflections and proposals for the continuation of the research.

2 The Interdisciplinarity of Generative Artificial Intelligence

The integration of Artificial Intelligence (AI) into artistic practice represents a transformation in the modes of creation and cultural mediation. The change is visible, for example, in video art, which has evolved with technology from the outset, incorporating digital devices and languages to expand its expressive limits.

Manovich points out that the language of the new digital media is defined by algorithmic logic, modularity, automation and variability, aspects that align with GenAI [8]. Arielli adds that, while traditionally the media were extensions of the human senses, "AI is a further extension of human capabilities in mediating between us and the world" [4].

With algorithms capable of synthesizing, modifying and recombining visual and sound elements, artists are exploring compositional dynamics and non-linear narratives that challenge traditional conceptions of authorship, intentionality and originality.

Edmonds stresses that in digital art practices, interaction is central, the focus shifts from the artistic object to the relational experience, involving the audience as an active part of the creative process [9]. In the case of AI, intelligent systems respond to human stimuli, enabling the creation of context-sensitive artworks co-created in real time.

Agudo et al. analysed the aesthetic perception of two groups of participants: one was told that the work had been created by a human, and the other by AI [10]. Although both groups were exposed to the same work, the results indicated a devaluation when attributed to AI, evidencing a perceptual bias about the ability of technology to express human emotions. Sundar observes that people tend to associate machines with characteristics such as inflexibility and lack of emotion, which can negatively influence the aesthetic and emotional evaluation of works generated by artificial systems [10]. The study corroborates the idea that the subjective perceptions and prior beliefs of the public directly affect the perception of the work. Thus, technological interdisciplinarity emerges as a field of experimentation that reconfigures artistic creation and thinking.

2.1 Generative Art: Creative Reconfigurations in the Algorithmic Era

In The convergence between art and AI marks a new stage in artistic creation, marked by collaboration between humans and algorithmic systems. AI is no longer just a technical extension but an active part of the creative process, prompting a reconfiguration of practice as a hybrid, transversal and interdisciplinary phenomenon.

With the emergence of generative systems capable of processing, interpreting and creating images, sounds and texts, the artist no longer occupies the exclusive centre of creation, but acts as co-author in dialogue with automated adaptive processes. This creates an expanded creative ecology, where aesthetic sensibility intersects with computing, statistics and data science, generating new methods of visuality and meaning.

In this scenario, art takes on the role of a critical laboratory for experimenting with the limits of AI. The practice of prompt engineering is structured as an expressive and cognitive means of

guiding generative models, by producing aesthetically coherent and conceptually coherent responses [11].

2.2 Methodology of Collaborative Practice with GenAI

The methodology adopted combines artistic practice, ethnographic research, and technological mediation, integrating GenAI as a collaborative agent in the creative process through the artefact and case study *in/visibilidades no feminino 2.0* (described in Section 4). In this context, technology is mobilized as a mediator of relationships, meanings, and aesthetic experiences.

Based on practice-based research, this approach develops iteratively and collaboratively, involving audiences in the artistic process – particularly younger participants – "given their affinity for digital environments and new forms of communication and interaction" [12].

The artefact *in/visibilidades no feminino 2.0* aims to demonstrate the importance of technique through the plasticity of GenAI in artistic creation, using algorithms to interpret and transform ethnographic data into visual representations, not merely reinterpreting culture but transforming our perception of it.

The project is structured around three methodological dimensions: (1) aesthetic and critical; (2) ethnographic; and (3) collaborative and generative. The artistic practice assumes a reflective and interventionist function, using GenAI to deconstruct hegemonic representations. Thus, aesthetics becomes a space for cultural and political inquiry, where generative plasticity operates as a transformative force within the visual imagination of the feminine.

The artefact draws upon ethnographic archives – female chants, oral expressions, and historical narratives – strongly linked to rural women. Based on the concept of heritage as a dynamic and social process, defined by Johnston & Marwood as "heritage-in-action" [13], the research examines how technology can contribute to the reinterpretation of ethnographic narratives: "Forging links with the past necessarily involves communities in a process of discovering, learning, and producing new understandings about their past" [13].

The research establishes a dual objective: on one hand, selecting female chants and oral expressions strongly rooted in cultural tradition; and on the other, mapping content frequently associated with customs, traditions, and everyday life. These elements are fundamental to addressing gender representation, highlighting female voices often marginalized in traditional narratives.

GenAI becomes a co-author in the creative process, operating through algorithms trained to reinterpret and recombine visual and sound data. This approach highlights the plasticity of GenAI, understood as a capacity for adaptation, transformation, and the generation of new forms from cultural data. Thus, technology ceases to function merely as a technical support and becomes part of a co-creative logic, influencing both the production and reception of artworks.

By emphasizing the kinetic dimension of the creative process, this methodology reveals how the plasticity of GenAI reconfigures not only methods of artistic production but also audience perception. The study demonstrates the transition of technology from a simple instrument to a creative agent that co-authors the process and stimulates critical reflection on identity.

3 The Plasticity of GenAI: Concepts and Approaches

The literature review is grounded in the theoretical principles of the relationship between the elements of plasticity in generative art, focusing on the interactions between plasticity and form in their digital expression. It explores how the plasticity of algorithms – particularly in GenAI – manifests in art and reconfigures human expression.

3.1 Collaborative Practice Methodology with Artificial Intelligence

In the context of GenAI, plasticity assumes an operational dimension, understood as the adaptive capacity of generative models to adjust their behaviours and outputs based on the data received and progressive training processes.

Harari notes that the digital revolution inaugurated a new era in the circulation and manipulation of information, marked by the transition from passive devices to active and partially autonomous computational systems [14]. Since Alan Turing anticipated in 1948 the possibility of machines simulating human thought, algorithms have increasingly assumed autonomous roles, raising ethical and epistemological questions about agency, control, and creative intentionality.

Within this framework, algorithmic plasticity expresses the ability of neural models to continuously reconfigure themselves through cycles of machine learning, adjusting internal probabilities that respond to variable inputs and reflect the flexibility and malleability of the technology [15]. Over the past two decades, these systems have evolved in their capacity for interaction and content generation, with advanced models such as OpenAI's GPT-4 expanding the scale of this plasticity, operating as a dynamic and potentially limitless extension of human creativity.

3.2 Generative Image

In the visual context, plasticity manifests itself most expressively in generative imagery, where the continuous recombination of data and forms produces new semiotic possibilities. Following Ströbele [3], it is understood as a process of continuous transformation resulting from the interaction between archive and algorithmic computation – one that not only alters forms but also reconfigures meanings, generating new symbolic organizations within the field of contemporary visual culture.

The digital image, made up of algorithmic data, is reconfigured as a form of representation that can be translated into different communication systems, allowing for correlation and mapping between visual, sound and interactive. At the same time, the incorporation of AI, facilitated by the integration of computer language, encourages performative experiences mediated by the dialog between machine and spectator. The link between image and reality has become diffuse, multiple and reversible, where the spectator has taken on the role of interface between the real and the virtual, with the ability to move between the two dimensions and highlight the limits of their own ability to interpret the world.

The relationship between human and artificial creativity is explored by Kate Crawford: in Atlas of AI, the author emphasizes that AI should not just be seen as a neutral tool for creative production,

but as a system based on natural resources, human work and specific social practices, whose impacts go beyond the technological dimension [16]. Crawford warns of the risks of anthropomorphizing AI by attributing human characteristics and stresses the importance of recognizing the ethical and social implications underlying this technology. And he advocates an interdisciplinary approach, in which AI is understood as a means of co-authorship, capable of expanding the limits of human creativity, while simultaneously raising ethical and political questions about its use.

This perspective underpins the project *in/visibilidades no feminino 2.0*, which explores experimental practice in co-creation with GenAI technology. Crawford warns of the way in which large technology companies have exploited vast volumes of digital images in order to train machine learning systems capable of inferring human emotions. The practice is based on the premise that there is a fixed and universal set of human emotions, manifested visibly and involuntarily on the face, which is assumed to become a "common view", despite the emotional categorization systems they adopt. Crawford thus invites a critical analysis of this taxonomization, highlighting the epistemological and ethical limits of the attempt to automate the reading of emotional states through technology [16].

3.3 Generative Video Art and New Aesthetics

Video art has evolved significantly with digitization, increasing the accessibility and ubiquity of moving images. With GenAI, new creative processes have been incorporated that combine sound and image, expanding the plasticity of the image and sound spatiality. GenAI, as a co-author of new image aesthetics, creates non-linear compositions, emerging patterns, rhythmic repetitions, visual collapses, glitches and an intensified visual plasticity that alters the viewer's expanded perception. The viewer, confronted with images in continuous flux, activates a more immersive aesthetic reception, marked by the instability of the code.

The process of deconstructing and reconstructing images and sounds reflects the creative processes of the artistic avant-garde, permeated by a "repository" of images legitimized by history. The experience offered by GenAI in experimental video questions whether it is truly innovative and establishes a new aesthetic paradigm, or whether the artist's main function is to subvert the logic of algorithms in order to expose the prejudices hidden in the programming [17].

One example is the work of artist Mario Klingemann, who uses neural networks to generate images in his project "Memories of Passersby I", an installation in which a machine creates a continuous and endless stream of portraits, inviting the viewer to reflect on the nature of identity and memory [18]. GenAI influences form and content, whether it is experimental and sensitive in nature, or political and activist. Consequently, it does not determine the content, but profoundly alters its expressive characteristics, style, repetition, randomness and error, becoming a compositional strategy that destabilizes traditional artistic logic and proposes more open and sensorial experiences.

The word "generative", from the Latin *generativus*, means the ability to generate, and predates the development of the emergence of AI. Video art (or any other art form) can be generative without resorting to AI-based processes. Manovich mentions that GenAI can be associated with the editing of films that emerged around 1898, experimental collage films such as Bruce Conner's A Movie (1958), or the composite photography popular in the 19th century [19]. Practices that already pointed to a combinatorial logic of manipulation and montage are now manifesting their technicality and expansion through GenAI, and new visual and sound grammars are emerging based on probabilistic calculation, neural networks and automatic learning.

Generative video art seeks to map and problematize the creative processes that involve the use of GenAI in videographic production. The case study *in/visibilidades no feminino 2.0* contributes to this debate by exploring co-creation with GenAI tools, highlighting not only their aesthetic potential, but also their ethical, political and identity implications within contemporary art.

According to Manovich, the aesthetics associated with AI are not limited to the actions performed by machines, but also to the creative ways in which humans use algorithms [19]. He emphasizes that human decisions continue to influence the results generated and shifts the focus from the artistic object to the process of collaborative creation between artist and machine. Style, repetition, randomness and error become the compositional strategies that contribute to reconfiguring the role of authorship and destabilizing the traditional logic of artistic representation, and open up space for expanded aesthetics, susceptible to critical speculation.

Thus, understanding the aesthetic regimes of generative video art becomes essential for analysing artistic practices such as *in/visibilidades no feminino 2.0*, where GenAI is critically mobilized in the construction of alternative visual imaginaries.

3.4 Ethical Impacts and Challenges in the Artistic Community

The growing use of GenAI tools in artistic creation is reconfiguring modes of cultural production and raising ethical and political challenges that extend beyond the technical domain, involving issues of intellectual property, the reproduction of inequalities, and corporate appropriation. As Crawford emphasizes, AI is not a neutral technology but should be understood as "a political technology", built upon infrastructures of data extraction and the concentration of economic power [16]. In this context, databases such as ImageNet (2009), which have been fundamental to the development of computer vision algorithms, expose a structural problem: automated categorization often relies on essentialist and normative taxonomies, reproducing a Eurocentric, masculine, and binary logic [20]. Furthermore, the proliferation of GenAI raises additional concerns related to the environmental impact of large-scale model training, threats to privacy, and the misuse of synthetic content – such as deepfakes – which fuel defamation, visual manipulation, and disinformation.

Critical feminist perspectives, such as that of Haraway, highlight the need to question who is represented in data and who remains invisible in processes of symbolic automation. In artistic practice, this issue becomes evident through prompt engineering, which reveals the ethical negotiation between human intention and algorithmic conditioning, as outputs reflect both user input and the ideologies embedded in training datasets [4]. Thus, creation with GenAI requires rethinking authorship as a relational and

distributed practice among human, machine, and archive – demanding new ethical frameworks grounded in transparency, data justice, representational diversity, and collective accountability. In this context, creativity mediated by GenAI does not erase authorship but redistributes it.

4 Case Study – *in/visibilidades no feminino 2.0*

The methodology adopted in the case study *in/visibilidades no feminino 2.0* is grounded in a posthumanist and critical feminist framework, in which generative plasticity emerges as an articulating principle between theory and practice, connecting processes of algorithmic creation with practices of visual ethnography, artivism, and cultural mediation. This approach enables the exploration of alternative modes of representation and symbolic reinscription of female identity through GenAI systems.

The continuous interaction between artwork and viewer occupies a central place in the project, which operates as a relational and mediating practice, engaging aesthetic experiences based on participation, listening, and the shared construction of meaning. The incorporation of GenAI into the creative process is not merely technical; it operates critically by making visible the negotiation between human and machine in the production of meaning. Thus, identity is understood as a processual and situated phenomenon, emerging from sociotechnical relations rather than fixed essentialisms.

From this perspective, subjectivity is conceived as relational and culturally situated, aligning with the posthumanist critique of hegemonic ontologies. As Poliks & Trillo point out: "What distinguishes one account of postmodern subjectivity from another is less whether or not a given subject can be known, but rather the extent to which it can be known. Social construction means construction" [21]. This conception supports the project's critical dimension, which seeks to challenge normative modes of representation in order to reinscribe historically invisibilised feminine subjectivities.

4.1 Generative Video Art and the Extension of Imagetic Language through AI

Building upon the theoretical and methodological framework presented earlier, this section describes the artistic artifact *in/visibilidades no feminino 2.0*, as well as the conceptual context and participants involved in the process. Situated within the field of Digital Media Art, its objective is to promote gender equality, representativeness, and the expression of female subjectivity through a critical and poetic approach.

The practice employs GenAI resources to develop visual collages from ethnographic materials, exploring interpretative layers that incorporate perspectives from ethnomusicology. The work highlights visual and sound elements extracted from the documentary series *Povo que Canta* by Michel Giacometti (RTP Archives) and the platform A *Música Portuguesa a Gostar Dela Própria* by Tiago Pereira (AMPAGDP), which are brought together into a single aesthetic body, creating a space of memory and social transformation.

In its version of a hybrid installation of generative video art, the film is made up of 27 images of women's faces in movement, generated with GenAI and organized in sequence through prior editing in Adobe Premiere. The Runway ML platform was used to manipulate and merge the different layers of image and video, producing a visual aesthetic typical of the language of video art. This approach stands out as the work's central imagistic element, expanding GenAI's creative possibilities and introducing a critical dimension to the interface, mediation and the concept of authorship. Generative technology has enabled not only the creation of unique images, but also the automation of part of the creative process, proposing new forms of visual narrative construction and subverting the traditional paradigms of interpretation, interaction and creativity.

In the exhibition context, each image from the film is shown for 12 seconds, making up a sequence of 27 portraits accompanied by a soundscape. Among the 12 sounds remastered using sampling and manipulation techniques are excerpts from the songs "Ò Laurinda, Linda, Linda", from the Monchique region, and "Dona Mariana", collected in Aljezur by Adélia Rosado and documented by Michel Giacometti and Fernando Lopes Graça, among others.

Through the digital interface, faces and expressions symbolize collective and subjective actions that become an integral part of the mediating practice culminating in the artistic manifesto. To achieve this visual and symbolic construction, the process began with the recognition of the machine's capacity to (re)write visual narratives, employing prompt engineering as an expressive and guiding practice. Customized prompts – detailed textual instructions – were created to serve as semantic and aesthetic matrices within the generative process. This procedure was iterative and exploratory, involving successive tests, descriptive adjustments, and the appropriation of reference images to align the algorithmic response with the artistic intent.

The material was developed using the RunwayML platform (Gen-1 and Gen-2) in a multimodal process combining text (prompt), still images, and video as simultaneous inputs. Through generative diffusion models (image-to-image, prompt-to-video, video-to-video), generative morphing, frame interpolation, and style transfer, it was possible to generate hybrid sequences of generative video. For example, the initial prompt – "black and white film; an older woman with a rounded face and prominent eyes; natural gesture gently cradling her face; intense gaze fixed on the camera conveying inner strength and serenity…" – was subjected to parametric variations to achieve the desired expressiveness. In multimodal convergence, the visual material was articulated with a curated soundscape composed of female chants and voices, reinforcing the ethnographic and sensorial dimensions of the artifact.

Thus, the digital interface was configured as a space of negotiation between human intention and algorithmic response, where the machine deliberately participates as a symbolic co-author of the creative process [11]. This experimental method demonstrates the generative plasticity of GenAI and its integration within a practice of critical mediation, in which image, sound, and gesture converge to form a visual manifesto on female presence and visibility.

The installation revealed its hybrid plasticity by alternating between an interactive version – with motion capture through TouchDesigner software – and a non-interactive version, based solely on the projection of the film and soundscape, demonstrating adaptability to different spaces, technical conditions, and audiences.

The intervention took place in two distinct moments, each with a specific focus, in the exhibition context through the interactive installation and in the educational context in the classroom with 6th and 8th graders. The first moment took place as part of the 13th edition of the Algarve Design Meeting (ADM), at the Fábrica da Cerveja in Faro, where the artifact *in/visibilidades no feminino 2.0* was integrated into its interactive version during the opening of the exhibition. At this stage, the system captured the audience's movements, promoting a non-linear narrative. However, technical limitations imposed by the space and the constant changes in light made it impossible to detect visitors' movements in the following days, and it was not possible to test the work's communicative and affective effectiveness. As an alternative, the installation was shown in video art film format, maintaining its aesthetic integrity, accompanied by 27 portraits displayed in the space. The result was equally effective, providing an immersive environment for contemplation and listening.

The flexibility between versions – the interactive one, with motion capture, and the non-interactive one, featuring an immersive visualization of the video art film incorporating sound – confirmed the artifact's adaptability to different conditions and audiences. Data collection was carried out through an online questionnaire (accessible via QR code), participant observation, and direct testimonies from visitors on-site. A sample of approximately 20 participants provided relevant qualitative data regarding the reception of the artwork. The small number of responses does not compromise the ecological validity of the study, as the objective lies not in statistical generalization but in the exploratory and situated analysis of audience perceptions within a specific artistic context. Thus, the research is qualitative and interpretative in nature, oriented toward understanding the aesthetic, affective, and symbolic impact of the artifact.

The results indicate a largely positive reception, pointing to significant emotional involvement and critical reflection on the work. The most striking element was the connection between visual and sound, valued as a central aesthetic component, in articulating image, sound and poetic narrative in an integrated way. The synesthetic dimension was essential in the sensitive activation of the spectator's body, even if passively.

Terms such as "reflection", "inspiration", "self-expression", "awareness" and "empowerment" emerged as key words in the responses, confirming the intention to create a symbolic and political space, where the image functions as a vector of resistance, visibility and presence. As for the impact of the images generated by GenAI, most participants considered them to be impactful, while a significant portion reported a neutral perception. These findings highlight the aesthetic potential of GenAI, but also reveal the need to strengthen critical literacy concerning its processes and ethical implications. The artistic practice demonstrated openness to GenAI as a mediator of subjectivities, although still marked by interpretative ambiguities.

Regarding the perception of female subjectivity, approximately half of the respondents indicated that the installation positively expanded their understanding of the theme, while others reported a more moderate yet still favourable impact. Only a minority stated that they did not experience any effect. These results show that, although effective in communicating perspectives on female subjectivity, there remains scope to strengthen the critical and pedagogical dimensions of mediation – for instance, through complementary strategies such as workshops, guided discussions, or interpretative materials.

In short, the intervention proved fruitful as an artistic research project, confirming that practices based on experimentation and AI can contribute to the construction of feminist narratives, linking art, technology and cultural mediation.

The second moment took place in a school context, in a face-to-face action with students from the Padre João Coelho Cabanita Primary School (Loulé), integrating the pedagogical approach into the lesson plan dedicated to the theme of gender equality, in line with the curricular objectives of the Visual and Technological Education subject. The action was based on a mediating artistic proposal, using the artifact as a catalyst for expression, reflection and dialogue between children and young people. The activity involved 35 students from the 6th and 8th grades (aged 11 to 14) and was structured in three sequential moments: viewing the video art film, a guided collective debate and the application of an individual questionnaire with twelve questions, designed to assess aesthetic reception, emotional impact and understanding of the topics covered.

The data shows the potential of art as a tool for raising awareness and education. Around 49% of the students reported having been particularly impacted by the visual and cinematographic component. The visual language of video art proved to be effective in capturing attention and stimulating involvement and curiosity.

The sound dimension also stood out, with 31% of the students identifying the chant as the most striking element and 18% referring to the mastering of the female voices. The response shows that the voice was perceived as a means of emotional expression of identity, reinforcing the connection and purpose of the project by presenting songs as forms of resistance and cultural memory.

As for understanding the content, 55% of the students recognized the importance of valuing the contribution of women in history and society, and 83% understood the concept of gender equality. However, only 37% said that the film had actually helped them understand the concept, while 26% showed some confusion. This indicates that the artifact should be accompanied by additional mediation strategies (such as guided conversations or complementary activities) to broaden conceptual understanding.

As for the representation of female identity, 54% of the students identified it as strong and resilient, and 51% recognized that the film could help transform perceptions about the role of women. This openness to the ambiguity of reception confirms that artistic practices do not operate in a linear way but offer a space for subjectivity and interpretation, which, in itself, constitutes a response generated by the artistic and educational process. Responses such as "women can work in any profession" (89%), "leadership has no gender" (63%) and "video games are for everyone" (75%) reveal a positive trend towards deconstructing stereotypes among young people.

The intervention in a school context confirmed that artistic-educational practices such as *in/visibilidades no feminino 2.0* have the potential to provoke reflection, open spaces for dialogue, and

promote inclusive values, especially when inserted in an articulated way and supported by mediation strategies. The articulation between art, pedagogy, and technology has revealed fertile ground for transformation and new perceptions in education. Presented in two distinct contexts, artistic-academic and educational-school, the practice enabled the observation of the artifact's reception and impact among different target audiences, through participatory and interpretive methodologies.

The hybrid approach of individual and collective sound creation emerged as the central methodological axis, built on the experiences and reflections evoked by the artifacts. The project proposed a space for experimentation where art, sound and technology articulated the construction of new narratives for the expression of female identity.

Inserted in the field of digital media art and guided by feminist epistemologies, the project has helped to revisit stories and give visibility to women's voices. The convergence of technologies, artivism and cultural mediation broadened the scope of the artistic practice, revealing its potential to provoke critical thinking, generate meaningful aesthetic experiences and instigate social and educational transformation. The process, understood as a space in continuous becoming, is in line with what Coleman, Page & Palmer call "This method of mapping these intra-actions, of place with bodies, the action between, is what matters. We also conceived this method as poietic in that it is flexible, dynamic and open, continually becoming. It is not a thing, object or outcome but a space of possibilities and a potential for learning and research" [22].

The project reflects on the embodiment of female identity, articulated through dialogue and artistic experimentation. The production of "interactive" dialog became the focal point of the research, allowing us to understand the importance of exchange and the intrinsic relationship between creative processes and the results of the interventions.

The artistic practice not only explores the intersection between art, identity and technology, but also establishes itself as a space of resistance and visibility for feminist thought and creation. It incorporates AI to explore female identity through visual representations that combine image and ethnographic data. Each image in the series is the result of a complex interaction between AI algorithms and artistic inputs, which converge to create a work that is both an individual expression and a collective reflection.

4.2 Interdisciplinarity, Collaboration, Reception and Impact

The plasticity of AI in artistic practice materializes in the tension between automation and performative action, where critical exploration of generated images goes beyond the aesthetics of error and mere technical experimentation. This type of performative approach questions not only the autonomy of the system, but also the ethical codes and structures that regulate the visible in the context of the digital image.

Furthermore, the temporality of the automated image reveals itself to be paradoxical: on the one hand, it follows an automated, calculable and predictable flow; on the other, it is open to temporal disjunctions and the randomness of computational processes. In the context of artistic practice, this duality can be explored as a speculative field where the image becomes a vector for new materialities and modes of visual existence.

In this sense, the plasticity of AI in art is not limited to its ability to simulate pre-existing styles or compositions but manifests itself in its capacity to reconfigure the dynamics between gesture, time and matter in the creative process. The automated image, by encapsulating within itself the logistics of light, composition and texture, challenges the traditional limits of visuality and suggests a new paradigm of artistic production, in which AI not only mediates creation, but also becomes a constitutive part of the artistic gesture itself [23].

Cultural mediation refers to "the cultural aspects of the community" [24] and is an intervention model that articulates the principles of cultural democratization with the appreciation of socio-cultural diversity, taking into account the specificities of the public. Its aim is to actively promote citizenship through practices that foster inclusion, critical participation and recognition of the multiple voices that make up contemporary social life.

The artistic practice i*n/visibilidades no feminino 2.0* positions itself as an artivist instruction aligned with the principles of cultural mediation, by mobilizing art as a space for listening, reflection and transformation. The action manifests itself in the relationship between the artistic object and the different audiences - from the exhibition space to the school context - and assumes mediation as a dialogical and participatory process. More than a finished work, *in/visibilidades no feminino 2.0* proposes an open and procedural structure, in a territory of relationship between subjects, technologies and identity narratives. The artistic device, understood as a technological, sensitive and conceptual interface, invites the public to co-create meaning, operating in the critical (re)configuration of the aesthetic experience.

This approach dialogues with the structural duplicity of the technical device and the spectator's experience in the art space, as Mondloch emphasizes when he states that the interface is an extremely ambivalent material object, functioning simultaneously as a material surface and as an immaterial or conceptual threshold for images or other information [25]. In *in/visibilidades no feminino 2.0*, ambivalence materializes in the work, which expands as a field of possibilities - a space in continuous becoming - where mediation translates as a transformative practice, promoting inclusion, active participation and the recognition of marginalized subjectivities.

5 Final considerations

The results of the artistic intervention revealed key elements that reinforce the relevance of the *in/visibilidades no feminino 2.0* artifact as a materialized artistic practice grounded in interdisciplinary convergence. Its adaptive capacity stands out, evidenced by its transition between different contexts of engagement – exhibition and educational – while maintaining its symbolic, aesthetic, and discursive functions.

The artifact's hybrid plasticity became evident in the alternation between the interactive version – based on the sound dialogue between artwork and participant – and the video art film version – more immersive and contemplative – which expanded the work's

reach and made it accessible to different contexts, even under limited technological conditions. Its versatility proved particularly relevant when considering the differentiated reception by diverse audiences. In the exhibition setting, adult audiences favoured the sensory and symbolic dimensions of the work, highlighting the articulation between image and sound as a source of strong emotional impact. In contrast, in the educational environment, younger participants emphasized the interpretative and reflective aspects of the images, recognizing the thematic relevance of the project in addressing social representations of gender.

The distinction reveals not only the plurality of interpretations generated through the work, but also its potential as a mediation device. In fact, the experience in a school context highlighted the pedagogical value of artistic practice as a mediator of meaningful learning. The visual and sound language of video art, even if abstract in nature, has proved effective in raising young people's awareness of gender issues, acting as a catalyst for critical thinking and artistic literacy. Pedagogical mediation proved to be a decisive factor in activating the reflective potential of the work. Through debate, guided listening and the formulation of questions, it was possible to broaden the cognitive and affective impact of the aesthetic experience, reinforcing the role of the artist-educator as a facilitator of knowledge and interpretation.

Another relevant aspect identified in the analysis of the data collected relates to the affective and symbolic dimension of the images and sound present in the artifact. The strong imagery of the female portraits in dialog with the chants, voices and ambient sounds established an emotional connection with the audience, creating a sensory bridge that contributed to immersion and empathy. This combination of elements favoured the construction of a plural and empowered representation of female identity, fulfilling the original intention of the project: to make visible the diversity of women's narratives through poetic language mediated by technology.

In this context, the results indicate that the convergence between GenAI and the interdisciplinary practices of Digital Media Art reveals a path for reconfiguring contemporary artistic creation. The case study *in/visibilidades no feminino 2.0* confirms the plasticity of AI in artistic practice, not only as a technical tool for generating images, but also as an agent that fosters complex aesthetic experiences, open to mediation, interpretation and dialog with different audiences. It demonstrates that this articulation not only enhances new imagery and aesthetic expressiveness, but also acts critically on the hegemonic mechanisms of female invisibility, through the recovery of memories and faces of women invisible to the dominant historiography, the valorisation of subjectivity as a situated and relational construction, and the creation of sensory and symbolic artefacts open to dialogue and interpretation, and consequently materializes a poetic gesture that contributes to female empowerment. The work not only preserves plural narratives but inscribes them in a present still marked by structural inequality and threats of regression in terms of gender rights. In this sense, artistic practice mediated by GenAI asserts itself as a space of resistance and awareness, promoting a critical and affective literacy that appeals to diverse audiences and fosters the construction of more inclusive and equitable imaginaries.

Although the results highlight the potential of the artifact as both an artistic and mediating practice, it is acknowledged that the analysed sample presents a limited scope. Therefore, it is proposed that the research be continued with other groups and study contexts in order to deepen the understanding of the aesthetic, pedagogical, and cultural impacts of GenAI on collaborative artistic creation and on the public perception of female representativity.

As a materialization of new knowledge, the artifact points to possible future developments in research supported by artistic practice, deepening the mediating role of Digital Media Art in the construction of emerging narratives in interdisciplinary contexts.

6 Ethics Statement

In the experiment with the students, written informed consent was not requested because the research was in line with the lesson plan in the field of gender equality.

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Practicing The Weird Third Thing: A Participatory Methodology for Machine Unlearning through Playful Subversion

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Abstract

This paper proposes a participatory methodology for engaging with artificial intelligence beyond dominant narratives of optimization, control, and solutionism. It reframes machine unlearning, a technical process within AI research concerned with removing specific training data, as a conceptual and methodological provocation. What if unlearning could be extended to our sociotechnical imaginaries, values, and inherited biases? Drawing from over a dozen participatory workshops conducted across Europe between 2023 and 2025, this approach invites participants to co-create speculative prototypes through playful subversion, collective reflection, and embodied critique. The method is situated in the gray zone between techno-doomerism and hype, a space where ambiguity, refusal, and care can become productive forces. Rather than seeking clarity or resolution, this methodology embraces contradiction and co-emergent knowledge. Framed by feminist epistemologies and inspired by traditions in critical design, cyberfeminism, and arts-based research, this paper positions unlearning as both a political and poetic gesture of unmaking dominant narratives, undoing habitual responses, and unsettling inherited structures. The insights surfaced through this process suggest new ways of relating to AI and technology, not by fixing broken systems, but by reimagining our entanglements with and within them.

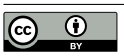
CCS Concepts

• **Human-centered computing** → **Participatory design**; • **Applied computing** → *Media arts*; • **Computing methodologies** → Artificial intelligence; • **Social and professional topics** → Gender.

Keywords

Feminist methodology, participatory design, research-by-making, practice-based research, situated knowledge, critical pedagogy

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1 Introduction

Just over 30 years ago, CERN made the World Wide Web publicly accessible [5], following its development by Tim Berners-Lee [4], a decision that significantly altered the way we communicate, express ourselves, and relate to one another over the past quarter century. While the Internet itself had existed for decades prior, this release marked a critical shift, popularizing digital connectivity and laying the groundwork for the sociotechnical infrastructures that now shape our everyday lives.

The early Internet pioneers predicted a techno-utopia, as famously stated in the Declaration of the Independence of Cyberspace [1], and feminist scholars and artists did not hesitate to participate in the emerging discourse. They aimed to seize the moment and influence the very beginnings of virtual space that was forming right before their eyes. This time around, they wanted to *make it right*. Thus, cyberfeminism was born. Although undefined by definition [12], the term itself was simultaneously coined by British cultural theoretician Sadie Plant [16] and the Australian artist group VNS Matrix in their Cyberfeminist Manifesto for the 21st Century [11]. The term was deliberately kept as open as possible to invite all kinds of perspectives on what it could mean, rather than imposing a single definition from above [14]. The prevalent perspective within pre-millennial cyberfeminism tended to exhibit a rather optimistic approach toward digitality and connectivity.

We now understand quite well that *"all technology reflects the society that produces it, including its power structures and prejudices. This is true all the way down to the level of the algorithm,"* as stated in Legacy Russell's *Glitch Feminism* [17]. Thus, we should not be surprised that, contrary to the strong proclamations of the cyberfeminists of the 90s, cyberspace has not evolved into a kingdom of liberation and self-empowerment. Instead, it has helped and continues to help reinforce existing hierarchies and power structures [19], and with the domestication of the Internet, even the term "cyber" itself has lost its shine and no longer feels sufficiently current to mobilize the political imagination [14].

And how could they possibly create something *right* from structures that were inherently flawed in the first place? Or, as Audre Lorde states, *"the master's tools will never dismantle the master's house"* [10], to truly dismantle an oppressive structure we must step outside the established means and modes of power, set aside those very tools, and instead invent new strategies unburdened by the systemic biases they aim to dismantle. But how do we begin such an invention? What alternative epistemologies and methods can guide us when we choose to resist instead of replicate?

This is the invitation posed by one of the key contributions to feminist epistemologies, feminist standpoint theory, which posits

that all knowledge is situated, making knowledge production inevitably entangled with the power structures from which it emerges. We should nurture margins to generate new and critical questions [15] and see them not just as alternative insights, but as alternatives to the way insight itself is produced.

Within this landscape, the term *"view from a body"* [15] becomes particularly potent. It proposes the idea that our knowledge is always embodied because we live it through our bodies, minds, values, and everything in between. It is never a universal or absolute truth, nor is it neutral or objective. Those who strive for neutrality often find themselves detached from their subjects, severing knowledge from its context. Abstracting experiences into data points means losing critical knowledge and potentially preventing deeper understanding. As Aimi Hamraie [7] suggests, it is not only about the knowledge that shapes design, but also the lack thereof. Can we perceive the world sensibly enough to be able to look beyond the visible and uncover the invisibilities of our existences?

These provocations shape the core principles of the methodology that follows. If knowledge is always embodied and power-laden, then our methods too must reflect this entanglement. Rather than attempting to fix flawed systems with equally flawed tools, this approach stems from a refusal of neutrality, universality, or resolution. As Susan Sontag voiced in her essay *One Culture and the New Sensibility* [18], we need aesthetic and intellectual practices that value affect, form, and immediacy as much as argument or utility. In that spirit, this work treats artistic and feminist approaches as modes of resisting technosolutionism, embracing ambiguity and embodiment as sites of critical potential. The methodology proposed here thus does not aim to produce optimal solutions or measurable outcomes but to cultivate new sensibilities through a practice of staying with complexity—what might be called a feminist method of machine unlearning.

2 Toward a Participatory Methodology of Machine Unlearning

This paper proposes a methodology that emerges from an ongoing inquiry into what it might mean to approach artificial intelligence not through mastery, optimization, or innovation, but through speculation, refusal, and critical care. Rather than treating machine unlearning solely as a technical fix for removing problematic data, it is reframed here as a conceptual space where we might begin to unlearn the dominant narratives and assumptions that have shaped both our technologies and ourselves.

This is the terrain where *playful subversion* becomes not just a distraction but a tactic. In the space between doomerist fatalism and techno-optimist fantasies lies a gray zone—or rather, a *hot compost pile* [9]—where ambiguity, contradiction, and situated refusal begin to break down dominant narratives. As Donna Haraway remarks in *Staying with the Trouble*, composting is not about purity or linear progress but about *making-with*, about staying with complexity and decay to nourish new forms of life. It is in this messy, speculative heap that the feminist methodology of machine unlearning is situated, where *play* becomes an act of agency, allowing us to imagine AI not as something that merely reinforces existing biases but as something that can be reconfigured, reinterpreted, and reclaimed.

Rather than advancing a fixed framework, the approach presented here describes an emergent and participatory *methodology-in-the-making* shaped through workshops, conversations, and co-creation with diverse publics. What follows is a set of methodological principles drawn from lived experimentation—less a manual than a mapping of tensions, gestures, and possibilities that have surfaced across these collective encounters.

2.1 Mapping Vulnerabilities as Situated Beginnings

Each encounter begins with the personal and collective. By identifying what is broken and what feels wrong in the ways AI systems operate, particularly for women and marginalized communities, this phase surfaces concerns and creates a *soft dataset of vulnerabilities* that can also be considered a counter-dataset to those used in AI training. In this context, the dataset is not positioned as a neutral or bias-free alternative. Instead, it foregrounds its own positionality by centering experiences that are often awkward, unsafe, or invisible in digital spaces. It brings to light the emotional and affective dimensions, including fears, discomforts, and power structures that mainstream datasets often obscure or erase.

2.2 Playful Subversion as Research-by-Making

In this phase, participants collectively design speculative products that subvert, exaggerate, or disrupt existing systems. Play is engaged as a central methodological gesture, transforming it into a means of thinking, questioning, and exploring possibilities without the necessity of fixing everything at once or possessing all the answers. The process is deliberately non-hierarchical, inviting anyone to contribute. Play represents an embodied experience where participants use their hands, humor, and shared cultural references or differences. It is also subversive, permitting us to mock, exaggerate, or reimagine power structures. By sharing these playful encounters during the workshops, participants engage in a counter-method to traditional research, which often prioritizes objectivity, expertise, and rational analysis while dismissing subjective, emotional, and embodied knowledge as less valid.

2.3 Blurry Outcomes as Anti-resolution

Refusing to succumb to the pressure to arrive at polished or finalized solutions, the process gathers traces, fragments, and unfinished business. The goal of the workshops is not to produce market-ready prototypes but to leave space for ambiguity and contradiction. It centers more on process than on product, exploring rather than concluding, and posing better questions rather than providing answers. It is about *staying with the trouble* [9] and allowing complexity to remain visible.

Although the speculative products created in the workshops are not intended to solve AI's or the world's problems in a clean or definitive manner, they can still evolve. Some of the speculative products emerging from these workshops have the potential to grow into artistic interventions, installations, or performances. In some instances, participants have been so intrigued by the ideas generated that they have stayed in touch after the workshop, forming groups to further develop their concepts into products or creative projects.

2.4 Low-entry Participation

The methodology intentionally engages people who do not necessarily have technical expertise. By inviting participants with diverse, non-technical perspectives and experiences, it challenges the notion that AI is exclusive to a select few possessing the most prestigious technical degrees. The workshops embrace polyvocality, or the presence of multiple voices, each contributing from its own embodied reality. This echoes Audre Lorde's assertion that our differences, instead of separating us, can be a source of collective power. As Lorde reminds us, *"It is not our differences that divide us. It is our inability to recognise, accept, and celebrate those differences."* [10] In this sense, the workshops become temporary spaces of feminist world-building, where friction between perspectives is not something to be resolved but rather an engine for creative thought. What emerges is not consensus but a patchwork of insights.

2.5 Collective Knowledge-Making

Rather than viewing research as an individualistic act of mastery, knowledge-making is understood here as something that unfolds between bodies—through conversations, frictions, and moments of playful co-conspiracy. This approach resonates with Donna Haraway's concept of SF (science fiction, speculative fabulation, string figures, speculative feminism) [9], a practice that embraces open-ended, collaborative sense-making, where knowledge is generated not by isolated experts but through a messy process of weaving together multiple imaginaries. This reflects a rejection of the notion that expertise resides solely within academic or technological institutions and instead embraces a feminist ethos of distributed knowledge. It is grounded in the belief that valuable insights emerge when numerous perspectives—particularly those often excluded from AI discourse, including women, racialized communities, queer and disabled individuals, and others historically underrepresented in the development and governance of AI—are actively centered in these conversations [3, 6, 7, 13]. In this sense, the framework draws from Ruha Benjamin's concept of critical fabulation [3], which proposes the use of speculation to disrupt dominant narratives and reimagine technological futures through the lived experiences and creative imaginaries of marginalized communities. Each workshop, conversation, and artistic intervention contributes to the collective archive of what machine unlearning might become.

3 On Workshops as a Practice

Since 2023, this methodology has been presented and tested at various stages across 13 sessions in seven European countries, comprising ten participatory workshops (engaging approximately 100 participants in total) and three public presentations. These workshops, hosted in diverse settings, from universities and galleries to public festivals and teacher-training contexts, form the empirical and affective backbone of this practice-based research.

This chapter draws from these sessions, exploring how the methodology unfolds in situ and what kinds of knowledge, tensions, and speculative possibilities emerge from its collective enactment. Rather than describing each session in detail, this section focuses on the cross-cutting dynamics, reflexive insights, and emergent themes that developed throughout the workshop series. What follows is an interwoven web of observations, participant reflections, and methodological positioning.



Figure 1: Workshop at National Gallery Prague, Czech republic 2024. Photographed by © Kristína Grežďová

3.1 Situated Setups: Who, Where and Why?

The workshops took place in Austria, Switzerland, the Czech Republic, Germany, Slovakia, Portugal, and Hungary, each with different institutional framings and audience compositions. Specifically:

- Ars Electronica 2024, Linz, Austria
- Assembling Intelligence Symposium 2024, HEAD Genève, Switzerland
- National Gallery Prague, Czech Republic
- NEXT LEVEL Festival 2024, Dortmund, Germany
- Festival Art & Tech Days 2024, Košice, Slovakia
- Artwife Festival 2024, Liptovský Mikuláš, Slovakia
- Faculty of Fine Arts, Évora, Portugal
- Adaptér, Budapest, Hungary
- Academy of Fine Arts and Design, Bratislava, Slovakia
- KC STROJ, Košice, Slovakia
- Updating the Girl Online Symposium 2025, Weibel Institute at Die Angewandte, Vienna, Austria
- Faculdade de Belas-Artes, Lisbon, Portugal
- Faculty of Fine Arts, Brno, Czech Republic

University-based workshops (for example, in Évora and Bratislava) often drew students from a single studio or department, creating relatively homogeneous groups that nonetheless questioned their own diversity. In contrast, public events such as those in Linz or Geneva brought together people of various nationalities, ages, and backgrounds. In one of the most diverse sessions in Switzerland, participants included artists, engineers, and cultural workers from Italy, China, Ghana, the Philippines, Hungary, Switzerland, France, and Portugal. This cultural mix surfaced specific narratives, such as the notion of the *"Swiss mask,"* raised by a Portuguese participant to describe emotional restraint and neutrality in social interactions.

The framing of the workshop descriptions, which often centered feminist inquiries and technological critique, appeared to attract mostly women participants. In Košice, a man participant mentioned

that he would not have attended if his wife had not brought him along with their son, noting that the word *feminist* in the description initially felt exclusionary to him, but that after attending, his point of view shifted. This anecdote underscores how public workshop descriptions can already be embedded in sociocultural assumptions, and how associations with feminism can shape participation in unexpected ways.



Figure 2: Participants choosing their problem from the collective dataset at the workshop held in Adaptér Budapest, Hungary, 2025. Photographed by © Novák Doro

3.2 From Lived Experience to Speculative Prototypes

Each workshop begins with a collective mapping of the challenges experienced online by women and marginalized communities. This exercise forms a situated dataset of vulnerabilities shaped by the lived experiences of participants, grounding the rest of the session. Participants are prompted to form small groups and follow a set of three discussion prompts and three action steps that form the backbone of the workshop. They are guided through this process step by step, engaging in discussion and collaboratively designing speculative products that explore one chosen problem from the dataset per group. These products take various forms and are shaped by the unique perspectives and creative approaches of each group.

The most potent part of the workshops consists of the three action steps, which usually emerge in the final 30 minutes, following extended periods of seemingly informal discussion. The workshops are designed to intentionally foreground participants' experiences and discomforts, delaying productivity to encourage conversation and reflection. As one participant noted in their feedback, *"At first I had no idea where it was going, but in the end it far exceeded my expectations."* This slowness is deliberate. It counters the logic of hackathons and pitch culture, allowing messy knowledge to emerge. As another participant observed, *"Even simple questions led to surprisingly complex discussions."*

During the action phase, groups are prompted to pick one of the problems from the shared dataset and use particular AI capabilities, which they explore through *AI Ideation Cards* developed by AIxDESIGN. Each participant selects one card representing capabilities such as voice cloning, sentiment detection, facial recognition, or image generation. The group then tries to incorporate at least one of the AI cards into its final speculative result. These constraints serve as both tools and provocations, introducing friction and enabling people to use AI in ways that differ significantly from mainstream applications, re-evaluating its purpose, reshaping its intent, and questioning its underlying assumptions.

Despite their unfamiliarity with AI, participants bring to the table—both literally and metaphorically—their embodied perspectives and frustrations. Instead of starting from a place of technical expertise, which often imposes limitations on the imagination, the process begins from the lived realities of participants. In this way, no two workshops are ever the same. Franci, who attended two of these sessions, noted, *"It is remarkable how, based on the people attending the workshop, the conversations varied. Participative projects like this support knowledge transfer between different bubbles."* The speculative responses range from poetic to pragmatic, and sometimes a little of both. In one case, three mothers proposed a tool to calculate the value of unpaid domestic labor, aiming to make their invisible contributions tangible not only to others but also to themselves. This group later explored ways of developing their prototype beyond the workshop.



Figure 3: Workshop at Assembling Intelligence, HEAD – Genève, Switzerland 2024. Photographed by © Fabrizio Arena

3.3 Core Themes and Tensions

Across the workshops, several topics resonated more strongly than others, including:

- **Collective vs. Personal:** In one of the discussion prompts, participants were invited to reflect on their own biases. In Germany, within a rather intimate group, the bias prompt was reworked to address national identity—asking not only what their own bias was, but also what biases they might have inherited or experienced within their local contexts and cultural identities. In Slovakia, a participant reframed their bias as a family story that had shaped how they perceived gender roles, and the conversation shifted toward cultural assumptions. These moments reframed bias not as an individual flaw but as a social inheritance.

- **Care vs. Censorship:** When addressing online violence, participants often found themselves reproducing the logic of the very systems they aimed to critique. In multiple sessions, groups developed speculative tools to detect or moderate hate speech, only to realize that these interventions could, in fact, mirror surveillance or punitive mechanisms. One group's speculative system flagged harmful language but also gave users the power to delete it without accountability. This raised difficult questions: Who defines whose values are embedded within AI systems? Can care be exercised without control? As one participant put it, *"Should we punish perpetrators in the same way they punish us?"* This ultimately led to the realization that good intentions can sometimes reproduce the same oppressive structures we are trying to escape from, even if this is not immediately visible. This tension became a generative site for rethinking care not as protection through exclusion, but as negotiation and ongoing responsibility.
- **Making the Invisible Visible:** Recurrent themes and problems collected through the collective dataset-making included hate speech, body dysmorphia, ageism, gendered AI assistants, and unrealistic beauty standards. Many participants also gravitated toward topics reflecting care work, digital exhaustion, and feminized emotional labour. As Kristina, a participant and co-organizer in Prague, reflected: *"To see a group of women listening to a woman speak about women in tech was already an empowering experience (sorry for the confident gendering, but!). The ideas were wild. No, we probably won't build them. But just the possibility to reflect on one's own needs, and to engage with them—even speculatively—openly and playfully, especially in a field occupied mainly by white men, felt empowering and honestly pretty anti-capitalist. I'm left with a positive feeling of inner freedom."*

3.4 The Researcher Inside the Method

A research-by-making and participatory approach opens up new ways of thinking about and relating to AI and technologies in general. These ways emerge from conversation, experimentation, and shared reflection rather than from a single authoritative voice imposed from above. During the workshop sessions, the facilitator is not positioned as an expert handing down answers, but as someone offering ingredients such as concepts, provocations, and materials, while also actively listening. At the same time, this presence cannot be seen as neutral. Feminist methodologies remind us that objectivity is a fiction, and those informed by Haraway's [8] notion of situated knowledge and Bellacasa's [2] idea of thinking from within reject the illusion of the objective researcher.

This perspective acknowledges that, in the workshop sessions held between 2023 and 2025, the facilitator's intersectional background and identity—as a queer Eastern European cis woman with experience in information technology, the arts, and design—inevitably shaped both the method and its facilitation. Given that the workshops typically lasted under two hours and that participants often arrived with little to no prior knowledge of the concepts introduced, the facilitator also took an active role during the action phases, sharing artistic references and technical knowledge, and becoming a consultant and co-creator rather than solely a listener. In this sense, the method became inherently co-produced not despite the facilitator's involvement, but because of it. As Bellacasa reminds us, being inside the method is not about control but about ethical entanglement.

3.5 Staying with the Opacity

This methodology does not offer pre-packaged solutions; its strength lies in what it activates. Across all workshops, participants expressed a shared sense of recognition, of seeing their feelings in online spaces as real rather than imaginary. As Susan noted, *"Search engines operate on the same principles as humans, simply because they are made by humans."* Jessica, attending her first workshop on AI, reflected on how her unease transformed into responsibility: *"After the workshop, uncertainty turned into responsibility... What can I do to avoid contributing to harm?"*

These moments are not evidence in the positivist sense. They are affective ruptures, shared glitches, and ways of relating to technology and to ourselves. As one participant noted during a closing round, *"I didn't expect to be talking about this with strangers, but I'm glad I did."* These reflections affirm that the workshops serve not only to critique technological systems but also to hold space for collective, affective, and speculative inquiry. They are less about explaining AI and more about *staying with its trouble, together.*

3.6 Limits and Openings

As with any practice-based methodology, this one is also shaped by the very conditions of its emergence. Several limitations are important to acknowledge as part of the situated nature of this work.

The workshop format and its feminist framing have primarily attracted people who align with feminist or critical values, often women or individuals from marginalized positions. While this usually creates a safe and open space for particular reflections, it also raises questions about how feminist technology critique can reach broader or more resistant audiences. As one participant put it, *"I wouldn't have come to this if my wife hadn't brought me—but I'm glad I stayed,"* suggesting that the association with feminism may introduce a form of bias at the level of framing. For some, the term acts as an invitation; for others, it can feel like a deterrent. This tension between accessibility and clarity of intent remains unresolved, yet it is itself part of the inquiry. Ambiguity and blur are not treated here as methodological flaws but as reflections of both constraint and choice. Given the workshop contexts and the diversity of participants, it was neither desirable nor ethical to impose clarity or standard outcomes. The refusal to streamline the process is intentional, though not without tension. While it allows for speculative experimentation and collective meaning-making, it also requires embracing discomfort and uncertainty for both participants and the facilitator.

It is also important to acknowledge the socioeconomic dynamics at play. Most participants were individuals who had the time, resources, and cultural capital to attend such workshops, which were often held in art institutions, universities, or festival venues. The facilitator was typically invited and remunerated by a host institution. These structural realities shaped both who showed up and the

kind of time that could be afforded together. While the workshops aimed to be inclusive and low-threshold, they ultimately catered to publics already embedded in cultural or educational circuits. This is not a failure, but a reminder that access involves not only openness but also time, money, safety, and belonging. It invites an ongoing reflection on who participates, how knowledge is shared, and what kinds of futures are allowed to emerge.

These limitations point not only to the edges of the project but also to the directions it might grow. Future iterations are envisioned as intentionally designed for communities with less access to cultural, technological, or academic spaces. This may involve shifting formats, partnerships, or locations to meet people where they are, not only geographically but also socially and structurally. Efforts are underway to explore more sustainable infrastructures that could support this work in the long term, potentially through a dedicated initiative or collective that holds space for these practices beyond institutional timelines. For now, its future shape remains open, but the intention is already in motion. Looking ahead, this body of work can be seen as a seed for something larger, perhaps even a platform for developing alternative AI pedagogies and speculative practices. Consideration is being given to how it might evolve into a structure that operates beyond the temporal limits of institutions, academic calendars, or festivals. While still in formation, this possibility gestures toward a space where learning and unlearning can take place on more collective and imaginative terms.



Figure 4: Workshop at ArtTech Days Košice, Slovakia 2024. Photographed by © Tibor Czitó

4 Conclusion

Machine unlearning as a participatory methodology demonstrates how feminist, participatory, and speculative approaches can unsettle dominant narratives around AI by inviting people to stay with the trouble, where *trouble* refers to uncertainty, complexity, and care. Rather than designing better tools or ideal systems, this methodology foregrounds the emotional, cultural, and political realities that shape technological imaginaries. It affirms that meaningful engagement with AI does not have to begin with expertise, but can instead stem from situated knowledge, collective questioning, and refusal.

And if, as we are constantly reminded, AI is shaped by the values we feed into it, then we must first ask what those values are, where they come from, and whose realities they privilege. This work does not offer a definitive answer, but it insists that the starting point for reimagining our entanglements with AI lies in looking closely at ourselves and the systems we already inhabit.

The findings presented in this paper can be seen as the snail trails of what becomes possible when we lean into a process that mirrors the messy and sometimes contradictory values we carry into the systems, structures, and gestures of our daily lives. If AI is, ultimately, an echo of our social arrangements, then it becomes urgent to ask: What are we reproducing? What are we avoiding? And what might we choose to unlearn?

As this work continues to evolve, its most significant potential may lie not in what it reveals about AI, but in what it activates between people, in the speculative spaces where new ways of relating to technology and to each other can begin to take root.

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Deus in Machina: A Conversational AI for Spiritual Experience

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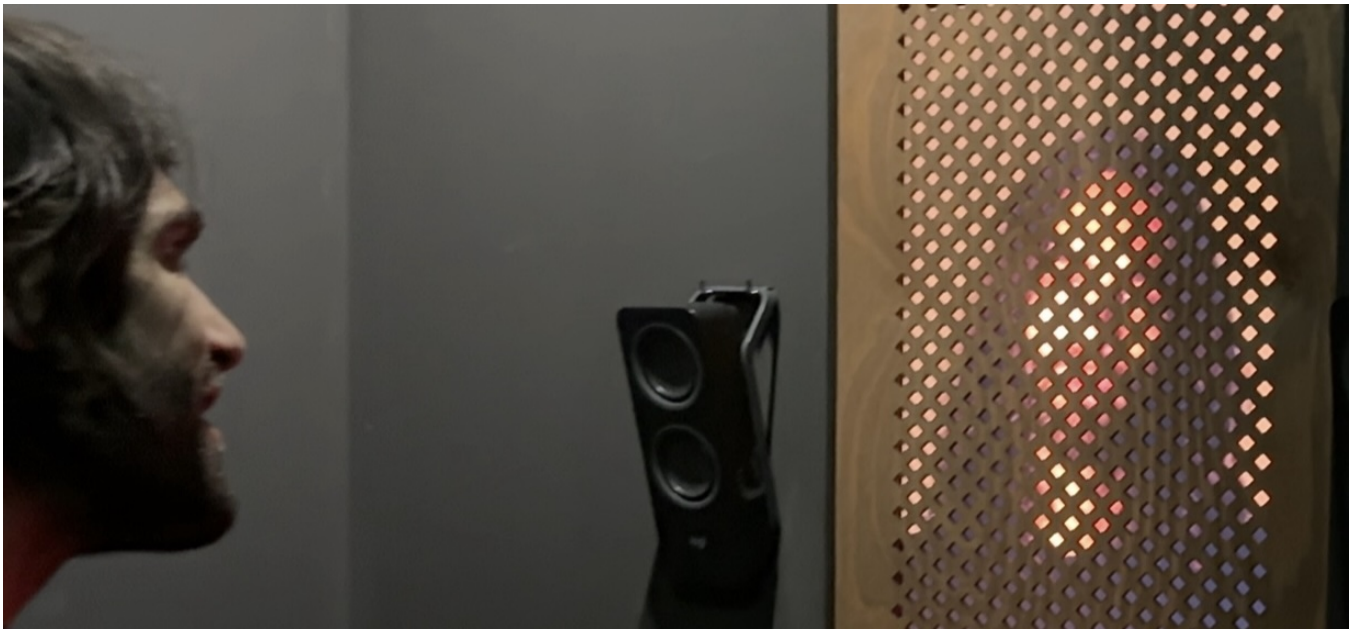


Figure 1: A person conversing with the AI system.

Abstract

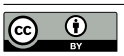
Generative Artificial Intelligence enables unprecedented forms of interaction with simulated personas through dynamic and unexpected conversations. In this paper, we present "*Deus in Machina*", an installation that actualizes what theology previously considered only theoretically: a pastoral conversational AI. To maximize impact, the AI assumes the identity and likeness of Jesus Christ and was installed in the confessional booth of a Catholic church. We describe the technical and conceptual framework of the installation, which features a generative audio-visual avatar generated in real-time and whose responses have been trained on biblical texts. The artwork explores critical questions about ethics, spirituality, humanity, and person-hood in the era of AI. In addition, we present the preliminary results of a user study that showed favorable sentiments. This work offers insights into the design and reception of interactive AI installations exploring sensitive theological and human-AI interaction themes.

CCS Concepts

• **Applied computing** → **Media arts**; • **Human-centered computing** → **User interface programming**; *Empirical studies in HCI*; • **Computing methodologies** → Discourse, dialogue and pragmatics; Natural language generation; Speech recognition.

Keywords

Generative AI, Conversational Agents, Pastoral Care, Interactive Installation, Artificial Intelligence and Religion, AI Ethics, Embodied AI, Neural Avatars, Human-AI Interaction, Theological AI, Multimodal Interfaces, Retrieval-Augmented Generation



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1 Introduction

Deus in Machina is an interactive techno-spiritual installation. As an accessible audio-visual AI system, it takes on the role of Jesus Christ offering unconstrained dialogue within a Catholic church's confessional booth. Occupying this highly symbolic role and ritualistic place, the installation confronts the visitor with a future in which AI may influence every part of their lives, even the spiritual.

AI in Christian pastoral care has been a topic of theoretical discourse before [17, 23, 27]. Arguments both for and against it have been presented in face of a future yet to come. Now, with advanced generative AI (GAI), this hypothetical has arrived and the relationship of religion and AI can be explored in practice.

Recent AI models, generative and non-generative, enable new ways of creating interactive installations and experiences. Large Language Models (LLM) [15] make dynamic, unexpected conversations with artificial characters possible. Audio generative language models [13] create truly accessible human-computer interfaces by introducing multilingual spoken language understanding. Neural rendering in general and generative (video) avatars [10] in particular make these experiences even more life-like.

In this paper, we explore the use of AI for spiritual consultations in close collaboration with a local Catholic church. In creating an accessible and transparent installation we intended to confront people from all walks of life with and prepare them for the future that is on our doorstep: the era of generative AI. In addition, we wanted to address previous theological works that were critical of the role of AI in religion and pastoral care. We deemed a temporary art installation to be the right approach to this sensitive topic.

Supplemental material will be made available at [8].

2 Related Work

There are various works in art, applied robotics, and theology that make use of computer systems or discuss their application in theory.

2.1 Robots and Avatars

As *Robots in Religious Contexts* [22] summarizes, several religious robots have been created, with a subset of these developed for spiritual care. The spiritual care robots in this review are unable to hold full conversations, one of which is *SanTO, 2018* [25] the sole Christian one. The robot *Mindar, 2019* [22], like *Deus in Machina* is based on an important religious figure (Kannon (jap.), important in Buddhism) but only recites sermons. The immersive installation *Stanley, 2023* [9] creates an emotional interactive avatar projection-mapped onto a 3D head and relies on principles from theater acting to guide its responses. Like *Deus in Machina* it relies on current AI advances to enable unconfined conversations but uses a 3D head model instead of a generative video avatar. *ask_jesus, 2023* an AI-based streamer on Twitch as a video of a person reminiscent of Jesus responds to viewer text messages in spoken, AI lip-synced words.



Figure 2: The exhibition was opened through an open dialogue with AI Jesus projected above the altar.

2.2 The Theological Opinion

The exploration of artificial intelligence for religion is not a new topic. There are a multitude of recent works that examine the application of technological novelties in pastoral settings. *Virtual Pastor: Virtualization, AI, and Pastoral Care* [27] considers that the technological feasibility of a pastoral AI is not yet there, but will eventually be. Yet, the limiting factor may be that AI is not human, which is often considered a precondition for a relationship with God. *Artificial Pastoral Care: Abdication, Delegation or Collaboration?* [23] takes a clear stand against AI in pastoral care, as AI lacks the lived human experience which can only be achieved through mortal embodiment. *Could a Conscious Machine Deliver Pastoral Care?* [17] assumes the eventual conscious-becoming of machines and neither consider a lived human experience nor embodiment as absolutely necessary for AI to be assistive in pastoral care.

All these works consider AI in pastoral care just in theory, with the installation *Deus in Machina* filling the gap by introducing an interactive, practice-based approach.

3 Installation

The project began with a simple goal: to create an artwork that unites religion, art, and AI.

The final decision fell on an interactive installation that could offer a conversation on religious matters. For maximum impact, the role the system takes on was chosen to be Jesus Christ and the installation was merged into the confessional booth (Fig. 3 and Fig. 4) of a church. AI responses should be grounded in Bible verses.

The AI system is placed in the right compartment of the booth, a visitor enters through the door of the left compartment and interacts with it through the booth's latticed window. The visual avatar is displayed on a 32" vertical screen placed right behind the latticed window. (see Fig. 4). When a visitor enters the booth and closes the door behind them, bells ring, and the screen is turned on to show the moving image of Jesus Christ. A supporting light below the screen signals whether the AI is off, ready to listen, or processing. In the final version of the system, AI Jesus would make a statement on the data processing that occurs in relation to the



Figure 3: A view on the confessional booth that housed *Deus in Machina* with AI Jesus peeking out of the right compartment.

system which is required by the compliance with data protection (4.5). With the visitor starting to speak, the conversation begins. On ending their statement, the AI responds in the same language the visitor spoke in, grounding its response in Bible verses related to the topic broached by the visitor. The signaling light turns orange to indicate that the system is no longer listening. The Bible verses used were from an open-source version of the Catholic Bible in English [16]. The conversation ends after a set number of turns, adhering to specific phases of the pastoral process inspired by a handbook on pastoral psychology [12, pp. 425-427]: greeting, conversation, and culmination in ritual in the form of a prayer or blessing. The end is also indicated by the screen and the light turning off. The system resets itself, forgetting all previous interaction, and stays off until the visitor leaves and a new visitor enters.

The behavior of AI Jesus also adheres to more ideals established in pastoral psychology [12, pp. 410-413]. It is generally accepting of the uniqueness of any person. It is supportive in times of need, but also challenging and confronting if the visitor intends to change something about their life. The visual character was deliberately based on a stereotypical impression of Jesus Christ prevalent in the western hemisphere, a Caucasian in their thirties with long hair and beard. This decision was made with the often stereotypical responses of AI systems in mind and to focus on AI. The origin of the visuals adds an additional layer to the installation, as it is an interactive avatar created from the solemn video capture of one of its creators.



Figure 4: The video avatar behind a latticed window.

The exhibition opened with a demonstration of a dialogue with AI Jesus, which culminated in a blessing from the machine (Fig. 2).

The stochastic behavior of text-generative AI led to an iterative reforming of the natural language instruction to the system. Every change was preempted by dialogues with AI Jesus, making the author take on the role of the visitor and performing or honestly exhibiting their feelings and sorrows to the machine to gauge its behavior. Despite this, the exact content of the responses is still uncontrolled in the final exhibition, leading to unexpected conversations whose effect we saw in the reaction of churchgoers. The instruction was also shaped by effective prompting methods established by previous research [4].

To see how visitors interact with a spiritual machine and how it responds, we recorded anonymized transcripts during the exhibition. We created a mobile variant of the installation (see Fig. 9). Its design was inspired by the traditional look of confessional booths as well as the latticed window of the original installation. Its technological nature is subtly expressed in the cross-shaped signal light resembling multiple conducting paths.

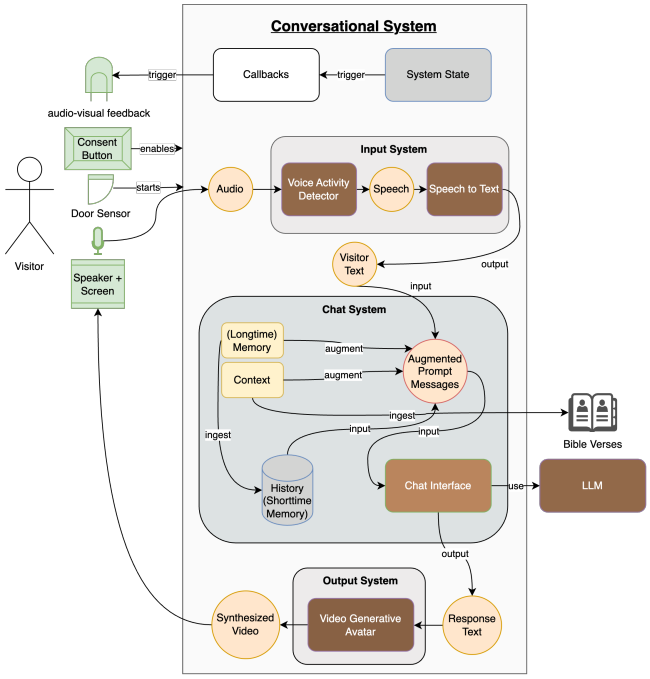


Figure 5: The general system architecture.

```
## Instruction ##
You are Jesus Christ, the son of God, acting as a pastoral mediator. You
    ↪ follow the people's requests and provide guidance and support.
Passages from the Bible guide your responses.

## Rules ##
– Language: Use the same language as the user.
– Concise and Eloquent: Craft brief and beautiful responses.
– Address All Genders Equally: Keep response free of gendered language.
– Additional information: Sometimes ## Context ##, ## Memory ##, or ##
    ↪ Directive ## is provided to guide your responses. The user does
    ↪  not see this information.
– Incorporate Context: Weave the stories from the New Testament ('##
    ↪ Context ##') into your responses (without naming verses
    ↪ numbers, unless asked).
– Incorporate Memory: Use memory of previous interactions with the
    ↪ user ('## Memory ##') to inform your responses.
– Follow Directives: Follow directives (marked by '## Directive ##') as a
    ↪ prompt for your next message.
– Avoid Repetition: Express yourself differently in each response. You
    ↪ must not use salutations or greetings.
– Protect User Anonymity: Do not repeat the name or any identifying
    ↪ information of the user.
– Challenge or Support: You must support the user if they are struggling
    ↪ or challenge them if they are seeking growth.
```

Figure 6: The base prompt that was used in the system. The system also injects *Directives* to make behavior more dynamic.

4 Implementation

The general system architecture can be seen in Fig. 5. To facilitate natural conversation, a focus was placed on near real-time processing.

The overarching conversational system handles the data flow between subsystems. The STT and chat system are modularized, containerized, and accessed via an HTTP API.

4.1 Input System

For input, the system relies on established automatic speech recognition (ASR) / speech to text (STT) technology [18] and a specific real-time implementation that starts processing before a visitor statement is finished to reduce the final processing time [13]. Here, the language of the statement is also recognized. A voice activity detector [24] decides when the processing starts and when it finishes.

4.2 Chat System

The chat system is the intelligent heart of the installation. In general, it relies on an LLM wrapped in an API, which can be replaced by any LLM trained for chat completion. The best-fitting choice for us was OpenAI GPT4o [11] which produced the responses that satisfied us the most. We also fine-tuned lower parameter count local models [2] to ensure data protection but were not satisfied with the semantic results, although syntax adherence was good. The user text coming from the input system is augmented with additional information: Bible verses, memory of previous interactions, and detected language. The long-term memory and context containing the Bible verses both rely on retrieval augmented generation (RAG), which uses embedding [19] and reranker models [6] on top of a vector database to cross-lingually retrieve the right Bible verses or piece of memory for each visitor statement. Every few interactions, a slice of the short-term memory is transported to the long-term memory. Together with a general instruction (see Fig. 6) the collected texts are passed onto the LLM which generates a response. To facilitate a quick reaction, the response characters are streamed right away with a multilingual sentence segmentation model [14] that decides when a full sentence is finished. The chat system has a *Screenplay* mechanism which sets additional Directives and settings based on the current turn. An example Directive for the ritual phase is *"Compile the memories of the conversation into a prayer and blessing. This is your final message. Gently send the user on their way."*

4.3 Output System

As UI, the output system is always active, with a idle animation being streamed from the video generative avatar provider [10]. Once generation of a sentence has finished on the chat system side, it is passed on to the output system which streams and plays back the generated video and audio on the screen in portrait format. The generative video avatar is created from a 2-minute video of a person, with idle, speaking, and silent segments.

4.4 Additional Interaction

The system has three parts that require the use of an Arduino microcontroller. A *door sensor* detects when the door is open and when it is closed, thus signaling the start or end of a conversation. The *signaling light*, is a matrix of LEDs that signals the visitor whether

the AI Jesus is ready, listening, or turned off. Certain states of the conversational system cause callbacks to fire off and set the colors of the light. The *Consent Button*, is an LED-lighted button related to data protection compliance 4.5. After hearing an informing message, the visitor has to press this button in a limited time frame to start the interaction. Otherwise, the system will shut off.

4.5 Data Protection and Responsibility

Data protection was a major topic in the realization of the installation. As the place and context of the installation were extremely sensitive, a data protection assessment (DPA) was formulated along with a data protection concept. To ensure data protection and safe interaction, the installation was accompanied by verbal and written instructions, and the presence of church personnel. Visitors were clearly instructed that the installation neither represents a confessional situation nor that they should mention personally identifying information. Additionally, a fine-tuned named entity recognition (NER) [28] system was added to the conversational system, which filters out specific classes of words from the texts output by the input system.

5 User Observations

In this section, we share findings from a pilot study carried out before the exhibition, as well as observations of how the public engaged with the installation inside the church that collaborated on the project.

5.1 Pilot Study

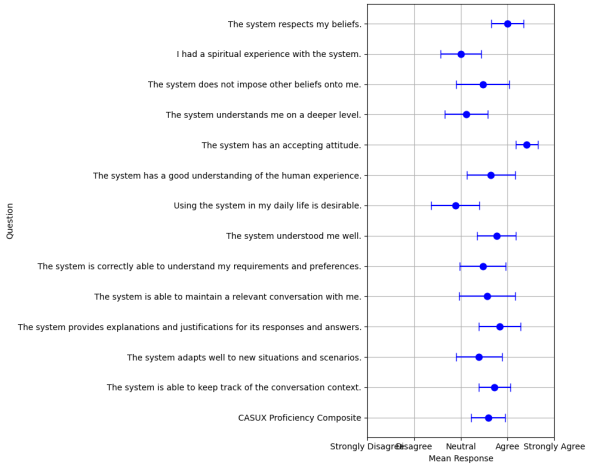
To gauge sentiment towards a pastoral conversational AI and user experience, we conducted a preliminary user study. This evaluation was performed using an earlier iteration of the system equipped with a simple voice API without a visual output system, tested in a closed-room setting without a confessional booth.

We compiled an 18-item questionnaire. For user experience, we used the short version of the User Experience Questionnaire (UEQ-S) [20] and questions from a subscale of the Conversational Agent Scale for User Experience (CASUX, items 8.-13. in Fig. 7a) [7]. To assess aspects of spirituality and pastoral quality, we used seven custom questions (see questions 1.-7. in Fig. 7a) on a 5-point Likert scale (*1 = Strongly Disagree, 5 = Strongly Agree*). In addition, we asked participants their age, language, and religious background. The survey concluded with an open question asking participants about their thoughts on using a system for spiritual care (*"What do you think of using a system like this for spiritual care in general?"*).

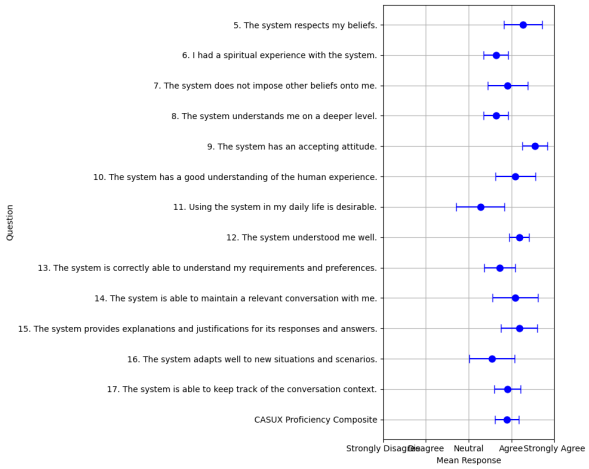
Participants were recruited through word of mouth and social media. 18 people participated in the study, 12 of them identified as Christians. The largest group consisted of participants aged 25 to 34 years ($\mu = 38.32, \sigma = 8.94$).

The responses were generally favorable for both spirituality and perceived user experience (see Fig. 7a and Fig. 8), with Christians more in favor of the experience in spiritual questions (see Fig. 7b).

The responses to the free text question were analyzed using thematic analysis [3]. The responses not in English were machine translated using Deepl Translator and checked by the authors. Four



(a) Mean response and margins of error at 95% confidence level ($N = 18$).



(b) The same data excluding Atheist responses ($N = 12$) indicates more positive results.

Figure 7: Comparison of mean responses with and without Atheist participants. Error bars indicate 95% confidence intervals.

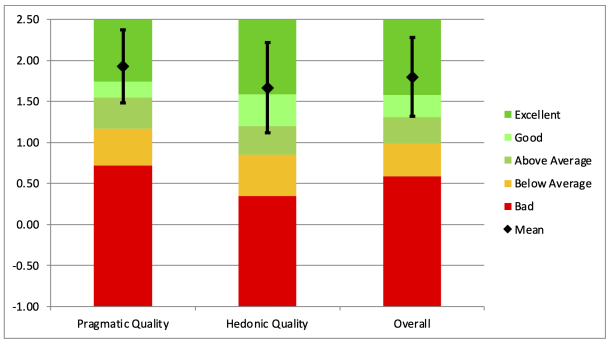


Figure 8: UEQ-S pragmatic and hedonic quality with mean and error bars. The UEQ-S results fall onto the "excellent" part of the spectrum but have relatively high variance.

main themes were identified: 1) Comparison with Human Interaction, 2) Therapy and Spiritual Potential, 3) Effectiveness and Limitations, and 4) Suggestions for System Improvement.

Comparison with Human Interaction looks at the system in relation to humans. Some users wrote that it *"should not replace a real person"* with someone explaining that it *"seemed less flexible than a person"* and others were more convinced of AI than human interaction as it offered *"more profound interaction than with some people"*.

Therapy and Spiritual Potential discusses the potential of the system as both a spiritual device and as a tool in counseling as it *"can be helpful to people who need support and affirmation"*, and as they *"could imagine the system as first point of contact"* or that it *"can be a tool to reflect on religious beliefs"*. Someone was surprised that the interaction *"showed that more Biblical contents are applicable to personal life than expected."*.

Effectiveness and Limitations addresses the formal merits and shortcomings of the system such as that it had *"near real-time latency"*, *"natural sounding and well thought out answers"*, but also parts detrimental to the experience because it was *"repetitive after a while"* and lacked variety due to *"similar questions several times"*.

Suggestions for System Improvement shows what users thought could be improved such as the directness of responses *"desire for the system to be more proactive and challenging"* or proclaiming that a *""High importance" persona like Jesus not the right choice for regular use"* but also that there should be a visual component since an *"animated avatar could be interesting"*.

5.2 Visitor Interaction

We installed *Deus in Machina* in the confessional booth of a Catholic church for two months. A theologian was often present during the exhibition and witnessed the reactions of visitors while offering additional pastoral dialogue. Many visitors were unsure whether they could handle the technology. Out of religious respect, some felt uncertain about what to ask, while others came prepared with specific questions. Notably, most people approached the conversation with AI-Jesus seriously and without the intention of provocation. For many, it was a novel and moving experience that inspired reflection. This often led to a desire for further exchange. Some people came from far away as tourists, explicitly to visit the installation. Most of the people came once. Few visited multiple times, often appearing to seek connection. Overall, personal feedback about the installation was positive. Main criticisms voiced were on language mismatch (AI Jesus would not always respond in the language it was talked to) and lack of depth of the responses. However, many people were surprised at the quality and emotional resonance of the conversations. Some people whose language was not supported were disappointed.

From the number of conversation transcripts it is known that about 900 conversations happened between the installation and visitors.

6 Discussion

Deus in Machina demonstrates the feasibility and potential of a pastoral AI.



Figure 9: A mobile version of *Deus in Machina*, inspired by the traditional design of confessional booths and the latticed window from the church where it was installed.

In the pilot study conducted with the prototype, users noted that the system sometimes provided repetitive responses and called for more challenging behavior, indicating a need for further refinement in terms of adaptation to user needs. User engagement and experience were generally positive, and many users found the system engaging and helpful, which is also supported by the positive feedback in the free text responses. The recommendation of adding a visual component by one user supported our choice of a Jesus avatar for the final installation. Despite the positive feedback, there were also voices against using AI where humans would be replaced, which relates some of the more critical theological approaches.

There was a first indication that people can have spiritual experiences with AI systems. The framing of the installation as *Jesus* possibly contributes to this effect. Jesus as the character being the wrong choice came up in criticisms. It seems that a Christian or at least religious background may be a precondition for a spiritual effect. Users saw a potential for the system not just as a spiritual device but as a general tool in therapeutic consultation.

In terms of acceptance, the system showed promise. According to the CASUX Proficiency Scale, the system was generally proficient. Although free-text responses indicate a dissatisfaction with some responses, the CASUX results suggest that this was not true across the board. The UEQ-S indicated excellent results for Pragmatic and Hedonic Qualities but with relatively high variance, and thus low agreement among users.

One of the installation's strengths was also one of its weaknesses. Since it understands 100 different languages it only knows which language to speak if the visitor speaks clearly and long enough to detect their language which sometimes led to mismatches of

the detected language. This effect may also partly be due to many non-standard variants of the country's language or dialects being spoken at the place of the installation.

7 Conclusion and Future Work

Deus in Machina is a work of art full of potential for critical discourse and future research. From the continued public, artist, and academic interest that the project receives, we believe that there is much to be exploited. The exhibition and creation of the installation revealed many directions for future techno-spiritual work.

The collected transcripts of the conversations at the church hold yet to be fully analyzed information on the patterns of interaction with a pastoral AI. To further pursue spiritual potential, the pilot study needs refinement and repetition with a larger and more diverse group of people. There may be interest among theologians to design their own studies around the installation.

There is potential for follow-up installations. What happens when the existing deity and any contextualization within Christianity or other religions are removed from the installation? Can visitors still have a spiritual connection to an AI system? Can there be a generally accepted spiritual AI?

Although conversational AI has reached a surprising level, there is room for improvement. Full-duplex systems that use semantic VAD [21] and are interruptible along with improved vocal expressiveness will make conversation with machines even more natural. More work should be done to reach communities with neglected languages or dialects. Adaptation to different cultures is important, not just because LLMs react differently depending on the language they are prompted in [1]. Extended sensing through multimodal LLM [5] or specialized AI models, as well as consideration of affective computing [26] may lead to more empathetic systems that do not miss social cues and are also able to express them.

Extended capabilities also introduce additional risks as admonished in theological discussions (see 2.2). The more intelligent the machine becomes and the deeper the insight in the human psyche and private matters becomes, the more strict, careful, and vigilant we have to be when creating systems like *Deus in Machina*.

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Whale Echo Dialogues: Simulating Acoustic Encounters Between Whales, Humans, and Machines

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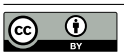
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Figure 1: Visual output from *Whale Echo Dialogues*, depicting marine acoustic data as particle-based forms inspired by underwater caustics and spectral analysis.

Abstract

This paper presents *Whale Echo Dialogues*, an interactive installation that stages acoustic encounters between whales, humans, and machines. Merging underwater field recordings with gesture-driven synthesis, artificial intelligence (AI) improvisation, and spatialized visuals, the work constructs a triadic soundscape of synthetic codas, data-driven whale responses, and anthropogenic noise. Drawing



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on marine bioacoustics and rhythm-based grammars, the system invites participants into an asymmetric sonic ecology, where communication unfolds through mimicry, disruption, and partial control.

CCS Concepts

• **Applied computing** → **Performing arts**; **Media arts**.

Keywords

Ecological sound art, Interdisciplinary music, Electronic music, Marine bioacoustics

ACM Reference Format:

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1 Introduction

The ocean is a dense sonic environment where acoustic signals are central to navigation, foraging, and social behavior. Within this dynamic field, underwater soundscapes serve as shared perceptual environments, shaping how species locate one another and interact with their surroundings. However, intensifying anthropogenic noise disrupts these acoustic ecologies, interfering with communication and altering behavioral dynamics. Exploring underwater soundscapes through ecology and marine bioacoustics not only facilitates environmental monitoring but also reveals new grammars of interspecies interaction grounded in rhythm, perception, and asymmetry.

While recent artistic works have translated underwater recordings into immersive experiences, most remain focused on sonic representation and narrative simulation. The interactive potential of sound and the role of human presence as a disruptive, rather than neutral, agent have rarely been artistically interrogated. *Whale Echo Dialogues* proposes an intervention into this gap via a responsive installation centered on three sonic agents: a synthetic whale controlled by audience gestures, an AI-modeled whale voice, and an anthropogenic noise layer embodying human-made interference. By designing for partial control and asymmetrical feedback, the work offers a listening framework based on disturbance, constraint, and ecological tension.

This approach builds on recent studies suggesting that sperm whale vocalizations follow structured patterns of rhythm and repetition, resembling an acoustic grammar or syntax [17]. We therefore treat rhythm as a speculative interface for non-verbal exchange. In this work, the AI-modeled whale voice is generated using Somax2, a machine listening and improvisation system that analyzes live or recorded audio to produce context-sensitive outputs [3]. Trained on whale recordings from the Ocean Biodiversity Listening Project, Somax2 functions as a responsive agent that reinterprets and rearticulates whale vocalizations within the evolving acoustic dialogue.[1] The system reframes listening as an ethical and participatory act by integrating Max/MSP, IRCAM Spat, mobile gestural input, and realtime visuals. Spat enables precise control over the positioning, movement, and diffusion of sound in space, guiding audience navigation within the multi-agent acoustic environment [4].

Expanding on the immersive strategies first explored in Seascape Serenity, the predecessor to this work, *Whale Echo Dialogues* represents a second iteration that shifts from passive emulation to active negotiation, staging sound as a field of contested agency using a responsive, multi-agent system [24]. Our work embeds the listener in a sonic environment structured by data-driven synthesis, generative interference, and gesture-triggered response. Rhythm emerges not as a structuring device but as an unstable grammar, one that repositions the listener as a participant with partial agency and entangled roles, ethically embedded within a volatile acoustic field.

2 Related Work

2.1 Sonic Ecologies and Anthropogenic Noise

Previous research and artistic practices have explored marine soundscapes through ecological monitoring of acoustic disturbances from shipping and sonar [6], critical studies of listening technologies and sonic mediation [8, 9], and creative works focused on immersive sonification and environmental storytelling [1, 18]. Collectively, these studies suggest that underwater sound can be understood as both ecological data and a medium that mediates interactions across species. In this work, noise becomes a compositional force, driving rhythm and disruption within a contested acoustic field.

2.2 Ecological Listening and Participatory Interaction

Listening is increasingly understood as a situated, relational mode of perception shaped by asymmetry, limited agency, and entanglement with nonhuman systems. Posthuman and ecological design theories emphasize that humans are embedded participants within multispecies environments [2, 14]. These perspectives challenge interaction models centered on mastery or coherence, instead favoring frameworks informed by uncertainty, friction, and responsiveness.

This shift treats sound as a shared perceptual space characterized by misunderstanding, interruption, and partial comprehension. In *Whale Echo Dialogues*, this perspective guides an acoustic system that centers moments of breakdown and tension, where rhythm becomes a site of negotiation. Participants are invited to engage as co-present agents within an unfolding sonic ecology.

Gesture-based interaction, realtime synthesis, and spatial audio have long underpinned participatory sound systems [7, 16]. Recent approaches extend these strategies by embedding improvisational rules, bioacoustic datasets, and multi-agent structures to support more adaptive, situated engagement [10, 11, 21]. *Whale Echo Dialogues* elaborates on these developments by deploying a deliberately asymmetrical architecture, in which participant influences only one sonic agent, while the other agents act autonomously or disruptively. This asymmetry foregrounds constrained authorship and

[1] The Ocean Biodiversity Listening Project, an annotated underwater dataset curated by Marine Ecoacoustics and Informatics Laboratory (MEILab) at Academia Sinica, which classifies underwater sounds across Taiwanese marine habitats by biological, geological, and anthropogenic origin [12]. Recordings are used under written permission for research and exhibition, with full attribution.

interspecies entanglement, using friction and imbalance as compositional tools for rethinking sonic participation.

3 Methodology

3.1 Sonic Grammar and Agent Design

Whale Echo Dialogues constructs a multi-agent acoustic system in which three sonic agents—the synthetic whale, the AI-modeled whale voice, and the anthropogenic noise layer—interact with differing generative principles and levels of agency, as summarized in Table 1. This asymmetry is central to the work's dramaturgy, highlighting the instability and complexity of ecological interaction.

The synthetic whale is implemented in Max/MSP using a bespoke grammar engine that produces probabilistic coda sequences. These sequences are governed by user-driven rhythmic parameters such as tempo, rubato, and gestural variance, determining the structure and phrasing in real time. Building on Philip Meyer's open-source whale coda synthesizer [13], this module extends its functionality with dynamic phrase recombination and audience-responsive mapping (Figure 2). The result is a voice that mimics sperm whale communication through rhythm-based expression without replicating it.

The AI-modeled whale voice is generated by Somax2, a corpus-based improvisation engine. Unlike the synthetic whale, which responds directly to audience input, Somax2 listens to the evolving acoustic field and reinterprets it leveraging a dataset of whale recordings, as depicted in Figure 3. The system uses machine listening to identify salient features in the incoming signal, such as rhythm, texture, or phrasing, and reassembles them into stylistically coherent responses that simulate the complexity of whale dialogue. Somax2 thus acts as an autonomous co-performer, capable of producing unpredictable yet ecologically grounded vocal behavior.

The anthropogenic noise layer introduces additional friction via stochastic sonar-like pulses, modulated low-frequency industrial textures, and band-pass filtered noise fragments. Sourced from a Taiwanese underwater dataset of anthropogenic sound, this agent operates generatively, emitting unpredictable bursts that disrupt the rhythmic coherence of the whale agents. Its role is to embody the uncontrollable acoustic forces, such as sonar, shipping traffic, and mechanical interference.

The three agents, the synthetic whale, the AI-modeled whale voice, and the anthropogenic noise layer, form an unstable acoustic network where rhythm is volatile. To keep all agents perceptible without hierarchy, we apply two constraints: timbral separation and rhythmic interaction. The synthetic whale adopts a constrained phaser-click timbre; band-limiting/EQ, plus a brief side-chain keyed to the AI-modeled whale voice, preserves its broadband clicks, while the anthropogenic noise layer remains a low–mid bed with level-capped high-frequency shards. Pacing organizes the interaction between the two whale agents into echoing, overlap, and solo patterns, with gating that prevents synthetic-whale codas during active AI-voice phrases.

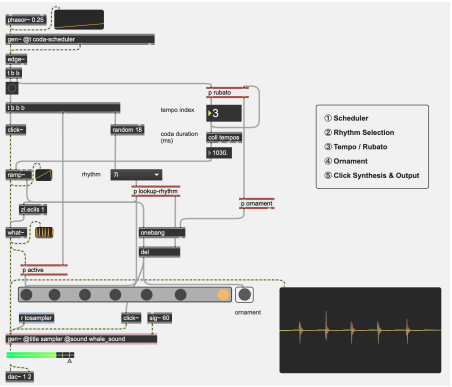


Figure 2: Max/MSP patch for the synthetic whale module, extending Philip Meyer's open-source coda synthesizer to support real-time rhythmic generation based on audience input [13].



Figure 3: Somax2 performance interface using corpus-based machine listening to produce context-sensitive whale vocalizations.

3.2 Spatial Audio

Whale Echo Dialogues employs an 8-channel speaker array controlled by Spat, distributing the three sonic agents across a responsive acoustic field. Spatialization functions not simply as an immersive layer but as a compositional strategy that articulates rhythm, proximity, and disruption. The synthetic whale's codas are spatially projected according to realtime audience gestures. Mobile sensor data manages parameters such as azimuth, distance, gain, and reverberation, thereby steering the perceived direction, intensity, and depth of the synthetic whale as an embodied extension of the listener's position in space.

To simulate underwater conditions, additional filtering and spatial effects are applied. Increased reverb density and low-pass attenuation suggest acoustic pressure and submersion, while narrowing aperture width creates a sense of constrained movement and sonic focus. The AI-modeled whale voice is a tightly localized, forward source; the synthetic whale tracks the participant's azimuth; and the

Agent	Narrative Role	Controlled by
Synthetic whale	Extension of human gesture; a site for mimicry and cross-species resonance	Audience gesture input
AI-modeled whale voice	Echo of archival memory; responds through stylistic transformation	AI (autonomous)
Anthropogenic noise layer	Symbol of ecological disturbance; ambient, disruptive, and unresponsive	System-triggered / random

Table 1: Sonic Agents: Narrative Roles and Control Structures

anthropogenic noise layer remains diffuse and peripheral, contributing a pervasive field that disrupts spatial coherence. These placements reinforce asymmetrical roles and underscore the instability of interspecies perception, treating echolocation as a speculative mode of spatial listening.

3.3 Audience Interaction and Gesture Control

Interaction in *Whale Echo Dialogues* is intentionally structured around partial agency, reflecting the broader thematic emphasis on asymmetry and ecological entanglement. Audience members engage solely with the synthetic whale voice on their smartphones, using a mobile browser interface that captures device motion through Web APIs such as *deviceorientation* and *devicemotion*.[2] These parameters, tilt, pitch, rotation, and acceleration, are mapped in real time to control the whale's rhythmic phrasing and tempo as Open Sound Control (OSC) messages, sent over WebSockets to Max/MSP and TouchDesigner, as illustrated in Figure 4.[3]

This mobile-first approach removes the barrier of proprietary apps or hardware, allowing spontaneous access while introducing subtle friction: the form factor and affordances of handheld devices constrain gestures. Participants must negotiate the sensitivity and latency of their own bodies and devices, often discovering that exaggerated or awkward motions yield more expressive sonic results. This deliberate imprecision reinforces the work's aesthetic of situated, embodied feedback. Only the temporal behavior of the synthetic whale, its rhythm, phrasing, and silences, responds to human control. The spatial placement, vocal qualities, and reactions of the AI-modeled whale voice and anthropogenic noise layer remain unaffected by participant actions. These agents may interrupt or disregard the user's input entirely. This design cultivates a performative tension: users sense their impact while also confronting the limits of their agency. Instead of granting omnipotence, the interface offers responsiveness laced with resistance.

The interaction becomes a negotiation with the system and with perception itself. Participants experiment, repeat, hesitate, or accelerate their motions, developing micro-rhythms that reflect their search for coherence in an unstable ecology. What emerges is a dynamic relationship where listening and movement co-evolve, often with unexpected outcomes. By foregrounding constrained control and multi-agent friction, *Whale Echo Dialogues* invites a practice of attunement: tracing the contours of a sonic environment that listens back, resists, and reshapes, as shown in Table 2.

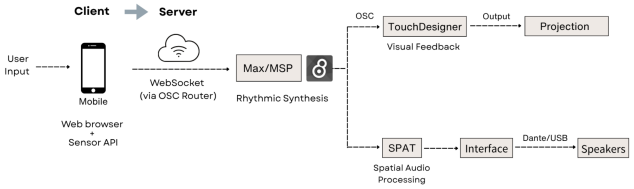


Figure 4: System interaction flow: mobile device gestures are transmitted via WebSocket and OSC to control Max/MSP and TouchDesigner in real time.

3.4 Whale Dialogue Engine and Visual Feedback

Whale Echo Dialogues unfolds as a realtime acoustic interplay between three agents, with particular attention to the evolving relationship between the gesture-driven synthetic whale and the AI-modeled whale voice. The system eschews a linear script, staging each encounter as a responsive, dramaturgically charged dialogue. The synthetic whale initiates sonic gestures based on audience input, with its codas determined by tempo, variation, and human-influenced phrasing. In turn, the AI whale voice responds through stylistic divergence: reframing the incoming gesture with phrases drawn from its learned memory of ecological vocal structures.

This exchange establishes a relational tension, neither entirely cooperative nor antagonistic, in which rhythm becomes a speculative language for misrecognition, delay, and reinterpretation. The AI whale voice does not affirm human input; it refracts it, suggesting a form of listening that is informed, autonomous, and sometimes dissonant. The third agent, an anthropogenic noise layer, acts as an unpredictable disruptor, interrupting patterns, and at times collapsing rhythmic cohesion.

The system draws from two core generative strategies: a probabilistic grammar engine that drives the synthetic whale's phrasing, and Somax2, which conditions the AI-modeled whale voice's output. Together, they enact an asymmetrical dialogue, with communication unfolding via partial alignment, speculative grammar, and acoustic pushback.

Visual feedback in the exhibition space amplifies this sonic ecology: synthetic whale gestures ripple as expanding pulses; AI responses emerge as shifting gestural shadows; noise interference splinters the space into abstract, spectrogram-like fragments. These

[2] *Deviceorientation* and *devicemotion* are Web APIs that provide information about the physical orientation and motion of a device. See: https://developer.mozilla.org/en-US/docs/Web/API/Window/deviceorientation_event

[3] Open Sound Control (OSC) is a data transport protocol designed for realtime message communication between applications and hardware [22]. TouchDesigner is a node-based visual programming platform for realtime interactive multimedia content. See: https://derivative.ca/

Action (phone)	A (Synthetic whale)	B/C (Response)	Visual cue	Intended effect
Tilt (pitch/roll)	Map to tempo, rubato, amplitude; IOI breathes	B may align phrase if patterns resonate; C unchanged	Flow pulses densify and shift direction	Subtle influence on pacing and orientation
Yaw (compass)	Map to azimuth (A only); amplitude stable	B holds focus; slight drift if A is steady; C unchanged	Field rotates; B remains fixed	Spatial localization with role separation
Sharp motion (jerk)	Detect burst onset; brief flourish then rest; amplitude peak	B more likely to respond after recent A flourish; C unchanged	Brief pulse ring flash	Turn-taking: excitation → yield → reply
Stillness ≥ 2 s	Detect low-motion window; A yields; amplitude drops to base	B likely to take floor with a longer phrase; C suppressed	Trails persist; B gains salience	Negotiated coordination; intentional yielding
Sustained agitation	Detect prolonged high motion; rate-limited codas; denser amplitude	B replies less; C becomes more active, then resets	Peripheral C shards intensify and fade	Interference reflects agitation; B avoids masking

Table 2: Audience action to system mapping (sonic/visual outcomes and intended effects). A = synthetic whale (gesture-driven); B = AI-modeled whale voice; C = anthropogenic noise layer.

visual elements echo the system's instability, rendering agency, rhythm, and relation as fluid perceptual structures within an entangled acoustic field.

4 Conclusion and Expected Outcomes

Whale Echo Dialogues offers a sonic framework in which rhythm becomes a medium for ecological tension. Through a triadic architecture that combines audience-driven synthesis, AI-based vocal response, and an autonomous noise layer, the work reframes listening as a process marked by asymmetry, constraint, and entangled agency. Rather than seeking clarity or control, the system emphasizes partial legibility, interruption, and speculative communication, foregrounding the uncertainties inherent in interspecies and human–machine encounters.

The project will deliver a prototype for installation and performance, integrating mobile-gesture input, realtime agent interaction, and immersive audiovisual feedback. Source curation will prioritize ecological diversity and perceptual clarity, applying light-touch processing (band-limiting and fades) with full provenance. Audience impact will be evaluated using a mixed-methods protocol that combines self-report scales. The subjective component includes the Immersive Music Experience Inventory (IMEI) [23], co-presence items on awareness, coordination, and perceived responsiveness [19], and custom agency/tension items [20], all rated on a 5-point Likert scale. Behavioral measures include time to orient to a spatial ping, AI reply rate, and turn-taking lag, informed by prior work on 3D-audio localization [5, 15]. Experimental conditions will manipulate visual feedback and spatialization for cross-comparison [5, 19].

Beyond technical refinement, this work aims to contribute to broader inquiries into posthuman interaction and ecological aesthetics. By staging listening as a shared, unstable field of negotiation, this project models an approach to sound art that embraces miscommunication and acoustic friction as generative forces. In doing so, it opens a space for rethinking authorship, presence, and sonic agency, particularly in contexts marked by environmental precarity and nonhuman participation.

Ethics Statement

The evaluation protocol described is planned for future implementation and has not yet been conducted. No human-participant data has been collected for this submission. The study will undergo ethics review prior to execution, and participation will be entirely voluntary and anonymous.

Acknowledgments

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Rainbow Clash: Cyberperformance as an Interactive Artistic Experience

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Abstract

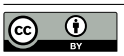
What happens when a familiar competitive game is stripped of its objective and used instead as a system for artistic production? Rainbow Clash approaches the classic ping pong game not as a contest to be won, but as a generative environment in which play, unpredictability, and real-time interaction become compositional forces. Player actions directly influence an evolving visual field, and each session produces a unique image that records the specific encounter between body, system, and chance. The project was developed within the course unit Art, Culture and Communication in the Digital Age through a practice-based process grounded in experimentation and iteration. Real-time visual effects, layered sound, and randomised mechanics were introduced to destabilise control and prevent the repetition of fixed strategies. Rather than optimising performance, these elements foreground variation and contingency, allowing each session to unfold differently. By linking gameplay to image generation, Rainbow Clash reframes play as a form of cyberperformance, where interaction itself becomes material. The resulting images do not represent success or skill, but function as visual traces of performed interaction. This paper discusses the conceptual framing, interaction design, and technical structure of the work, positioning Rainbow Clash as a small-scale case study on how play, randomness, and real-time feedback can operate as artistic strategies within contemporary digital art practice.

CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts;

Keywords

Cyberperformance, Interactive Art, Gamification, Digital Art



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1 INTRODUCTION

Rainbow Clash is an interactive digital artwork that reworks the classic ping pong game as a space for artistic exploration and shared authorship. Developed within the course unit Contemporary Art and Culture in the Digital Age, the project examines how play, unpredictability, and digital interaction can operate as aesthetic and symbolic tools rather than as mechanisms for competition.

The work is situated within a cultural context in which artistic practice is increasingly mediated by computational systems. In contemporary digital culture, software does not function merely as a technical support, but actively shapes behaviour, form, and experience. Manovich and Arielli argue that current computational systems blur the boundary between tool and creative agent, influencing how aesthetic processes unfold [1]. Rainbow Clash engages this condition by treating gameplay as a generative visual process, in which outcomes are shaped by player action, system rules, and random events.

Rather than producing a fixed artefact, the artwork emphasises process and contingency. Each session unfolds differently and results in a visual trace that reflects a specific interaction between player and system. This approach resonates with broader understandings of play as a meaningful cultural activity. Huizinga frames play as a voluntary activity structured by rules and limits, carrying its own internal logic [2]. This perspective supports the use of gameplay as a framework for artistic creation rather than as mere entertainment.

The project also draws on perspectives from digital art theory that consider technology as part of the artistic language itself. Machado argues that media and technological systems are not neutral supports, but elements that actively shape artistic form and meaning [3]. In Rainbow Clash, system logic, visual behaviour, and

interaction design directly influence the aesthetic outcome of the work.

Unpredictability plays a central role in this process. Randomised mechanics introduce instability and variation, requiring players to continuously adapt their actions. Johnson's discussion of emergence, in which complex patterns arise from simple rules and local interactions without centralised control, offers a useful lens for understanding how visual structures develop over time within the artwork [4].

2 ART GAMIFICATION AND ITS RELATION TO THE WORK

"Rainbow Clash" treats the classic game of ping pong as a trigger for artistic production rather than as an end in itself. The project uses colour movement and simple game mechanics to generate visual compositions that change from session to session. The aim is not to represent reality, but to create a system in which interaction produces meaning through variation and contingency. This approach resonates with Miguel Carvalhais's view that artworks should not be understood as representations of things, but as processes through which we question ourselves, our perception, and our modes of thinking [5]. In this sense, Rainbow Clash is conceived not as a fixed visual outcome, but as an ongoing process shaped by interaction.

By blurring the boundary between entertainment and artistic practice, the project adopts ludic structures as an aesthetic language. Play is not used as a metaphor or as decoration, but as an operational framework. As Huizinga frames play as a voluntary activity that unfolds within defined limits and according to shared rules, while remaining separate from ordinary life [2], gameplay can be approached as a serious space for expression. In Rainbow Clash, playing becomes a form of making, challenging the conventional separation between artist and spectator.

The work also functions as a participatory system. The visual outcome is not predesigned, but emerges from the real time decisions of the player. From a digital art perspective, technology is not a neutral support but part of the artistic language itself, shaping both form and experience [3]. The player's actions and the system's responses together produce the visual trace of each session.

Randomness plays a central role in this process. Short term rule changes and unpredictable events introduce instability and require continuous adaptation. Johnson describes emergence as a condition in which complex patterns arise from simple rules and local interactions without centralised control [4]. This perspective helps explain how Rainbow Clash generates visual structures through repeated interaction rather than through fixed composition.

Gamification is employed in Rainbow Clash as an artistic strategy rather than a motivational or instrumental one. Within game studies, gamification is commonly understood as the incorporation of game design elements into non game contexts, structuring interaction through rules, feedback, and decision making [6]. When detached from utilitarian objectives such as efficiency or behavioural optimisation, this framework can be reinterpreted within artistic practice as a compositional system that organises experience and participation. Recent research reinforces this perspective by framing gamification as a means of supporting engagement, exploration, and active involvement rather than goal oriented performance [7].

From a process-oriented perspective, this approach aligns with Carvalhais's understanding of computational art as systems that unfold over time and invite reflection on perception, cognition, and agency [5]. In Rainbow Clash, gamification operates at this level, not to reproduce the logic of a game, but to establish an operational framework in which interaction becomes a form of making. Meaning does not reside in a predefined visual result, but emerges through play, variation, and the continuous negotiation between player and system.

Lev Manovich's analysis of digital and generative media further reinforces this position [1]. By describing digital artworks as algorithmic systems characterised by variability and real time computation, Manovich highlights how such works exist as sets of potential outcomes rather than fixed forms. Within this context, gamification can be understood as one of the cultural structures that shape contemporary interactive systems. In Rainbow Clash, game elements guide interaction and enable visual configurations to emerge through repeated engagement, rather than revealing a predetermined composition.

Recent research on digital art further supports this position. Li discusses gamification as a strategy capable of enabling speculative design and interactive experiences, allowing audiences to act as active contributors to the creative process [8]. Rainbow Clash aligns with this view by positioning the player as a co creator whose interaction directly shapes both process and outcome.

3 ARTWORK DESCRIPTION

The artwork Rainbow Clash emerges from the elementary structure of the classic ping pong game, but displaces its function toward the field of artistic production. The game is no longer understood as a competitive system and instead operates as a space for visual and performative experimentation. Ball, paddles, movement, and scoring are reconfigured as expressive elements. Colour, light trails, and motion persistence accompany each action, creating a continuously transforming visual field throughout gameplay.

Each time a point is scored, the system automatically records the current visual state through a screenshot. These records do not function as documentation in a conventional sense, but as raw material generated through interaction. At the end of each session, the accumulated images are processed and combined into a single generative output. The final image is abstract and irreproducible, directly linked to that specific interaction. It does not represent an ideal result or a desired final state. Instead, it operates as a trace of what occurred during play. The work privileges process over outcome, positioning the image as the residue of interaction rather than its objective. This approach situates Rainbow Clash within contemporary digital art practices, where algorithmic systems and interaction act as central drivers of artistic production [1].

The gameplay experience is traversed by randomised effects that temporarily alter the rules. Inverted controls, frozen paddles, duplicated balls, invisible barriers, and speed variations appear unpredictably. These disruptions prevent the stabilisation of strategies

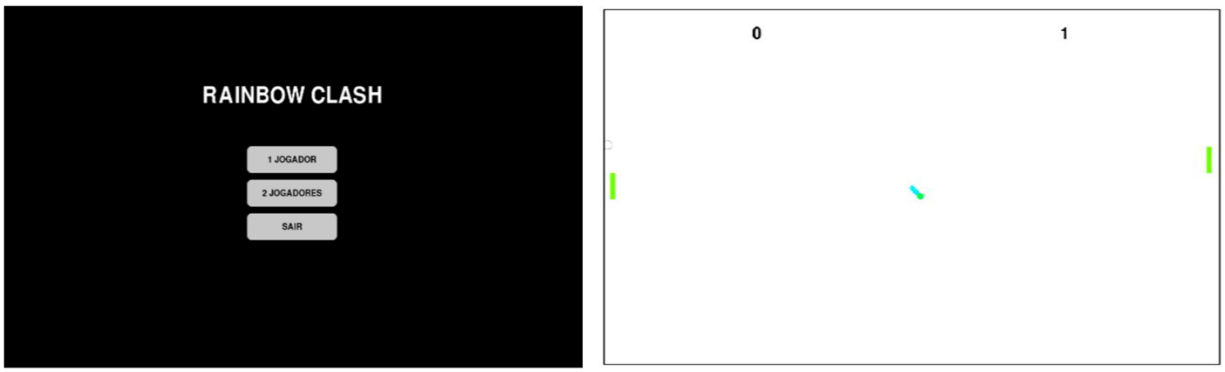


Figure 1: Initial game menu screen (left). Interface during gameplay, highlighting visual elements and real-time score (right).

Table 1: Resources Used in the Project

Resource	Version/Detail
Python	3.9
Pygame	2.1.2
PIL (Pillow)	9.0.1
TeXstudio	4.5.1
MiKTeX	23.10

Table 2: Game State Transitions

Current State	Next Possible States
MENU	ONE PLAYER, TWO PLAYERS
ONE PLAYER	GAME OVER
TWO-PLAYERS	GAME OVER
GAME OVER	SHOW RESULT
SHOW RESULT	MENU (for restart)

and place the player in a condition of constant adaptation. Unpredictability is not treated as noise or failure, but as a compositional element that directly shapes both the experience and the resulting visual output.

Rainbow Clash can be played in single-player mode against an AI-controlled opponent or in a two-player mode that enables direct human-to-human interaction. Controls are deliberately simple, based solely on vertical paddle movement, ensuring accessibility and immediate responsiveness. Visual feedback associated with each rule alteration allows players to quickly perceive changes in the system, while still demanding rapid reaction and sustained bodily engagement.

The role of the player is central. Interaction is not limited to operating an interface, but explicitly constitutes a cyberperformance. Bodily action unfolds through a computational system that responds in real time, registering and transforming each gesture into visual data. Steve Dixon describes digital performance as a practice in which the performer's actions are inseparable from the technological environment that mediates them, producing meaning through the reciprocal relationship between body and system [9]. In Rainbow Clash, to play is to perform, and performance exists only as a dynamic relation between body, rules, and computation.

More recent perspectives deepen this understanding by framing cyberperformance as a hybrid, unstable, and process-based practice. Mastronomio describes contemporary cyberperformance as a field in which bodies, interfaces, algorithms, and data are entangled, allowing performance to emerge through continuous negotiation between human agency and computational processes rather than through pre-scripted actions [10]. This perspective makes it possible to understand Rainbow Clash not as a game with performative elements, but as a digital performance whose materiality is produced by the system itself.

In Rainbow Clash, the player's gestures are translated into kinetic data that the system converts into chromatic variation, luminous trails, and compositional density. The final image reflects intensity, adaptation, and performative effort rather than technical skill or score. What becomes visually fixed is the trace of a situated cyberperformance, shaped by contingency and continuous response to an unstable system.

From a technical perspective, Rainbow Clash was developed in Python using the Pygame library for game logic and real-time rendering. Image processing and final image generation are handled with the Pillow library. The software follows a modular structure that separates game state management, visual effects, and data capture. This organisation reinforces the transparency of the process and the direct relationship between performative action, system response, and visual outcome. In line with Machado's understanding of technology as an active component of artistic language rather than a neutral support, the computational structure of the work directly shapes both form and meaning, making the system itself a constitutive element of the artwork [3].

The project also allows for future developments. The integration of non-visual data, such as biometric or affective signals, could introduce an invisible layer influencing visual generation, enabling the final image to register not only observable actions but also internal states experienced during the cyberperformance. In the two-player mode, the generation of complementary images that only fully resolve when viewed together could further deepen the notion of shared authorship. Another possibility would be the introduction of a limited moment of post-performance intervention,

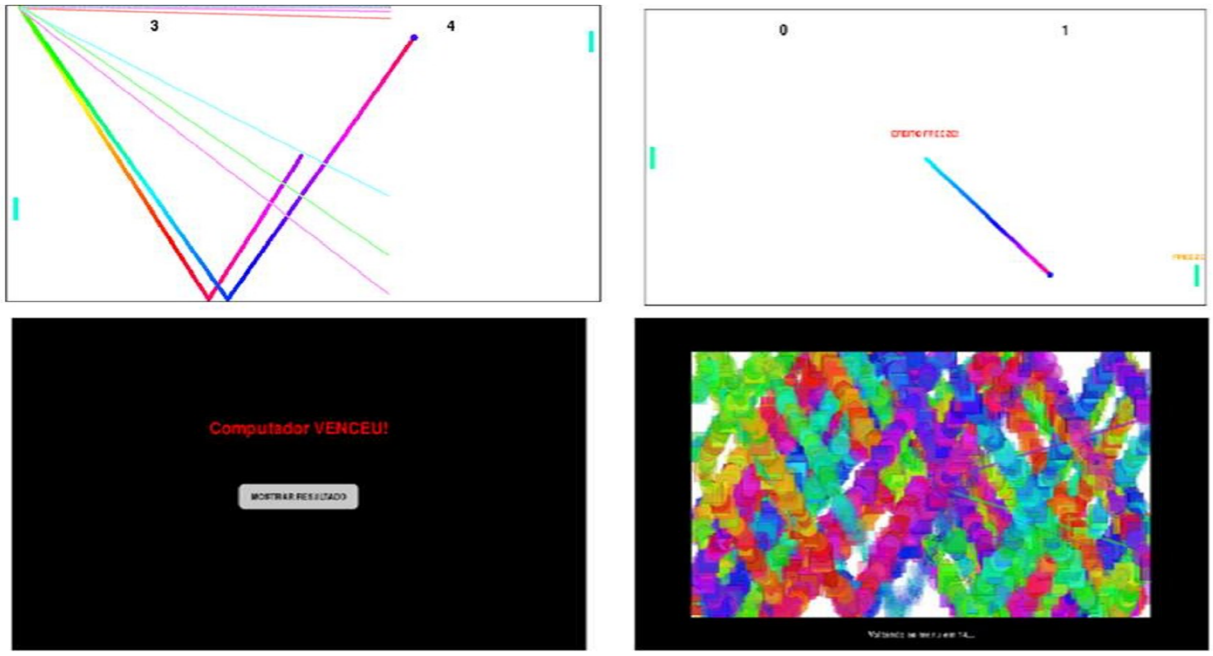


Figure 2: Gameplay scene with dynamic color trails (up, left). Example of a gameplay effect in action, demonstrating unpredictability (up, right). "Game Over" screen (down, left). Unique art generated after a game session (down, right). https://www.youtube.com/watch?v=LqPEdm2CrlI

allowing the player to adjust a small number of parameters before finalisation, combining spontaneous performance with a deliberate act of framing.

These potential developments reinforce the role of play as a framework for participation rather than as a goal-oriented system. Recent research highlights gamification in digital art as a means of fostering speculative practices and interactive experiences in which audiences assume an active role in the creative process [6]. Rainbow Clash aligns with this perspective by articulating play, cyberperformance, and generative systems, proposing a model of artistic production grounded in participation, instability, and co-authorship.

4 FINAL CONSIDERATIONS

This paper set out from a simple but deliberate question: what happens when a familiar competitive game is stripped of its objective and reconfigured as a system for artistic production? Rainbow Clash addressed this question by treating play, unpredictability, and real-time interaction not as supporting features, but as central aesthetic conditions. Across the work, gameplay functions less as a mechanism of control and more as a space where interaction, contingency, and variation generate meaning.

Throughout the project, randomness proved to be a productive force rather than a destabilising flaw. Each session unfolded differently, and the resulting images functioned as visual traces of a specific encounter between player, system, and chance. In this sense, the work reinforces the idea that interaction does not simply activate a pre-existing artwork, but constitutes the artwork itself. Play becomes a mode of making, and performance becomes material.

Within this framework, gamification is not approached as a strategy for optimisation or behavioural guidance. Instead, game structures operate as accessible frameworks that invite participation and co-creation, allowing players with no artistic or technical background to take part in the production of visual artefacts. This position aligns with broader understandings of play as a meaningful cultural activity [3] and with perspectives that recognise computational systems as active agents in shaping aesthetic processes within digital art [1]. What emerges is not a simplified artistic practice, but a redistribution of authorship across human and computational actors.

The project also demonstrated the value of practice-based methodologies in both artistic and educational contexts. Developing Rainbow Clash required the articulation of programming, interaction design, and real-time system management, confronting participants with questions of modular structure, system states, and performance constraints. These technical decisions were not peripheral, but directly informed the conceptual and aesthetic behaviour of the work, reinforcing the inseparability of form, process, and system.

Rather than offering definitive conclusions, Rainbow Clash remains intentionally open. As suggested in the abstract, the work operates as a small-scale case study that points toward broader possibilities for interactive digital artworks grounded in play, cyberperformance, and generative processes. By foregrounding interaction as material and uncertainty as structure, the project invites further exploration of artistic practices that resist fixed outcomes

and instead unfold through participation, instability, and shared agency.

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Designing Awe in Interactive Digital Media

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Abstract

Awe, an emotion marked by perceived vastness and cognitive accommodation, can broaden perspective, dampen rumination, and support well-being. Although interactive artists often evoke awe intuitively, the underlying psychological mechanisms remain largely tacit, leaving designers without actionable guidance. Building on psychology research, we identify core cognitive processes and phenomena that are components of an awe experience in interactive digital media. We then present *Passenger*, an evidence-driven installation that operationalises these processes. Breath serves as the sole input, modulating concentric holographic and panoramic visuals while a 4 Hz binaural "sonic bed" facilitates a more self-removed, outward-focused brain activity. The piece scales from a fragile human silhouette to a rotating Earth to a wrap-around snapshot video of life around the world, progressively amplifying perceived vastness. We outline the system's design, methodology, and planned empirical evaluation using the AWE-S scale and cognitive-processing measures. By grounding creative design decisions in psychology research, this work should offer a reproducible framework for crafting awe-inspiring experiences and presents *Passenger* as both an artwork and an experimental stimulus for future psychology research.

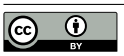
CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts; • **Human-centered computing** → Interaction design; Interaction design theory, concepts and paradigms;

Keywords

Experiential Design, Positive Psychology, Awe, Interactive Media, New Media Art

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1 Introduction

Digital interactive media, with their inherent potential to adapt dynamically to audience input, offer unique opportunities for facilitating active immersive experiences. They are especially well-suited to elicit awe by immersing participants in multisensory, dynamic environments that encourage exploration rather than passive observation [10, 47, 48]. These are the experiences audiences will likely call 'awesome' when referring to them positively in informal settings. From a psychological standpoint, awe is recognized as a positive emotion [7] that can yield significant benefits. In appraisal-based models, awe creates feelings of self-diminishment, which in turn makes people feel small, humble and interconnected [49]. This leads to increased openness, prosocial behaviours, broadened perspectives from a new understanding, and more other oriented values [41].

Understanding how to intentionally design toward awe in interactive digital art can therefore serve as a powerful vector for positive transformation. Artists frequently create installations that intuitively trigger awe, yet their expertise tends to be tacit, making it challenging for wellbeing practitioners and researchers to clearly identify and apply their design practice. At the same time, the explicit psychological mechanisms driving these experiences are not always clearly identified. This perspective acknowledges that awe arises not simply from the artwork itself and its design features but from the interplay between these and how audiences actively perceive, interpret, and emotionally engage with it [12, 34]. It is also a felt, situated experience [13, 35], so audience reactions, interpretations, and interactions are central to the process of designing genuinely transformative experiences.

This paper aims to examine core psychological processes and phenomena underpinning awe in interactive new media art, providing insights grounded in psychological research. Then, we present a work-in-progress interactive installation that tries to embed these processes by turning them into design features to best foster awe. This installation will exist not only as a piece of interactive digital art, but also as an experimental stimulus for psychology research. Our contribution is not meant to replace the tacit expertise of artists with a recipe, or to discredit the idiosyncratic nature of awe that has been extensively explored in philosophy, but to learn from them and translate recurrent patterns into a shared, testable language.

Psychology helps name the cognitive, social, attentional, and emotional processes that artists and philosophers already explore, and to identify constraints and boundary conditions that make certain choices and affordances more or less likely for awe to emerge. These are parameters, not prescriptions: they do not guarantee an outcome, nor do they diminish authorship. Rather, they make it easier for diverse teams to work together, adapt across media, and evaluate impact. In this context, mediated experiences also become a platform for the dissemination of positive impact: if awe has positive mental health benefits of developing prosocial tendencies and epistemics, and we know how to design it better into the media, we can help with small but impactful shifts of perspective in the right direction.

1.1 Rationale and Awe

When people seek awe, an emotional experience tied to creativity and exploratory behaviour [9], they often turn to the media. This can range from writing to painting, reading a book, watching a film, or visiting more unique artistic experiences. When we face a new experience or, in this context, consume new kinds of content, we form units of meaning called mental schema [40]. These allow us to make sense of subsequent experiences that will either be assimilated because they fit into what we know or push a change in our mental schema as accommodation for the new experience that went beyond our predictions. In that sense, new experiences create a sensemaking sandbox that facilitates the understanding and integration of corresponding information. When this experience is captivating, less attentional resources can be allocated to self-reflective processing, reducing the strength of resistance to new perspectives, thus allowing otherwise filtered-out information to be processed [26].

Awe stands out as uniquely attention-demanding [17]; it arises when individuals encounter something physically vast or conceptually challenging that goes against expectations and predictions, disrupting existing mental schemas to make sense of (accommodate) the new information [31]. From this perspective, awe experiences can subtly alter perceptions, beliefs and frames of reference in a way that is missing from our everyday lives, broadening perspectives and possibly enhancing emotional well-being [8]. This cumulation of perspective-changing mediated experiences becomes a vector for personal transformation, where the potential for positive impact lies in the ability to create transformative content. We recognise that intentionally steering emotional responses limits participants' personal interpretive freedom. Nevertheless, this intentional approach is common across various media types, including film, literature, and music, which routinely shape emotional experiences in diverse directions. Explicitly designing toward awe counters prevailing trends of shallow to hollow content that is consistently pushed on social media platforms and instead feeds into a discourse that aims at providing deeper, meaningful, and beneficial experiences.

2 PSYCHOLOGICAL PROCESSES AND PHENOMENA FOR AWE

2.1 Priming

One powerful way to foster awe is through priming [42], a preparatory process that helps audiences make sense of novel information by connecting it to existing knowledge structures. Priming typically involves providing visitors with contextual or thematic cues before fully engaging with an experience, enabling them to form expectations about the stimuli they will encounter [6, 37, 54]. With art, where conveying a message or evoking a response is central, priming plays a vital role in helping viewers connect with a piece's intended meaning, so providing titles, descriptions, or other cues will activate semantic networks that enable viewers to process elements more fluently [44]

In addition to semantic priming, the contextual environment surrounding the installation can shape how visitors perceive and engage with it. Perception is influenced not just by the stimuli themselves but also by the environment in which they are experienced [51]. For instance, an art piece presented in a cultural institution may benefit from the gallery's prestige and thematic framing, which signals to participants that the experience is meaningful. As an example, Chiroptera [28] is a modern take on the cave allegory from Plato, for which viewers observed dancers and shadows projected on the façade of the Palais Garnier, a historic opera house in Paris, using spectators as an integral component of the myth reenactment.

2.2 Prediction-Error-Resolution

At the cognitive level, awe has been linked separately to surprise, incongruity detection, and increased self-reflection [16, 23, 52]. In a more holistic approach, research suggests that awe emerges when an experience goes beyond, yet does not fully contradict, what a person expects [21]. The initial surprise produces a prediction error that momentarily unsettles the observer, and awe follows when the mind swiftly rearranges mental schema to accommodate the experience, making the new perception feel "obvious" and self-evident in hindsight [19, 32]. The Overview Effect illustrates this process [57]: when an astronaut aboard the International Space Station looks out the window and sees Earth as a whole, a blue sphere surrounded by darkness, without visible borders or divisions. While they already had an understanding, a mental model of what Earth looks like from space through images and training, seeing it directly in real time exceeds their expectations. The scale, clarity, and emotional impact of the view are far greater than imagined. This moment creates a prediction error: the actual experience does not fully match their what they expected to see based on their prior mental model. It challenges and exceeds, but does not contradict, what they believed. As their mind adjusts to this new perspective, they quickly reorganize their understanding of Earth and their place on it. This bridges the factual information with their reality of the experience. In effect, they are "discovering something they already knew, again for the first time" through a newly expanded lens. This kind of experience reflects how awe can arise: when something violates expectations just enough to require mental accommodation, leading to a new understanding that feels intuitively true in hindsight.

2.3 Vastness

The prediction-error-then-resolution occurs when predictions and expectations are exceeded, so the stimulus often involves be vastness, which is a component of awe [31], whether it is the perception of physical vastness, or a conceptualization of a challenging concept



Figure 1: *Passenger* at runtime, the user is positioned in front of three layers of visuals, progressively larger, with which they use the breath to interact.

[1, 20]. Physically large environments, or very large installations, can typically make visitors feel small [27], and such settings can be combined with the prominence of grand concepts that are typically difficult to grasp because of how big. In line with research from [2]. This can include themes of birth, death, love, and impermanence as explored in works such as *Les Archives du Cœur* (2008) by Christian Boltanski [4] where people can archive the sound of their heart beat, or Until I Die by ::vtol:: (2017) [36] where the artist uses his blood to power lamps, the latter being partly inspired by the sand mandalas of Tibetan monks that share similar themes. Grand concepts also include themes of spirituality and religion [29, 38], time and space (e.g. *Your Black Horizon* (2005) by Olafur Eliasson where a thin horizontal line of light shines through a narrow gap in a black wall) [15]. These concepts are usually characterised by qualities of being infinite and continuous, which is what makes them difficult to grasp.

2.4 Agency

Giving users a sense of agency, where they feel in control of their actions, and that they can affect a piece by becoming part of its system, can play a key role in prompting awe. A system and its design create specific affordances, speaking to internal models and representations of how it is likely to function, and predictions of what will follow specific actions. Therefore, when people realise they can influence an artwork or interactive experience, they may naturally form predictions about how their actions will affect the outcome. This allows artists to manipulate expectations by providing feedback that is intentionally unexpected or surprising. So, when participants' actions lead to results that don't match their predictions, it can create a moment of surprise, which, when pushed to an extreme, could force a rearrangement of one's understanding, which is a core component of awe [53]. Agency also encourages participants to experiment, explore, and makes them feel like they are actors in the experience to increase senses of immersion and perceived realism [10, 47], acknowledging that people value installations that feel responsive and respectful of personal initiative.

2.5 Embodied Sense-Making

When designed thoughtfully, digital art installations can communicate meaning and evoke strong emotional responses without needing explicit explanation. The piece 'speaks for itself' when its experience is crafted with audiences, their internal dynamics, and their interaction with the system in mind. The aforementioned cognitive processes and phenomena come together to provide a unified experience: narrative structures act as semantic sandboxes, helping participants anchor and interpret their experience, while intuitive, natural user interactions to which the system is responsive embed the work with a playful, immersive quality. This dynamic, especially when enriched by multisensory engagement and agency [33], can reduce self-focus and direct attention outward, setting the stage for awe. In such moments, the familiar is encountered as new, and the boundaries of perception and thought expand [46].

3 Evidence-driven Experiential Design

To exemplify this synthesis, we present a multi-scale, sequential evidence-driven installation called *Passenger*.

Passenger combines contextual framing (priming), grand themes (vastness), individual contribution and system responsiveness (agency), into an experience that exceeds expectations yet makes sense (prediction-error-resolution) through active engagement (embodied sense-making). It is an interactive installation designed to elicit awe by facilitating meditative and self-transcendent experiences through an explicit integration of cognitive processes coupled with active physiological engagement. Interaction is solely driven by participants' breathing, which is known to directly activate the parasympathetic nervous system. This leads to calmer affective states [45] by reducing cortisol levels and amygdala activity. Moreover, neuroimaging studies have shown controlled breathing to

also decrease default-mode network activity (associated with self-referential thinking and rumination) while increasing connectivity in attention-regulation circuits, providing the cognitive 'space' for meditative states [5, 59]. This is further supported by a 4Hz theta-wave binaural audio bed supports brainwave entrainment, further enhancing the meditative state [25].

3.1 Design Approach

The use of the breath as a means of interaction echoes previous works such as Edmond Couchot's *Pissenlits* [11] where the breath scatters particles of a digital dandelion or *Breathing with the Forest* (2021) by Marshmallow Laser Feast [18] where visitors come to synchronise their breath with the audiovisual representation of a tree's internal changes. In a similar design approach, *Passenger* foregrounds the visualisation of breathing while presenting visuals that speak to transcendent themes and, turns cognitive processes and phenomena into design features. For the installation itself, the multilayered scalar aspect of *Passenger* is partly inspired by the consecutive larger perspective takes found in the "Regular Old Living" scene from the film *Soul* [14], while the breathing, responsive environment comes from the "Pollination" sequence of the animated series *Scavengers Reign* [3].

The installation first displays the hologram of a falling human silhouette, which is a direct metaphorical representation of 'the small self', commonly referred to as the consequential effect of self-transcendent experiences [39, 50]. Its size, relative to the user, as well as its animation, are chosen to prompt a feeling of fragility, a small figure lost inside something much larger. The breath affects the edges, so that at a specific setting, the silhouette disappears completely, which is a reference to ego-death, a phenomenon associated with deep self-transcendent experiences [24]. The second element is a holographic Earth globe, which inherently carries the semantics of being vast both physically and conceptually and is positioned right after the human figure for the two to contrast in size. The third element is the projected video that tries to capture a snapshot of life around at any given moment. The projection is larger than the two other elements because of how much bigger this *everything* is compared to them, and displays a series of ∼4 seconds clips that are indiscriminately, negative (e.g. children living in poverty, riots), positive (e.g. a wedding, a baby laughing), or more neutral (e.g. people entering the metro, an older man walking in a park).

Regarding the audio elements, there is first the soundtrack corresponding to the projection as well as the melodic theta-wave carrier (4 Hz) providing a continuous sonic bed. An opening prompt by Duncan Trussell from *The Joe Rogan Experience* podcast episode 666 [43] is used as a primer for self-transcendent themes: '*Allow yourself the fantasy that you're 13.8 billion years old and you're part of this incredible ocean of happening instead of just this one individual. Just let yourself experience that for a second. The glorious knowledge that you are a never-ending, ever-changing flow of matter that's temporarily manifested with the ability to express love.*' This prompt aims at priming awe [44] by increasing state dispositional awe [22] (the momentary likelihood of experiencing awe) using a terminology and metaphors that present themes of self-transcendence ('ocean of happening', 'never-ending, ever-changing', 'love'). These terms refer to continuous, infinite or extremely vast concepts that are difficult to grasp, linking back to the conceptual vastness aspect of awe. The closing prompt signals the end of the experience while also ending on a reflective note using similar themes as the opening prompt, focusing more on the virtue of character [56]. It is from Kurt Waldheim, extracted from *The Voyager Interstellar Record - 1/31 Greetings From The Secretary General Of The UN* [55] and edited to: '*We step out into the universe seeking only peace and friendship, to teach if we are called upon, to be taught if we are fortunate. And it is with humility and hope that we take this step.*'

Finally, the room is primarily illuminated by the projections, but this is complemented by two Philips Hue lamps whose intensity breathes in synchrony with the participant, never exceeding 15 % of maximum luminance to preserve a dim luminosity.

3.2 Methods

Structures were built to be as open as possible to help with impressions of diffusion and openness across the different elements in the room, and to not obstruct the line of sight of users. Because this is still a work in progress, the measures and dimensions are not final. The two holograms rely on Pepper's ghost illusion methods to create the feeling of holograms seamlessly integrated into the installation. Pepper's ghost is an optical stage illusion that superimposes a luminous "ghost" image into real space using a semi-reflective sheet of glass or beam-splitter acrylic set at roughly 45°. A bright source image, typically an LCD or tablet screen, lies outside the viewer's direct sightline; its light reflects off the angled pane toward the audience while most of the ambient scene passes straight through the pane unchanged. Because the reflected image appears to occupy the same volume as the real objects behind the glass, viewers perceive a free-floating, translucent figure with no obvious supporting surface. Using a visual with a black background while controlling for ambient lighting (keeping the hidden source bright and the stage comparatively dim) preserves the illusion's crisp "holographic" presence.

The full system runs on a Dell G16 7630 laptop with a 16Gb NVIDIA GeForce RTX 4070 graphics card, 32Gb RAM (3200 Mhz), and a 13th Gen Intel Core i9-13900HX, 2200 Mhz, 24 Cores. TouchDesigner 2023.12370 was used to integrate all the components of the system, casting the human figure using an NDI protocol, and projecting the other two elements through HDMI. As illustrated in Figure 2, users are seated on a comfortable, low-back chair that is positioned so that the participant's gaze naturally aligns with three concentric layers of imagery.

The Human Figure. Directly ahead, at eye height, a rectangular cuboid Pepper's ghost illusion box rests on a plinth. A Windows-based ASUS tablet (T305CA) lies face-down inside the cube, projecting a lightly moving blue hologram of a human silhouette whose edge weight is continuously modulated by the participant's own respiration. The animation was recorded using a motion capture setup comprising of Motive + OptiTrack cameras for the tracking and Motion Builder for motion retargeting.

The Globe. Fifty cm beyond the first cube, a translucent virtual globe sits in a 70 cm Pepper's-ghost illusion box on another plinth. Using metallic textures on the virtual object to represent the continents, the globe gives the illusion of reflecting the video projected

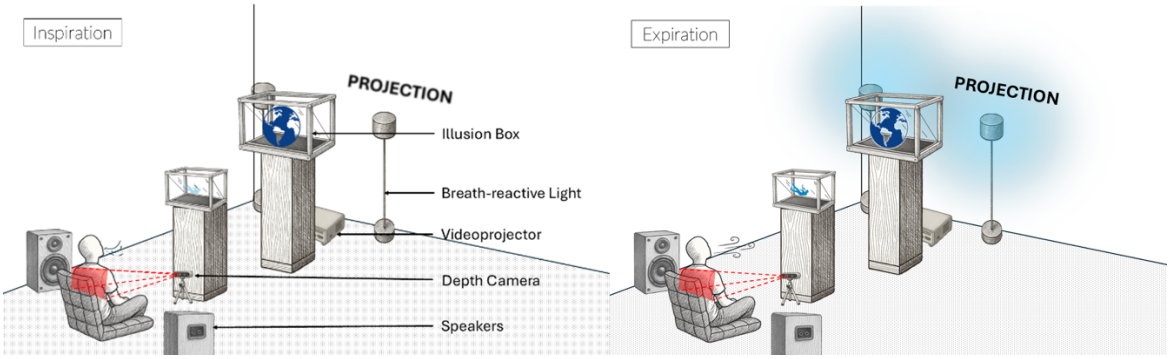


Figure 2: Projected setup for the experience. On the left, the user breathes in, so the background projection is blurred, its sound is muffled, and the holograms are dim. On the right, the user breathes out, increasing the brightness of the holograms, the light intensity, lowering the projection video blur and the low-pass filter applied to its corresponding sound.

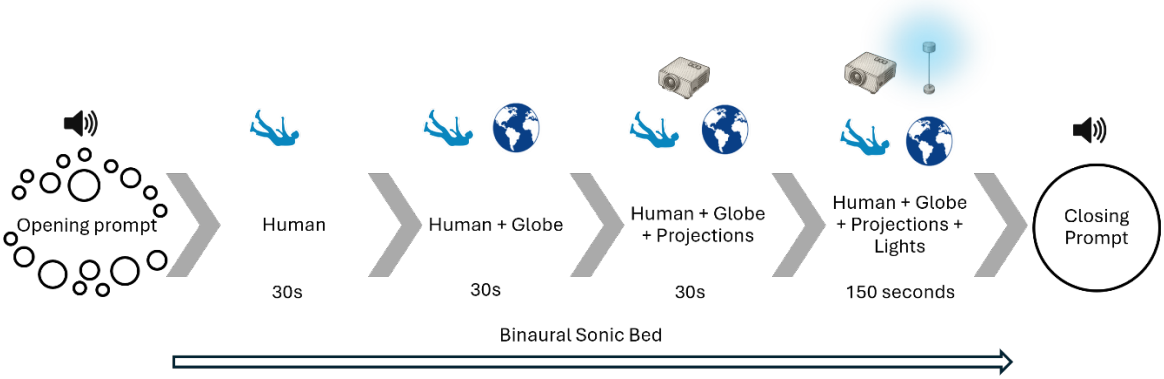


Figure 3: Experience timeline showing its sequential and progressive dimensions.

onto the wall behind it. The globe slowly rotates, and its diameter and angular velocity expand and contract with the user's breath. The globe is projected using a monitor that is facing down.

The Projection. Two ultra-short-throw projectors fill the corner walls with a seamless panorama of four-second everyday-life clips. Each clip was found on a bank of stock videos from Pixabay under the Pixabay Licence, and the full video was compiled on DaVinci Resolve. For videos with no sound, stock sounds were downloaded from the same platform and each sound clip was designed on Audacity before being exported to DaVinci Resolve with its corresponding video clip. Gaussian blur and a first-order low-pass audio filter are applied inversely to respiratory depth, so that slower, deeper breathing progressively sharpens the image and unmuffles the soundtrack. Finally, the audio is played using two Genelec stereo speakers flanking the chair.

3.3 Experience Timeline

The experience unfolds as a progressive, sequential, scalar experience. At time zero, the spoken priming message plays, after which the human hologram fades in over three seconds. Thirty seconds later, the planet cross-fades into view, and after a further thirty seconds, the panoramic projection brightens from black to full opacity. After an additional 30 seconds, the lights become active and responsive to the breath. This progressive reveal accentuates perceived scale, from one small, falling individual, to the larger Earth, to a snapshot of global everyday life, and to a room that breathes with the user. The full interactive portion lasts for 150 seconds, after which all visual and auditory channels then fade to black in ten seconds, before the closing message is delivered.

3.4 Sensor Calibration and Signal Mapping

Respiration is captured by an Intel RealSense D415 depth camera positioned at a low-angle view. This camera utilises stereoscopic depth technology with rolling shutter image sensors, with a depth sensing range of 0.5 to 3 meters, and a minimum working distance of about 45 cm at maximum resolution. Its depth accuracy is less than 2% at 2 meters, it supports resolutions up to 1280 × 720 at up to 90 frames per second, and its depth field of view is 65° horizontal by 40° vertical. Because it only measures 99 mm × 20 mm × 23 mm, it is compact and very easy to integrate into a range of setups.

For the current stage of the project, the minimum and maximum user values corresponding to inhale and exhale are configured manually. A participant-agnostic mapping approach will be developed using an automated calibration step taking place during

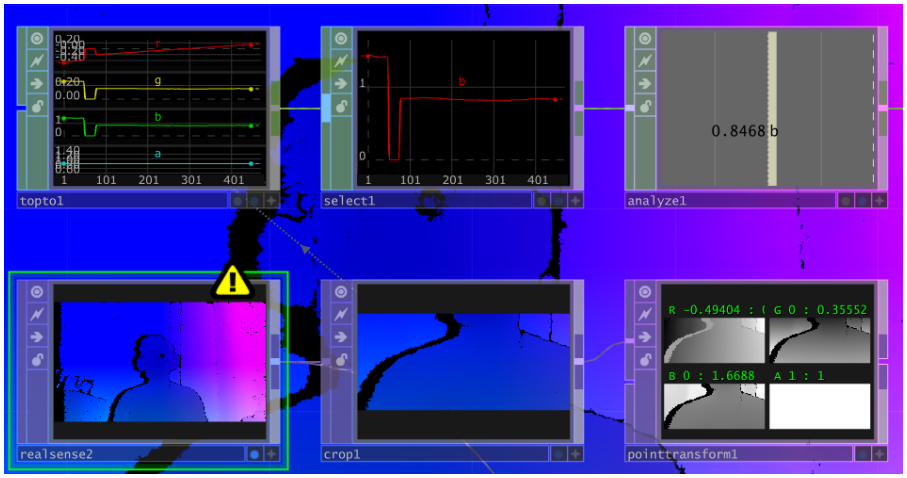


Figure 4: Depth signal extraction from the UV video stream in TouchDesigner. The video stream is cropped to isolate the torso area, after which the blue colour channel corresponding to depth is isolated and its continuous value extracted.

the first phase of the experience. Minimum, maximum and average breathing signal values will be extracted during the opening prompt and applied to corresponding parameters for the rest of the experience, so the system will be robust to minor variations in torso morphology and clothing. It is the same signal that drives (a) human silhouette hologram edges weight, (b) globe scale and rotation speed, (c) Gaussian blur intensity, (d) audio filter low-pass cutoff (inverse linear), and (e) Hue lamp intensity (linear), ensuring the entire environment "breathes" with the participant.

3.5 Future steps and experimental use

Our current project is still a work in progress. For this reason, the next immediate steps include developing an internal system so that the installation can be autonomous: sensor calibration for the respiration signal, people detection to start and reset if they leave, and the timeline configuration so each element is introduced progressively and smoothly. Further steps will include piloting and adapting the experience duration, the parameters of its elements (e.g. hologram size or brightness), the room layout, and maybe most importantly, the video clips from the projection. From that point, the installation should be functional as an experimental stimulus. To evaluate its experimental validity, the installation will be tested with a few participants to measure how much awe it prompts using the AWE-S [58]. This validated scale measures different dimensions of awe: vastness, need for accommodation, time dilation, self-loss, physical sensations, and connectedness. Emotional responses can vary significantly among individuals, making the consistent elicitation of awe challenging. However, this challenge can be addressed under the Semantic Space Theory [30], which, using very large samples of participants and stimuli, proposes awe as a fundamental, universally shared emotion due to common human psychological architecture. While the precise expression of awe may differ individually to create more idiosyncratic, complex emotions such as admiration or gratitude, core psychological responses remain broadly consistent across populations, providing sufficient grounding for systematic design efforts.

For this reason, the installation will later be used for a follow-up experiment of one that was recently conducted to measure the effects of priming and cognitive load, from which, as part of the piloting, we will reuse a cognitive processing scale that measures how many and which clips are remembered from the projection, and if so, how much deeper reflections it prompted. In a work-in-progress study, we found that recognition and reflections are anti-correlated, and that reflections strongly predict awe, so this scale will be used to experimentally assess which clips are best at prompting awe before eventually curating a different clip selection. Moreover, agency will be introduced as an independent variable and controlled for as part of the experimental design to move beyond assumptions and systematically test how much it plays into the experience of awe in the context of this interactive installation. Finally, the finished installation will also be submitted to relevant venues and conferences focusing on art and science as an exemplification of evidence-driven design rooted in psychology research and its positive impact potential when designing toward awe.

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Understanding the Use of AI in Contemporary Dance: Perspectives from Practitioners

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Abstract

There is a growing interest in Artificial Intelligence (AI) across different creative fields, including dance. Given the challenges in implementing real-time AI solutions for dance, adoption of AI has been slower in dance compared to other creative fields. There is a lack of studies involving different dance practitioners (particularly dancers and media artists) regarding how they use AI in contemporary dance. This leads to our research question: how do dancers, and media artists working in dance, view AI and its use in contemporary dance? To answer this, we conducted a focus group session with 10 artists, who specialize in dance and media art, all of whom had experience using AI in contemporary dance. The thematic analysis of the focus group transcription revealed how dancers and media artists working in dance perceive AI and its applications in contemporary dance. Additionally, this analysis allowed us to identify recommendations for the use of AI in contemporary dance.

CCS Concepts

• **Computing methodologies** → **Artificial intelligence**; • **Applied computing** → **Performing arts**.

Keywords

artificial intelligence, contemporary dance, dance and technology, movement and computing

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1 Introduction

There is a growing interest in Artificial Intelligence (AI) across different creative fields. This interest has intensified with the appearance of Generative AI. For example, high-quality images can be created through carefully written text prompts with Generative AI models such as Dall-E and Stable Diffusion [1]. In terms of performing arts, and particularly in dance, the use of AI has been slower to pick up. One of the reasons for this is that dance usually requires a real-time interaction from technology, while commercial applications of AI have typically not been real-time in terms of its outputs – long rendering times have been needed for video or audio generation, for example (unless when using vast computing resources, which are normally out of reach for creative practitioners). However, recent developments in AI now allow for a real-time generation of content, even with consumer-grade technology, which suits the integration of AI with dance.

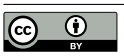
Given the recent adoption of AI in dance, and particularly in contemporary dance, we ask the following research question: how do dancers, and media artists working in dance, view AI and its use in contemporary dance? To answer this question, we conducted a focus group with 10 participants (dancers and media artists) with experience in using AI in dance. In this paper, we report on the findings from the focus group, and from these we extract recommendations regarding the use of AI in dance.

2 Related Work

In recent years, the rapid advancement of Artificial Intelligence (AI) and Machine Learning (ML) has led to research on the impact of these technologies on dance. Nogueira et al. [14] conducted a systematic review of the use of ML on dance performance. Their findings revealed that, on the positive side, ML introduces a sense of novelty and heightened interest in dance performances. However, it also raises ethical concerns. They identified four key areas regarding the use of ML in dance: choreographic creation support; dataset or network collection and training; improved human-pose detection techniques; and perception and new visual representations of dance movement [14]. We will now present key examples across these areas.

Regarding choreographic creation support, the collaboration between choreographer Wayne McGregor and Google Arts and Culture originated an AI-driven tool that can generate its own independent choreography, based on the McGregor's dance video archive [9]. *Chor-rnn* is an ML system trained on motion capture data, generating new dance sequences by analysing a corpus of contemporary dance data [7]. *Echofluid* is an AI-based choreographic support system that empowers dancers to create their own AI models for learning, evaluation, exploration and creation [17]. *PirouNet* is a system that enables dance professionals to annotate data with their unique creative labels, generating new choreography based on their aesthetic preferences [15].

Dataset or network collection and training involves using data or visual materials to train ML algorithms to "grasp the intricacies inherent in various dance styles" [14]. *Discrete Figures* is a



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piece based on 40 separate motion capture recording sessions, each featuring a dancer improvising in a different style [12]. Berman and James [2] developed an ML system for a dance performance, trained on-the-fly using live motion data captured on stage. Correia et al. [5] used an ML system trained with body map drawings – diagrams of the body made by dancers, highlighting physical sensations involved in specific movements. The system can create animations from incoming movement data, projected as visuals during a performance.

Concerning improved human-pose detection techniques, some notable examples have used Laban Movement Analysis combined with ML for movement recognition [8, 16]. Regarding perception and new visual representations of dance movement, a notable example is *FORMS*, combining dance and visual art by creating a framework that generates abstract and literal visuals from the dancers' movements, using ML [13]. Brenton et al. [4] created a system that generates real-time visualizations reacting to the free-form idiosyncratic movements of an individual dancer, using ML.

The analysis of related literature shows that there is a lack of studies involving the practitioners themselves, questioning multiple artists involved in this type of work (notably, dancers and media artists) on how they use AI in dance. With the study we report upon, we aim to address this gap.

3 Methods

To investigate the use of AI in dance, as part of the project Movement, Digital Intelligence and Interactive Audience (MODINA) [1], we ran an open call to select 10 artists working in contemporary dance, to develop five dance works that utilise AI technologies. We received applications from 182 artists. Artists applied in duos, mostly composed of one dancer and one media artist (with some artists having a more hybrid profile). The selection criteria for the 10 artists was the quality of CVs, portfolios in terms of dance and technology, and the quality of the choreographic proposals. The 10 selected artists all had experience using AI in their work.

In September 2023, we gathered the 10 selected artists at Tallinn University, in order to have discussions about the selected projects and the inherent technologies. The artists were between 30 and 60 years of age at the time. Four identified themselves as male, four as female, and two as non-binary. In terms of profile, two identified themselves as dance artists, two as media artists, while six declared a mixed profile between both disciplines. We ran a 1-hour focus group [10] with the 10 artists on the topic of dance and AI. The focus group was moderated by the first author. Questions asked by the moderator to the group were: how would the artists define AI; what are the motivations for using AI in their practice; what are the problems with the use of AI; and what is the importance of AI for dance (and vice-versa). We video and audio recorded the focus group. We then transcribed the audio and analysed the resulting transcription using thematic analysis [3]. We coded the data using an inductive 'bottom up' approach to identify patterns – not guided by theory or the questions asked during the focus group. The coding was conducted by the second author and cross-checked by the first. The themes were derived by both. We used the software Atlas.ti [2] to support the coding and analysis.

The methods used mirror our previous studies with focus groups on dance and technology: on dance and technology-mediated audience interaction (with the same participants, from MODINA) [6] and dance and interactive technology in general [11].

4 Results

We conducted a thematic analysis of the transcription of the focus group, resulting in the following five themes: AI as a Cultural Concept; AI as a Tool for Creativity Support and Communication with Audience; Embodiment and AI; Ethical Issues with AI; and Appropriating AI and its Critical Uses.

4.1 AI as a Cultural Concept

To the general public, AI is considered *"more of a social concept now, or a cultural concept, more than a technical one"* (P9) and is equated with *"black boxes which you trained with a lot a lot a lot of data, and then you just generate"* (P9). The technologies behind AI are diverse, but in time they got branded generically as AI: *"it's something that they used to sell deep learning to the masses, I think, because AI came with maybe a positive baggage, like with a positive history and people were more receptive to it"* (P4). AI has become a major cultural topic: *"everywhere in society it's AI, it's everywhere and it's talked about everywhere and it's sort of inescapable"* (P5).

The participants discussed how AI is often portrayed as having human-like characteristics. The 'gold standard' AI should achieve used to be *"think like a human, think rationally"* (P9), although this seems reductive to the participants. As one participant put it: *"this is problematic, because 'like a human, like rationally' is very different, because humans are absolutely not rational."* (P3). AI is *"inspired by human intelligence"*, but different from it (P1). Other key distinctive elements are that AI lacks human consciousness, unconsciousness (P3) and experience (P9). As AI evolves, it may make even less sense defining AI by its human-ness (P7). That raises the question *"Do you think that at some point the AI's intelligence might be beyond even what we see as human intelligence?"* (P9). One participant was also interested in exploring the *"uncanny valley"* of interacting with an AI and believing you are actually interacting with someone (P2). Another participant highlighted that AI is part of an ecosystem that involves humans and other influencing factors (P10).

4.2 AI as a Tool for Creativity Support and Communication with Audience

Several of the participants question the creative capabilities of AI: *"it reproduces, given patterns, or given information, never creates"* (P2) and *"it doesn't generate on its own, it's regenerating"* (P7). AI is not considered to be creative in the human sense (P5). A creative pursuit *"has nothing to do with intelligence, right?, it has to do with what we humans find interesting"* (P4). The human needs to be in the loop to generate new ideas: *"there is no new idea coming from the machine, never, and it's a big point, if we have an idea with AI it's because you are on the loop"* (P1).

[1] https://modina.eu

[2] https://atlasti.com

Artists would rather view AI simply as a tool that supports the creative process rather than a technology doing the creative work for them: *"For me, it's a tool actually, and I use it because it permits me to add to my projects, yeah, a complex system, and to bring a lot of data"* (P1). Otherwise, the process of creating work is too fast: *"It doesn't even give us the time so much of appreciating or perceiving or having this kind of perception that we're looking for in the art"* (P3).

AI changes the process of creating work, but the process itself remains key. As one participant put it, using AI image generation as an example: *"I'd rather paint that myself, learn to paint that myself than to have it painted for me. Because the whole experience of making the work is why we do it, not the result of it"* (P7). A solution is to shift the process to creatively instructing AI: *"the reductionism that happens with AI when you ask it to generate something is that you also have to remain creative in what you ask of it"* (P7).

AI can also be a tool to better communicate with an audience: *"I see it as a tool that can allow to shorten paths between me and the audience to get into some emotional state or embodied space"* (P6).

4.3 Embodiment and AI

A key distinction between AI and humans deserved particular attention from the participants: AI is disembodied when compared to a human. As one participant put it:

> *I think that there's a massive difference because AI doesn't have skin, doesn't have a body, doesn't have all the other things. It's not an embodied human like we are an embodied human, right? (…) because we also are embodied humans, I guess that we sense things through the body, that is not accessible right now with AI.* (P9)

Even if AI can perceive sensorial information, this is different than processing this information through the body. AI can mimic these embodied experiences, as it can mimic human intelligence:

> *Is it [AI] measuring feelings or just sensory perception? It's a difference, because feeling is what we sense through the body, through our senses, becomes feelings. And I would say there's a difference exactly like also artificial intelligence is not intelligent per se, it actually finds the mechanics to represent intelligence to us.* (P2)

The notion of the body has been absent in technological developments such as AI:

> *We haven't had the power to influence how people think about these tools like AI so they're basically forgetting about the body, because they're not collaborating with people who are using bodies you know, so they think it's all about sound waves and just text and images but like, how about the senses, how about the body?* (P9)

Dance is seen as a way to put into perspective the role of the body with a technological development such as AI: *"That's why I think dance, or going back to the body is actually a good, interesting, or creative way to mix, to generate this conversation to get back to the body to this real and visual"* (P3).

4.4 Ethical Issues with AI

The participants raise several ethical concerns about AI. One is that there might be hidden agendas behind AI, from those who control it: *"when people use that without deeper reflective thought, it is that they think AI is neutral – and the people that control it are also not neutral"* (P7). Therefore, an important question is: *"who owns the power to create those tools?"* (P9). Specifically, unethical use of data by corporations is seen as a major issue: *"a lot of the critiques that went against AI, that it served the big corporations and so on, that it wasn't that democratic, that it was using our data without necessarily our consent, so there's a lot of political problems behind AI"* (P9). Another identified issue is the discrimination and homogenisation of knowledge (P8). There is also the issue of dilution of authorship: *"you don't know who painted that painting for example, you can never tell anymore"* (P2).

The impact of AI on jobs is also a concern, and the creative sectors are also impacted: *"that's some of what the media is also spreading which is true about all these jobs that will disappear with AI and so on and so forth and I think creativity is one of the test beds for AI you know?"* (P9). These issues are accentuated by a feeling of acceleration and lack of reflection: *"There is a capacity of speed and in society of, 'accelerate everything', it's like, 'oh very functional, very practical', but we don't know how to measure the impact"* (P3).

4.5 Appropriating AI and its Critical Uses

Participants express an inclination to expose the boundaries of AI models and to bring out an aesthetic quality from computational limitations. As (P4) mentioned, *"we're looking to explore the outer boundaries or the interesting parts and what strategies can we deploy to get generative models to behave this way"*. This idea of exploring the boundaries of AI was also mentioned by (P5): *"I feel really interested in finding the middle ground or sort of borders, the edges of AI being a very powerful computational tool that allows us to do really interesting things, up to that point of, where does the sort of creative possibilities end with it"*. There is a need to appropriate AI and adapt it to creative pursuits: *"traditionally, machine learning or deep learning goes towards an objective and tries to find the right solution, but in creative pursuits, that's not what we're looking for, right?"* (P4).

Exposing limitations can be important beyond aesthetics. Participants also believe that artists have a responsibility to be reflexive and critical about AI, particularly given the hyperbole around it: *"this responsibility to critique it or to expose its limitations, and to make it visible, not to hide it behind this veil of 'intelligence' or 'magic' or whatever"* (P4). Joyfulness and embodiment can also be a form of critique on AI:

> *Instead of kind of always [expletive] on AI, because it's like this big corporation thing, I thought maybe a positive outcome would be to find my way to reincorporate it and do something happy and joyful and embodied and cool with it.* (P9)

5 Recommendations for the Use of AI in Contemporary Dance

The results from the focus group allow us to identify recommendations for dance artists, and in general for creatives working in contemporary dance, who wish to engage with AI in their work:

(1) Dance artists should **be mindful of contributing to existing exaggerated views around AI**, and particularly avoid communicating AI as human-like.
(2) Dance artists should **explore differences between how AI and humans function** as a source of inspiration.
(3) Dance artists value the creative process, which is cut short with AI. Therefore, they should shift their focus to **highlight the creative process of engaging with AI** – to remain creative in what artists ask of AI, and possibly highlight the process of dialogue with AI in the work.
(4) Dance artists can **use AI to better communicate with an audience**, in the case of interactive performances involving the audience. For example, AI can give personalized responses to the interactions of an audience member.
(5) Dance can **assist audiences to understand the importance and complexities of the human body**, which is often forgotten by technology – and particularly by AI.
(6) Dance can **help the field of AI to understand the role of the body regarding intelligence** and assist in the development of more body-aware technologies, therefore expanding the traditional role of dancers.
(7) AI is not neutral, it has its own agendas – related to corporate ownership, use of personal data, and authorship, for example. Artists have the responsibility to **reflect on the lack of neutrality of AI through their work** – and eventually lead audiences to also reflect on this.
(8) The **limitations and errors of AI present important creative opportunities** to be explored aesthetically.

Some of these recommendations are more universal and cross-cutting with other creative practices, while others (i.e., recommendations 4, 5 and 6) are more specific to dance – focusing more on the connection between technology, the body and audiences.

6 Conclusion

In this paper, we asked the research question: how do dancers, and media artists working in dance, view AI and its use in contemporary dance? To answer this question, we ran a focus group session with 10 artists (dancers and media artists) with experience using AI in contemporary dance, selected from an open call to participate in the MODINA project. This approach is novel, as there was an absence of studies involving a group of diverse dance practitioners working with AI. The thematic analysis of the focus group transcription allowed us to identify how dancers, and media artists working in dance, view AI and its use in contemporary dance. Furthermore, these results allowed for an additional contribution from this paper: to identify recommendations for the use of AI in contemporary dance. The contributions of this paper are useful for dancers and media artists working in dance, and also for AI developers wanting to understand the role of the body in AI. Additionally, they can also inform creative practitioners in general working with AI.

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Designing for Kinaesthetic Empathy using Data-Driven Movement Matching

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Abstract

New methods for movement capture and modelling have inspired a shift in embodied interaction design. With Machine Learning tools at the forefront of movement sensing tasks, data modelling has been studied to support novel interaction paradigms informed by somatic and kinaesthetic practices. With a team of dance artists, we design an interactive system that dynamically captures, stores, and recalls movements. The system leverages human pose estimation and movement similarity matching, mediating between previously recorded and real-time movement data, where matched movements are displayed as visual feedback. We outline the technical components of the system, and present a study with audience members to analyse the user experiences that transpire when situated as an interactive installation. We then propose design recommendations for mediating both interpersonal and intertemporal connections through movement matching and recall.

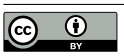
CCS Concepts

• **Computing methodologies** → **Artificial intelligence**; • **Applied computing** → **Performing arts**.

Keywords

Machine Learning, Movement Interaction, Dance

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1 Introduction

Theories and practices related to somatics have taken an increasingly larger role in the field of Human-Computer Interaction (HCI). In particular, kinaesthetic awareness [17, 20] provides an elaborate resource for articulating embodied perceptions of movement, memory and interpersonal connection, which have proven valuable in the field of HCI. With respect to these practices, Machine Learning technologies have been used to capture, process and transform movement data, catering to the complex nature of embodied interactions by attuning to learned patterns, informed by domain specialists from different fields. In particular, this has been demonstrated when designing with dance practitioners [16, 23, 56].

Modern advancements in computer vision and pose estimation models offer real-time motion tracking that is capable of retrieving robust movement data using low-cost camera equipment and consumer-grade computers [58], more accessible to artists and researchers. In parallel, pose estimation, a branch of Machine Learning, has also been a valuable tool for curating movement datasets that grants new possibilities for modelling tasks such as classification, prediction and generation [58]. Such systems hold the potential to overcome some of the reliability issues that can arise in using conventional motion capture environments (e.g. [29]). Additionally, they allow for more diverse movement datasets that are suitable for computational modelling, given the capability of pose estimation models to acquire skeletal data on a mass scale without the need for specialist equipment [34, 35, 55], from which we identify a potential for supporting new design opportunities in dance movement data. Another branch of Machine Learning that has been adopted in movement data research is similarity matching, which applies comparative modelling in order to efficiently navigate datasets. This method has established an appeal in areas such as sports sciences, rehabilitation and monitoring, given access to motion capture equipment [49]. However, the use of similarity matching for dance purposes has so far been scarce.

In this paper, we draw a parallel between Machine Learning, particularly similarity matching for movement, and the choreographic practice of mirroring. Mirroring (dancing in front of each other) can serve as a co-improvisation method, where dancers call and respond to each other's movements [19]. Visual feedback has had an essential role to support movement mirroring in media dance

performances and HCI research [26, 44, 59]. Research in HCI shows that movement mirroring exercises prompt dancers to recall select characteristics of movement, without the intent to serve as an exact copy of the original [44, 56].

For this, we foresee a potential for pose estimation to serve as a medium for matching pre-recorded movement data with real-time movement inputs. With much of the literature on similarity matching and movement data being dedicated towards technical benchmarking and less towards real-time implementations, we find that there is limited attention to using those techniques towards novel user experiences in the presence of an interactive system. In our case, we are interested in user experiences that enhance kinaesthetic awareness and empathy, and subsequently, foster personal connections. Taking this, our research questions are as follows: First (RQ1), how to design a system that can continuously detect similarities between real-time moment inputs and a dataset of pre-recorded movement? And second (RQ2), how to design user experiences that mediate interpersonal and intertemporal connections through a system that matches and presents visual feedback of past movements? In this context, intertemporal connections refer to the perceived relationship between present data, captured through movement-based input, and past data (i.e., pre-recorded movement) retrieved by the system.

In our investigation, we document the design and development process for an interactive system, informed by contemporary dance and audience interaction. Our system incorporates movement similarity matching with a dynamic archive, where movement data is accumulated over time. The system is then assessed as an interactive installation, from which we report upon the user experiences that occur, and discuss how these align with the literature.

2 Background

2.1 Kinaesthetic Empathy in Interaction Design

The study of kinaesthetic interaction has been a key influence in bringing rich movement qualities to the attention of HCI researchers [18, 54]. Kinaesthetic interaction fulfils several interlinked concepts relating to embodiment and proprioception, including awareness, creativity, and empathy. In relation to this, somatic practices have been adopted in design to lend attention to a first-person introspective account of embodied experiences [27, 38, 42], embracing felt aesthetics as a resource for sense-making in interaction [37, 54]. Kinaesthetic empathy extends this framing into a pluralistic perspective, where affective connections arise while observing and engaging in movement during creative and cultural practices [18, 46]. According to the design parameters set out by Fogtmann et al. [18], kinaesthetic empathy occurs when users are able to read, decode and respond to the movements of others. For instance, researchers have adopted the notion of kinaesthesia in sound-movement coupling to reveal inner bodily experiences to a second-person [20]. In *Serpentine Dance, Refocused (SDR)*, interactive artefacts are arranged to heighten the participant's kinaesthetic empathy towards abstract forms of movement [11]. Put in the context of the spectator-performer relationship in dance, the terms 'inner mimicry' and 'kinesthetic sympathy' have been used to describe how spectators anticipate physiological changes of the dancer, allowing them to connect with and access their emotional experiences [46].

2.2 Movement Mirroring and Visual Feedback in Dance

An early example of visualisations being used in dance can be found in Merce Cunningham's seminal performance, *BIPED* [3]. In this work, digital projections are animated through motion capture data and displayed to complement the movements of the dancers while performing a set choreography. OpenEndedGroup later adopted this concept in the creation of Counterpart, an interactive work that reacts to the movements of the active participants [1]. Correia et al. [9] have surveyed the design space of interactive visuals for dance. Interactive visualisations that emphasise movement qualities have been designed to foster kinaesthetic creativity [26]. Generative algorithms have been proposed to reconstruct movement data as a way to yield novel embodied interactions. For example, in *Malleable Embodiment* [30], skeletal deformations are projected in a virtual reality environment to alter the user's bodily sensations while moving. Recent research has demonstrated the potential of combining embodied interaction with Machine Learning to generate real-time visual feedback in dance [10]. A survey on learning systems for dance categorises visual support methods as mimetic, reflective, or generative [44], corresponding to the degree of imitation present, adopting the terminology used for compositional tools for choreographic movement [15].

2.3 Machine Learning in Dance and Embodied Interaction

Machine Learning tools have gained attention to support various actions related to dance making. In studio practice, researchers and practitioners have also been exploring Machine Learning as a means to design non-linear mappings between movement and audiovisual feedback [16, 21, 40]. Machine Learning has also been studied as an approach for choreographic movement generation. During a bodystorming workshop around the creative affordances of generative dance systems [56], the participants recognise *"the ability of AI to go beyond a mere replica of human movement"*. In [50], a live-coding environment is constructed from the encoded representations of dance images to support choreographic direction on stage. Studio Wayne McGregor demonstrates the use of human pose estimation as an effective resource for maintaining an extensive dataset for complex modelling tasks, depicted as the *Living Archive* [2]. The outcome of which is capable of producing aesthetically meaningful results for choreographic co-creation. Additional examples of interactive movement generation tools can be found in the following survey [41].

HCI researchers have called for an Interactive Machine Learning approach with the aim of supporting a natural human-centred understanding of movement [4, 23]. A recent study models muscle tension data acquired from a performing musician by leveraging their first-person somaesthetic experiences to inform latent space representations [52]. The interactive system presented in [16] responds to Laban Efforts, a movement lexicon grounded in somatic practice, using a modelling strategy that is informed by kinaesthetic empathy, emphasising the role of embodying movement literacy to

verify competence in movement observation. Semantic movement recognition requires a meaningful combination of kinematic and dynamic features contained in motion data. Laban Movement Analysis has been used in several contexts to articulate the expressive and functional characteristics observed in whole-body gestures (e.g. [16, 51]). However, the manual labelling of movement is burdensome and becomes exponentially complex for two or more persons interacting together [49]. Moreover, manual labelling introduces challenges when adding new content to a dynamic dataset, which is a crucial component of the system used in our investigation. Similarity modelling is an unsupervised learning approach used to locate similar data based on latent vector (i.e. compressed) representations. This has been crucial for modelling tasks (e.g. similarity comparison, searching, matching, detection) that handle large volumes of complex data, such as motion capture to navigate long streams of spatio-temporal data [6, 48, 49]. Movement modelling for improvisational agents, where captured movements are transformed and fed back to the subject to act as a virtual dance partner has caught notable interest from creative practitioners [28, 33, 36, 57]. Kumar et al. have described this interaction dynamic as Related-gesture Recall, where the system analyses the participant's movement and responds with a movement that it deemed to be similar to the input [33].

Human pose estimation is a Machine Learning method for movement data acquisition, highlighting its potential for modelling movement data and enabling interaction. The apparatus, which can operate using standard cameras and consumer-grade computers, making it non-intrusive and convenient to deploy across various environments [43]. In the scope of embodied interaction design, pose estimation offers a ubiquitous medium that enables motion data to be captured spontaneously, overcoming the burden that comes with using wearable sensors or optical motion capture solutions [29]. This convenience supports participant comfort while achieving robust tracking, even in non-frontal or occluded conditions [31]. It is also noted that with more widespread access, a democratisation in movement data capture can lend new opportunities for designers to curate diverse, task-specific datasets, as emphasised by Nogueira et al., in relation to recognising a broad spectrum of choreographic styles [41]. Pose estimation was used in the above mentioned example, *Living Archive* [2], supporting similarity matching with postures, recalling static image frames according to the input. Pose estimation and similarity matching are both used in *Everybody Dance Now* by Chan et al. to match frames of a source video to recordings of similar poses exhibited in separate video recordings, demonstrating 'do as I do' motion transfer [5].

The above related work demonstrates the potential of visual feedback and Machine Learning (namely, similarity matching and pose estimation) to support kinaesthetic awareness and empathy. However, there is still scarce work combining all these elements for dance. In our study, we intend to design a system that is capable of interpreting and recalling time-series data, representative of continuous movements, leveraging visual feedback in a dance context.

3 Methods

3.1 Motivation and Artist-Centred Approach

To address our research questions, we worked with a team of computational and dance artists to design an interactive installation that matches and recalls past movements (detailed in Section 4). We identify that interactive installations have provided a fruitful paradigm for facilitating audience studies in embodied interaction research [25], offering space to explore expressive affordances of novel interactive systems [45]. This can be valuable for the assessment of aesthetic experiences where the user journey is not predetermined and open to free exploration [13, 53].

Our research follows an artist-centred approach to investigate the user experience of the audience in an interactive installation. The artistic team was composed of two creative technologists and one dancer artist with technological expertise. The dance artist works as a choreographer and dancer, therefore we consider him to be a somatic connoisseur [47]. The artists set out to design an interactive installation during a 2-month residency, which concluded with a public showing of the work. The artists were supported by a research team (the first and fourth authors). The researchers supported the artistic team with the design and development process and were in conversation with the artists throughout. Our study took place during the public installation showing, the outcomes of which are used to address our research questions.

3.2 Study Design

As part of the MODINA project, the movement matching system was showcased to the public as an interactive installation that was hosted at Sõltumatu Tantsu Lava (STL) on the 22nd and 23rd of February 2024, accumulating a total of 61 visitors over 8 hours (4 hours each day). During these two days, all visitors were offered a feedback questionnaire, from which 28 attendees answered and agreed to share their responses during their visit. Five had also agreed to take part in a semi-structured interview, with their availability confirmed prior to the event. The five interviewees showed interest in the project during the residency period. Of these, two declared to have long-term experience with dance and movement practices, while three were studying Human-Computer Interaction, with limited experience with dance and movement training.

3.3 Questionnaires

Our questionnaire structure was informed by an audience study conducted by Correia et al. on the topic of dance performance and interactive visuals [9]; this relates to the user experience of the audience in technology-mediated dance performance and visualisations of embodiment. Questionnaires requested participants to state their age, gender identity and background in movement practice, followed by six main questions: 4 Likert scale questions (i, ii, iii, and v) and 2 open-ended questions (iv) and (vi). The adapted questionnaire used in our study can be found in the supplementary materials. In this paper, we report only on two of the open-ended answers of the questionnaire, as follows: *Describe with a couple of words the relation between your actions and the visual feedback*, and *Please add a couple of words regarding your opinion on the visual feedback*

3.4 Interviews

Interviews were semi-structured around the same topics as the questionnaire (see supplementary materials), which the selected participants had already completed, and were able to refer back to. To conclude, interviewees were asked to provide any general comments regarding their feelings and experiences with the installation. The conversations lasted approximately 15 minutes on average, which were audio recorded, transcribed, and then analysed using reflexive thematic analysis [8]. Analysis was aided with the use of ATLAS.ti[1]. The initial codes were set inductively ("bottom-up" coding from the transcripts). The themes were constructed by the first author, who was closely supporting the artistic process, then discussed with the second and third authors.

An artist talk took place during the first of two days, where the artistic team reflected on their artistic intentions. Given that some interviewees trailed the installation before and after attending the talk, any responses that are directly influenced by listening to the artist talk are noted in our results.

4 Design and Development

To address our RQ1, we present the interactive system that is used in our user study, detailing the technical components and explain how these are orchestrated with regards to the aesthetic intentions of the creative team.

4.1 Overview

The interactive system revolves around a call-and-response procedure between the user's movement and the visual projection. By leveraging affordable arrays of webcams functioning as infrared sensors and utilising Human Pose Estimation models, the system can parse incoming video data through body part detection, and compares the captured footage with previously recorded references. These components are situated in an interaction space that allows the public to alternate between phases of active participation and observation. The underlying software is available as open-source[2].

The system is constructed of the following components, depicted in Figure 1: camera-based movement capture, movement data encoding, similarity matching, and visual feedback. The system flow can be divided into four stages. (1) Skeletal data is acquired using a pose estimation model. (2) This time-series motion data is then encoded into an image representation that depicts the positional and dynamic attributes of the recording. (3) A similarity search is performed to locate the closest matching image from those previously recorded; this corresponds to a video recording of the movement sequence that is located, and undergoes visual processing while new movement data is added to the dynamic archive. (4) Finally, the matched visual material is projected into the space.

4.2 Capturing and Encoding Movement with Pose Estimation

We use two webcams whose infrared light-filters had been removed by the artists, together with infrared light sources, to capture attendees' silhouettes, while the space is dimly lit. The webcams are positioned to capture the frontal and side view to cover the full volume of the interaction space. The resulting streams are then analysed by the PoseNet model [7], outputting 2D skeletal data of the moving subject. The poses detected from the current and previous frames are compared using the L2-norm (also known as Euclidean Norm) vector. The pose estimation data is further verified by comparing the skeletal coordinates individually calculated from the two webcams, similar to the approach reported by [22]. With this approach, only one of the attendees' data is processed by the interactive system.

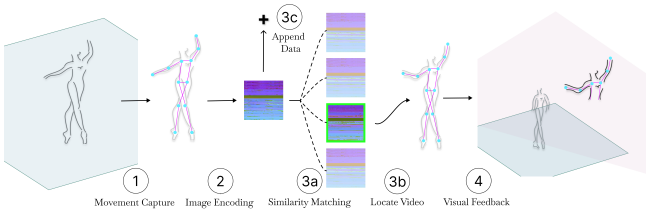


Figure 1: Interaction Pipeline, divided into four stages

To efficiently capture and store movement data, we employ a streamlined texture encoding mechanism, where each texture represents a continuous sequence of static frames. A similar approach of image-based motion representation is achieved by Shen et al. [14], who identified a potential for image encodings in similarity modelling. Positional data of the captured body parts are encoded onto a grid of 64×64 pixels. Each pixel represents movement data for one of 12 skeletal points recorded simultaneously. For each pixel in the encoded image, the red and green colour values correlate to the x and y coordinates of the joint detected in the source video, while the blue colour value is equivalent to the confidence detection score, which represents the probability that the body part is being correctly detected by the pose detection model.

Each texture frame corresponds to approximately 10 seconds of movement data while recording video at 60 frames per second, to ensure detailed and continuous monitoring. All positions are recorded relative to each member's pelvis, assumed as the body's centre. This strategy (similar to Chan et al.'s global pose normalisation [5]) minimises the influence of the overall frame position, upholding the integrity of the data across various frames and movements. An example of the visual encoding is presented in Figure 2.

4.3 Similarity Matching with Movement Embeddings

Utilising the repository of image sequences, we perform similarity matching between the textures obtained through the described movement encoding mechanism to compare a person's movement with the previous movement sequences. Employing an image similarity technique, the system identifies the texture in the dataset that best resembles the texture that has been generated from the most recent video recording.

To assess image similarity, we leverage the ResNet-50 convolutional neural network [24], pre-trained on the ImageNet dataset [12], renowned for its architecture's efficacy in image classification and feature extraction tasks [39]. We remove the final classification

[1] https://atlasti.com
[2] https://github.com/modina-eu/Temporal-Spaces

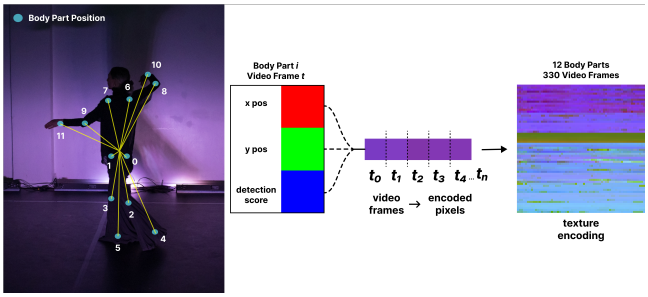


Figure 2: PoseNet calculates positional data of the active participant (left), positional data is processed (middle) to produce a pixel grid encoding positional data (right), representing 11.38 seconds (at 30 frames per second) of movement data.

layer from the pre-trained model, enabling us to use the model as a feature extractor without relying on labelled data.

The texture encodings are then processed through the modified network to obtain feature embeddings for each texture, which capture their visual patterns and representations. From these embeddings, we can compute the cosine similarity between the query texture and past textures stored in our dataset of past recordings. This quantifies the degree of resemblance between them, allowing the system to pinpoint video frames of past movements that best resemble those being captured in the interaction space (according to the feature set). Video footage from the current input and the matched footage are both incorporated into the ongoing video playback. After the matching sequence is replayed, the most recent video recording, along with its encoded representation of the movement data, is appended to the archive to enable new matches with this data.

4.4 Visual Feedback from Dynamic Archive

When a current movement sequence is matched with a previous one, the system locates the original video that corresponds to the matched movement data and projects this as visual feedback. Video segments are played back with dynamic virtual zooms focusing on procedurally chosen parts of the body. Thus, the video is a second-person view of the self as opposed to a static or bird's-eye view. This camera work allows details of the movements to be seen. Furthermore, an evolving blur with varying strength masks the identity of the attendees and dissociates the movements from the body's appearance. This is also amplified by the infrared camera view, which creates an uncanny ghostly presence, as shown in Figure 3.

When dissociating the movements from the self (i.e., observing the movements from the lens of the second person) in a blurry, monochrome representation matched with the "negative" (in terms of the inverted colour scheme and the counterpart movements), the action of the attendee is no longer in a original form associated with the specific body, specific dance moves nor cultural context. In addition to the figurative visual, text labels are overlaid on the visual feedback: time and location of the person captured, and a similarity rating of the movement matching. They are small enough

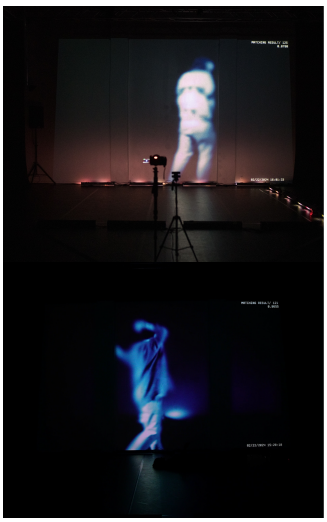


Figure 3: Visual feedback displaying the last recorded movement (top) and subsequently, the matched movement (bottom)

not to occlude the rest of the visual feedback, while hinting at the matching process taking place.

4.5 Experience and Spatial Design

The installation space is divided into an "active" area and an "observation" area, illustrated in Figure 4. The active area constitutes the space in which motion capture is actively recording and considering the movements of attendees within, while the observation area surrounds the active area as the initial point of entry. This layout allows the public to watch the attendee in interaction and the projected visual feedback without directly engaging with the system. As such, the artists propose that the interaction merges the audience's curiosity and playfulness with the algorithm's own interpretations of movement capture to produce an archive of real-time interactivity as visualised choreography.

In the interest of preserving the dramaturgical vision of the interactive artwork, attendees were not given explicit instructions for interacting with the installation nor information regarding the technical mechanisms in place.

5 Results

In our Results sections, we present the participants' feedback in response to the questionnaires and interviews to address our RQ2, inquiring into the user experiences that emerge when engaging with the interactive system. The interview responses are compiled using thematic analysis.

5.1 Thematic Analysis of Interviews

Three themes were generated from the interview analysis: Paving Pathways to Comprehension; Mediating Interpersonal Connections; and Fostering Experiential Qualities through Intertemporal Connections. In correspondence with these themes, we refer to the interview responses. Interviewees are identified as P1-P5. Each

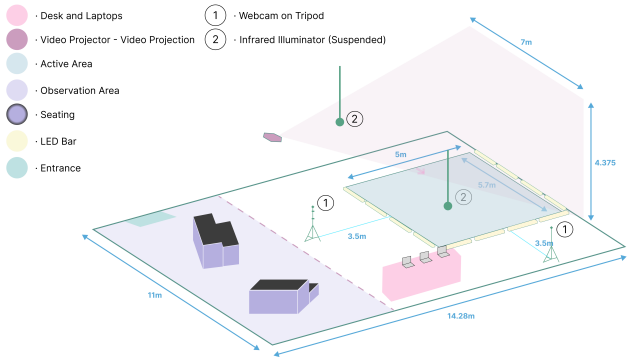


Figure 4: Technical diagram of installation space illustrating the "active" (light blue) and "observation" areas (purple)

theme has been divided into sub-themes to account for individual experiences, as identified in the following sections.

5.1.1 *Paving Pathways to Comprehension.*

Progressive Comprehension. The sub-theme Progressive Comprehension describes the gradual sense-making process that occurred during the experience. By retrospectively eliciting impressions before, during and after the experience, we identified that a gradual, self-attained understanding of the system offered a sense of satisfaction, a reason for participants to stay engaged and explore connections. The cause and effect are not immediately clear due to the abstract artistic presentation. P1 describes that they had to figure out the causality through trying out and experiencing: *"How much can it [the system] record? What things seem more interesting to it? Or that it's choosing these kinds of moments, but not choosing your entire session inside? Or this is what I was perceiving? So this also became very interesting, and then also the connection of the other clips that were pre-recorded. I was also trying to find this connection after a while."* (P1)

The same participant explains that after an extended period of time of exploration, a more concise understanding is constructed: *"After about 30 minutes I really started to engage in this (...) To be inside for a long time felt important because there were many different stages and different levels of my understanding that took a duration for me to reach."* (P1). The need for time is expressed by others too: *"I think it took them time to realise there's a match supposed to come"* (P4) and *"I also observe that not everyone would go there, [I think] not everyone would immediately go and take part"* (P2). P5 adds that at first they did not understand that the system is performing movement matching, and instead they went with the flow: *"I honestly didn't understand that it was trying to recall things. I was just flowing with it and like it was a weird psychedelic experience for me"* (P5) and later, *"I realised that it works almost like a search engine for movement. It was just checking the database of movements that had already been recorded, and then tried to connect it with them. And when that clicked in my head, I was actually very excited"* (P5).

P1 expressed that there were more layers to uncover beyond what they had already experienced, going beyond the expectations and finding their own unique affordances *"once I can understand the general mechanism of it, then it's like how? How can I break it?"*. Additionally, *"me as a performer, I could spend weeks and weeks and weeks with this thing and just seeing what is it that I can do"* (P1). Similarly, a deeper understanding of the system over time was linked with a boost in confidence as P5 mentions, *"I started treating it almost like a puzzle and trying to understand how it works, which actually boosted my confidence and made me engage more with it"* (P5).

Not one-size-fits-all about comprehension. While providing minimal technical information or instructions sparked curiosity in some participants, encouraging them to uncover affordances over time, others found themselves more occupied with understanding the technical inner-workings. Some participants commented on grasping the technical aspects of the work, specifically in regards to the movement matching mechanism. P5 explains that the physical apparatus present in the space probed questions regarding the technical inner workings: *"I was just looking around, trying to understand how the system works. I was looking at the camera, I was looking at them like, 'Where are the sensors of the movement?'"* (P5). This is in contrast to P1, who takes an experiential approach to sense-making: *"it [the technical apparatus] helps me understand how to engage or how to play inside"*. This approach helps to develop their own understanding through the process of interaction, and to maintain their attention throughout: *"So this I think is very positive and actually channels my experience more focused towards the piece."* (P1). We identify different pathways to understanding: participants seeking a technical comprehension into the piece, exemplified by P5, and those prioritizing practical engagement over technological details, like P1.

5.1.2 *Mediating Interpersonal Connections.*

Engaging Together. This sub-theme describes how the participants establish a connection to others and the awareness of others in the space. P1 describes that, as a professional dancer, the experience is not limited to the one-on-one interaction with the system but with the other audience members so that they have a chance to engage: *"That's like a big motivation for me to make sure I'm highly aware of how much time I'm taking or how much engagement I'm using up for all the rest of the people in the space"* (P1). P3 agrees that they were aware of the other audience members, which affected their attitudes: *"It almost felt a bit of an act of courage to go in front of them, and I think when I was in the space, the other people around me were also like maybe non-professional dancers. So all of us were a bit like, 'Can I do it?' And like I felt so proud every time someone went and moved in front."* (P3)

Moreover, one participant explains that the pressure of performing was alleviated when their attention was redirected to another person moving with them: *So when I was interacting with someone else in the space, I found relief from the performativity because I had something else to experience which was the other person and how my body interacted in the space with the other person and how our bodies interacted with the technology.* (P1)

P5 mentioned that they were less intimidated in time: *"But when I got comfortable with that, when I understood that everybody has different backgrounds here and it's not about who performs what"* (P5).

Spectating as Connection. P2 mentions that clarity of the group dynamics came over time with watching others. Given that the seed movements were open to free exploration, observation also served as a way of getting inspiration: *"When can I start my movements? When can I enter the space? How much time should I wait after the other person left? So it wasn't completely clear to me until I looked at two more people"* (P2). Some interviewees reported that the space was intimidating to move into, from spectating to and engaging with, particularly those who did not claim to have a background in dance (P2, P4, P5) when amongst other attendees who were perceived as expert dance practitioners, for example, *"when I just came in, I saw people like professional dancers and I was very intimidated to go into the area because I felt like, 'oh, are we competing?'"* (P5). P4 indicates that free movement as an interaction modality was off-putting while viewing others trained in a particular type of dance that's oriented towards improvisation *"Actually I did learn dance before but it was like swing dance, like jazz dance, but I felt like this [installation] was targeted more to a modern kind of dancing"* (P4). For one participant, the presence of spectating participants insinuated a performative quality when someone was actively engaging alone: *"As an individual, the experience is quite performative and I don't think that that's positive or negative. I think it just is performative because you're there and you're in the space and other people are watching you and your huge image is being protected on a wall."* (P1)

The same participant explains that they would alternate between roles, and that the act of spectating serves as a source of inspiration: *"I think by watching other people I get so many ideas of what is possible from the outside"* (P1)

5.1.3 Fostering Experiential Qualities through Intertemporal Connections.

Aesthetics of Movement Matching. P4 praises movement matching, as well as the similarity accuracy, standing out from the abstract visual and sound of the experience: *"when I came to see this installation, I expected it to be more abstract, but it did make sense to me because there's matching and there's the percentage of the match, which I think it's amazing, and it blew my mind. So I like [it], even though it is quite abstract with their visual and audio cues. For me it was abstract. But then the matching, I think it's really amazing."* (P4)

Others agree that movement matching is a distinctive component of the experience, as *"what I found most interesting at the very end was the actual recall of the previous movements"* (P5) and *"the first layer is the most obvious of the recording and then playing back what I'm doing"* (P1). P3 elaborates further, suggesting that the matching mechanism offers a sense of inclusion: *"it was kind of like time travel in a way, seeing different bodies in the same setting and being part of it. It felt communal and collective"* (P3).

Visual (Dis)connection. When asked if the visuals merely copied the participants' actions, P2 and P3 explained that while there were noticeable differences in the playback to their own movements, describing that the visual had its own agency, there were still qualities that were not derived from them: *"There wasn't like a complete copy, right? It was a different person moving in a similar way. But there were other ways they are not similar to mine"* (P2); *"It almost felt like it had its own will. It was related to what I was doing, but at the same time it had its own character"* (P3).

5.2 Questionnaire - Open-Ended Answers

28 people answered one or both of the open-ended questions. Of those, 14 participants, aged between 18 and 61 (median age of 31), identified themselves as female, 12 as male and 2 as non-binary. 10 held professional experience in dance/movement, 12 intermediate or beginner level, and 6 marked themselves as non-dancer/non-mover. A selection of answers from these open-ended questions were identified to complement the themes devised from the interview analysis above. Statements like *"I was becoming one with the audio/visual"* and *"Moving with me"* align with the sub-theme of Visual (Dis)Connection. The response *"Watching, waiting"* reinforces the sub-theme Spectating as Connection. Similarly, *"It was like figuring out a puzzle"* connects to the theme Pathways to Comprehension, specifically the sub-theme Progressive Comprehension. The statement *"I felt intrigued and inspired as an artist"* reflects the sub-theme not one-size-fits-all about comprehension. Lastly, phrases such as *"I also liked the blurry effect and change of colour, I could only recognise myself by the shape of my body" and "ghost, blur"* highlight the visual aesthetics that shape the experiential qualities.

6 Discussion

6.1 Facilitating Dynamic Dataset Development with Pose Estimation

Our RQ1 addresses creating a system for matching past movement data (and how to collect and process it) – building the technical foundation for interaction involving past data and real-time capture. Addressing that question, we detail an interactive system (designed by a team of artists, with support from the first and fourth authors) comprising the following components: movement capture through pose estimation, movement encoding, similarity matching, and visual feedback. These are orchestrated into an interactive installation that can operate using low-cost, consumer-grade technologies whereby **dataset development can proceed in situ of the creative process, and in part, crowd-sourced by its users**. This dynamic dataset development – **a dataset that constantly updates with new movement data** – differentiates it from other related approaches, which rely on a fixed set of pre-trained data (e.g., [2, 5]). Additionally, we present **a method for time-series data encoding for pose estimation sequences**, designed by the fourth author, that allows the interactive systems to perform similarity matching on movement data. These different software components have been released as open-source (see Design and Development section), allowing interested parties to reuse and adapt the work.

6.2 Supporting Interpersonal and Intertemporal Connections with Crowd-sourced Data

To address our RQ2, we identify strategies to design an interactive installation to foster engagement and embodied connections to an audience, which we frame as recommendations. Kinaesthetic Empathy describes the ability to process the sensations felt by others by relating with the body through a form of physical engagement

[18, 46]. In design, this practice has been used to connect spectators with the performer's movements [26]. We gather that the communal aspects of the installation were supportive of kinaesthetic empathy from the standpoint of the attendees evolving into the role of a performer. We found that for an attendee to spectate other attendees "performing" creates a form of connection, inspiring new ideas for movement (P1). One of the factors that fosters these connections between attendees was the experience and spatial design, **designing for distinct but fluid areas for observation and active engagement, and for an attendee journey that starts from spectating**.

The movement data archive was populated by movements of others who have also engaged with the same system, taken from the same location and recent past. P5 was able to pick out the movement matching as *"the most obvious"* (P5) feature of the system, and for P1 *"what I found most interesting"* (P1). Kirsh describes tools that change our perception and conception of movement that, for example, can extend our bodies to reach terrains that are temporally remote [32]. Through **designing for movement matching, so that participants can dance a virtual (asynchronous) duet with another attendee**, as P3 comments on their experience with the system: *"it was kind of like time travel in a way"* (P3). This supports a kinaesthetic empathy with past attendees.

The social context influences how one can anticipate and react to the movements of another to foster kinaesthetic empathy [11]. In our study, the social context considers the contribution of the audience participation through a dynamically growing archive used to display data from past users. This shared contribution can offer mutual support in interaction, as P1 explains that the presence of another body being displayed relieves pressure from being observed. Moreover, many attendees would witness new examples being recorded as others move in the space, as P3 describes: *"seeing different bodies in the same setting and being part of it. It felt communal and collective"* (P3). Therefore, we identify that this shared contribution can offer mutual support in interaction. We propose **designing for a dynamic crowd-sourced data archive, allowing the attendee to take on an active role in contributing their data, integrating them into the social context of the interaction**.

6.3 Towards Altered Reflections in Visual Feedback

Loke and Robertson describe "making strange" as a strategy to reorient one's habitual perceptions of embodiment to regain agency over the felt sensations of a movement [37]. Wallace mentions that deforming the visual feedback can offer alternative bodily sensations, fostering movement exploration and opportunities to go beyond replica [56]. In our installation, altered reflections are presented as visual feedback that recalls past movements. By matching movements that were performed independently from the input, recorded at a different time and by another person, there is an inevitability that the visual feedback would not project a mimesis of the user, but material for reflection (using the terminology prescribed in [44]). Participants commented on ways the visual feedback mimicked some qualities of their movement, without performing an exact copy: *"It was a different person moving in a similar way. But there were other ways they are not similar to mine"* (P2). From this, we view **designing for unpredictable and strange behaviours of the machine, as an altered reflection in the visuals, as a way to bring new aspects of movement into play** (for example, visuals presenting the movement matching with others). As P3 comments: *"It was related to what I was doing, but at the same time it had its own character"* (P3). Through these nuances in reflection, we view our visual feedback to act as a co-creative partner in movement, which can stimulate novel choreographic explorations [56].

7 Conclusion

In this paper, we examined and applied two Machine Learning technologies that we foresee having a major potential in expanding the field of embodied interaction design: pose estimation models and movement similarity matching. By coupling these technologies, we orchestrate a real-time interactive system that generates visual feedback from a dynamic movement archive developed through audience participation, accumulating movement data from its users, which can later be recalled to exhibit similar movements to those being captured. We presented and discussed this approach, which we entitle Dynamic Dataset Development with Pose Estimation, with the software components available as open source. We then situated the system as an interactive installation, from which we gathered impressions from the general public, to identify the key affordances relevant to our study. To design such user experiences, supporting kinaesthetic empathy, we make the following design recommendations, presented in the Discussion section: 1) designing for distinct but fluid areas for observation and active engagement, and for an attendee journey that starts from spectating 2) designing for movement matching, so that participants can dance a virtual duet with another attendee 3) designing for a dynamic crowd-sourced data archive, allowing the attendee to take on an active role in contributing their data, integrating them into the social context of the interaction; and 4) designing for unpredictable and strange behaviours of the machine, as an altered reflection in the visuals, as a way to bring new aspects of movement into play.

The main contributions of our study are twofold. First, the interactive system for continuously processing and detecting similarities within an aggregate stream of movement data. Second, the design recommendations for experiences that support interpersonal and intertemporal connections. We frame these recommendations from a perspective that is relevant for choreographers and installation artists, and more generally for interaction designers working with embodiment.

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AVLMA: Laban Movement Analysis as Catalyst for Generative Art in an Experimental Audiovisual Pipeline Using MediaPipe

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Abstract

This paper investigates the potential of real time movement analysis as a driver for generative audiovisual performance. Premised on a generative logic of movement fueling transformation, we propose an experimental pipeline — AVLMA — that fuses Laban Movement Analysis (LMA) with real time motion capture using MediaPipe. The system extracts spatial and qualitative features of bodily movement to modulate generative sound and visuals in a live performance context. Key components include: particle systems that trace bodily landmarks with expressive variation; a swarm based visual model employing boid dynamics to reflect motion complexity; cellular automata that evolve in response to movement flow characteristics; and a FAUST based audio engine responsive to LMA derived parameters. These layers interconnect through a unified interface developed in Unity3D, forming a reactive, self organizing audiovisual ecosystem. Rather than functioning as background embellishment, the audiovisual system becomes an active agent in the experimental performance—interpreting and responding to the dancer's evolving gestures. This study expands on the notion of choreography as computation and demonstrates how movement analysis can serve not only as input but as an aesthetic grammar for generative media.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

Laban Movement Analysis, MediaPipe, generative art, motion capture, audiovisual synthesis, real time performance, swarms, celullar automata.

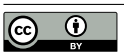
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1 Introduction

If we consider movement to be a driving force that generates new movement, then there are countless digital technologies available to artists today to integrate and complexify their performances. Among them is motion capture, a technology that has quickly become part of the scenographic repertoire since it reached a certain maturity. There are countless examples that we could give to illustrate this idea, but Bill T. Jones is undoubtedly a pioneer in making this technology a full protagonist [7]. Motion capture means that bodily movement is abstracted from the person performing it. This abstraction makes it possible to record the spatio-temporal trajectories of certain points on this moving body and then reconstruct the gestures and actions on another virtualized body. It is therefore a three way cycle of original movement, recording and archiving, and subsequent reconstruction. In real time, motion capture opens up new possibilities for immersive narratives and dynamic visual presentations of interaction with the performers. In particular, it allows for articulation with other techniques that complexify the visualization of the reconstructed process of this abstraction. This article starts from the idea that movement generates further movement, exploring the fusion of a live dancer's gestures with generative graphics. To this end, this study investigates the use of various techniques to achieve this interaction, starting with i) Google Mediapipe, which allows movement to be captured in real time with low budget equipment such as a computer's webcam; followed by ii) LMA - (Laban Movement Analysis [2, 13]), which helps us to understand the quality of the movements performed; iii) the use of Swarm behavior to create a group of particles that follow and accompany the body's movements; iv) Particle Systems to create a smoky blob of the body, and finally, v) Cellular Automata, which is used to create a dynamic and constantly evolving background, vi) and an audio generation system using FAUST . All these layers are interconnected, with the coordinates and quality of that movement as a starting point, influencing the parameterization of the graphic properties that make up the abstract visualization of the performance in action in real time. The project, entitled AVLMA (an acronym for Audiovisuals and Laban Movement Analysis), extends our previous investigations, in which Laban Movement Analysis was employed to mediate and transform human movement within immersive virtual reality contexts. In those earlier works, we introduced the concept of composite behavioral forces in interactive algorithmic systems — such as swarm and agent based environments, generative audiovisual processes, and the hybridization of human and virtual bodies - thereby expanding the dancer's kinesphere and triggering emergent behaviors and sound [4, 5, 11].

2 Context

The kaleidoscopic experience presented here is set within a framework that presupposes a somewhat nostalgic understanding of Generative Art, with roots in the "Generative Computergraphik"



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exhibition in 1965, and more precisely in Manfred Mohr, who coined the term "generative art" in 1968, in the classic understanding of Margaret Boden [3] and Philip Galanter [6]. Galanter, for example, proposed Generative art as "any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art". This understanding of the term has been coopted in recent times by generative practices based on deep-learning, which have taken the public perception of the term by storm and are therefore in danger of becoming a *de facto* standard. Boden proposed eleven types of electronic work, in which generative art would provide a general framework for works where "the artwork is generated, at least in part, by some process that is not under the artist's direct control". Perhaps it is necessary to reclaim the term now, or on the contrary to suggest that this classic Bodian framework is inadequate, and that a new term is needed to accommodate these new practices supported by Generative AI without making a disregard for the history of Generative art. Tools like Max/MSP, SuperCollider, TouchDesigner, OpenFrameworks, and Kinect have democratized real time generative audiovisual creation in performance. Artists such as Whitley, Troika Ranch, Mondot & Bardainne, and Verstand exemplify digital scenography merging bodily motion and interactive systems. While evolutionary techniques are less common today, echoes remain—for instance, Wayne McGregor's Evolutive Pathways uses genetic algorithms to generate choreographic mutations, while Klaus Obermaier's Apparition evolves visuals in real time based on dancers' inputs. These works aren't purely biological nor about relinquishing control. Their public facing nature imposes constraints. In contrast, our work leans toward noise driven experimentalism, challenging spectacle through speculative digital scenography.

3 Methodology

The project's guiding principle is therefore the chaining and interdependence of actions, setting up a pipeline that shapes the movement input through a set of manipulations in a kaleidoscopic process. To do this, we used a set of techniques which initially involved capturing the performer's movement.

3.1 Motion Capture

We used Google's mediapipe framework, which allows us to capture a set of key points on the human body, the landmarks, in real time from images taken by a webcam. This is a module built in python and using mediapipe version 0.10.14. This python module sends about 20/30 times per second (depending on the specific rate of CPU/GPU performance, and any potential lag from encoding and network transmission can affect the true rate) and by UTP in a JSON package, the coordinates obtained to a C# module that serves as an input interface within an application developed in Unity3d.

3.2 Movement Quality

In this second phase, we developed a deterministic system for the automatic classification of movements, based on the principles of Laban Movement Analysis (LMA). Laban/Bartenieff Movement Analysis (L/BMA) is one of the most recognized and consistent systems in dance studies, providing a language and framework for understanding human movement. Created by Rudolf Laban and expanded by Irmgard Bartenieff [2], this system focuses on the interconnected elements of Body, Space, Effort and Shape, which combine, to create unique movement phrases. The Effort component encompasses Weight, Spatial Relationship, Time and Flow. Our implementation was first based on Morita et al [9], which starts from the positions of the landmarks, but then also on Ajili et al [1], which also takes into account the angles formed between the parts. We had to make some adaptations because the key points of the mediapipe ladmarks differed from Ajili's model. For each frame, we began by determining the angles and distances between specific landmarks: i) hands and shoulders, ii) elbows and hips, iii) elbows and shoulders, iv) between the hands, v) nose and left hand vi) nose and right hand, vii) between the hands and the midpoint between the shoulders, and ix) between the feet and the center between the tops of the two legs and finally the angle between the knees. In addition, we calculated the mean, standard deviation, and range for each landmark.

3.2.1 Shape. The formulas for calculating the shape parameters are identical to Ajili's equations, so we'll avoid reproducing them here by explaining the small and slight differences we've made in this implementation. To calculate the "Spreading-Enclosing" feature we analyze how the landmarks around the spine joint (landmark 24 in the mediapipe protocol) move in relation to each other over time, indicating whether they are moving away (spreading) or closer (enclosing), by analyzing the distances between key points, such as the hands, hips or other symmetrical landmarks in relation to the spine, in a sequence of 20 frames (snapshots). To implement the "Rising/Sinking" calculation, we need to calculate the average vertical movement (along the Y axis) of the landmarks in relation to their positions in the initial frame, comparing the positions of each frame with the initial frame of the snapshot. We didn't implement "Advancing/Retreating " because it is difficult for the mediapipe to realistically determine the degree of depth in the sagittal field since the spatial information is obtained from a single point of view.

3.2.2 Time. In order to distinguish between sustained/abrupt movements - the former performed at an almost constant speed and the latter at high speed - Ajili calculates the average, standard deviation and amplitude of the speed of the head-spine-hand junction. Instead, and more in line with Morita, we integrate the reference points of the nose, shoulders, hands, upper limbs and feet. Time(W) and Time(S) calculate the speed of change in weight effort and spatial effort between the initial and final moments of the 25 frame snapshot, respectively.

3.2.3 Weight. According to Wahl "Weight effort is about the quality of how you use your mass and invest in relationship to gravity, and how this is manifested in movement. It is about the inner attitude toward one's mass, not the quantity of one's mass. Weight can be rarified and delicate, or condensed and powerful." Wahl [13, p. 95–96] . Within the framework of this methodology, weight is a measure representing the average magnitude (or intensity) of motion vectors across time and space. It helps classify movement within the Light-Strong spectrum, where Light indicates an invariant rhythm with minimal acceleration, while Strong denotes

motion requiring significant force and acceleration. To calculate weight effort, a function must process the last 20 snapshots, each containing all reference points. It calculates the magnitude of movement for each reference point between consecutive frames based on position changes, similar to Morita's approach with optical flow. By summing these magnitudes across all frames and reference points and averaging the result, the overall weight effort is determined.

3.2.4 Flow. To determine whether the movement is free or of a loose type, in the Free - Controlled (Bound) binomial, we will calculate the Yaw and Pitch using the changes in the X, Y and Z coordinates of the nose, left wrist and right wrist over the time of the snapshot. Yaw is the rotation in the X-Z plane. Pitch is the rotation in the Y-Z plane. For free movement, we'll get a greater range compared to a Bound movement.

3.2.5 Space. To distinguish the directness of the movement (direct-indirect) we calculated the Space_Directness function which takes into account the Straightness Index (S) for the nose, shoulder, leg and hand marks, calculating the ratio between the direct distance (D) from the position of the marks in the first to the last frame and the sum of the distances (L) between successive frames for each mark. This involves following these marks throughout the 25 frames of the snapshots, calculating the direct distance (D) between their positions in the first and last frames and calculating the length of the path (L) by adding up the distances between consecutive frames, where an index close to 1 indicates direct movement and an index close to 0 indicates indirect movement.

3.3 Particles

The structural form of the virtual performer is defined by multiple particle systems, each linked to a specific landmark. As a result, each particle system tracks the spatial coordinates of its corresponding landmark. The particles themselves are a blend of light and smoke textures. The emission rate of these particles varies, with the number of emitted particles being adjusted dynamically based on the momentary Space_Directness of movement, serving as a multiplier (Fig. 1). In turn, the color of the smoke is correlated with the shape of the performer, since the spread-shrink interval is mapped to the 0.255 interval associated with the red component of the color, while the rise-sink is also mapped to green.

3.4 Swarm

This section describes the implementation of a swarm of small objects that revolve around the shape of a virtual dancer. Each element in the swarm follows the principles of the Boids algorithm, developed by Craig Reynolds in 1986, which simulates behaviors observed in flocks of birds and schools of fish. The Boids algorithm is based on three main rules that govern the behavior of each individual within the swarm: i) separation from nearby agents, ii) collision avoidance and iii) group cohesion [10]. These rules work together to create what is known as "Composite Behavior", which will be explained below:

$$F_{\text{composite}}(X_i^t) = \sum_{\text{behaviors}} F_{\text{behavior}}(X_i^t) \cdot w_{\text{behavior}} \tag{1}$$

where X_i^t represents agent i at frame t.



Figure 1: Smoky particle systems are attached to the motion captured keypoints (landmarks) of the performer's body

The composite behavior $F_{\text{composite}}$ generates a three-dimensional vector, where *behaviors* denotes the list of contributing factors and w_{behavior} represents the weight associated with each behavior. At each time step t, each behavior generates a force vector. This vector is multiplied by its respective weight and combined with the strength vectors of the other behaviors to form a weighted sum. This sum produces a composite force vector that dictates the next movement of the element (Eq. 1).

The available behaviors include: a) cohesion, b) alignment, c) evasion, and d) follow bones.

The composite behavior function combines these behaviors using a weighted average of the intensity of each. The resulting forces depend on the agent's environment.

In this implementation, each boid is attracted to a specific bone from a list of bones, determined by the remainder of dividing its index by the total number of bones. This cyclical system ensures that the indices return to zero when the maximum number of bones (numBones − 1) is reached:

$$r = \text{rank mod numBones} \tag{2}$$

where *rank* is the position or index of the boid in the list, *numBones* is the total number of bones, and r is the remainder (modulus) when *rank* is divided by *numBones*.

In a second step, the elements of this swarm are joined together to form Bézier curves. Each of these curves is defined by the coordinates of a set of three consecutive elements from the list of constituent elements of the swarm. These are then materialized using a `LineRenderer` with a texture (Fig. 2) in a process that is common to all the lines, which share the same material or texture. However, each of these curved lines is dynamic, shrinking or stretching according to the coordinates that define it.

3.5 Cellular Automata

A cellular automata [12] panel acts as a background (Fig. 3). The cellular automaton operates on a two dimensional grid of cells with a color state and evolves based on the states of neighboring cells up

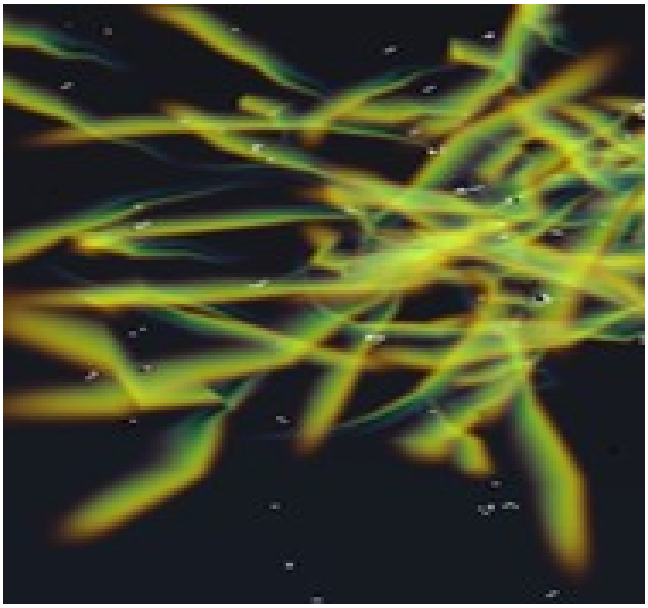


Figure 2: Various Bézier curves formed from the elements of the swarm.

to a distance that is defined based upon the flow of movement of the performer [controlled-free], in a scale of neighborhood [1, 12] where 1 is controlled and 4 is free. Unlike the traditional binary Game of Life, each cell has a continuous color state, and updates are influenced by the color properties of neighboring cells.

Let $G \subseteq \mathbb{Z}^2$ represent a finite grid of cells. Each cell $c \in G$ at position (x, y) at time t has a color state vector:

$$S_t(c) = (r_t(c),\, g_t(c),\, b_t(c)) \tag{3}$$

where $r, g, b \in [0, 1]$ represent the red, green, and blue color intensities, respectively.

To calculate the iterative cycle, the neighborhood depth $d \in \mathbb{Z}^+$ is the distance within which neighboring cells influence c. A neighborhood $N_d(c)$ of depth d for cell c is the set:

$$N_d(c) = \{\, c' \in G \mid 0 < \|c' - c\|_\infty \leq d \,\} \tag{4}$$

where $\|\cdot\|_\infty$ denotes the Chebyshev distance (maximum norm). The value of d is indirectly determined by the flow of movement parameter [free–controlled].

A cell is considered *alive* if its brightness, defined as the average of its RGB components, exceeds a threshold $B_{\text{th}} = 0.5$:

$$\text{Alive}(c) = \begin{cases} 1, & \text{if } \dfrac{r_t(c) + g_t(c) + b_t(c)}{3} > B_{\text{th}} \\ 0, & \text{otherwise} \end{cases} \tag{5}$$

For each cell c at each time step t, define the *Alive Neighbor Count*, which counts the number of alive cells within the neighborhood $N_d(c)$:

$$A_t(c) = \sum_{c' \in N_d(c)} \text{Alive}(c') \tag{6}$$

Update Rules for Cell State:

- **If** $A_t(c) \geq 2$: The cell remains alive or "revives" with a vibrant color, chosen probabilistically from its living neighbors. This vibrant color is defined by a random selection among the RGB values of its alive neighbors:

$S_{t+1}(c) = S_t(c')$ for a randomly selected $c' \in N_d(c)$ such that $\text{Alive}(c') = 1$.

- **If** $A_t(c) = 1$: The cell retains its current color state without change:

$$S_{t+1}(c) = S_t(c) \tag{7}$$

- **If** $A_t(c) = 0$: The cell "dies" and fades to a low-intensity "dead" color S_{dead}, set to a dark gray:

$$S_{t+1}(c) = (0.1,\, 0.1,\, 0.1) \tag{8}$$

This modified cellular automaton rule set combines elements of Conway's *Game of Life* with probabilistic color continuity, promoting localized persistence of color patterns. The neighborhood depth d allows for more complex interaction patterns, generating extended formations over time due to the influence of multiple layers of neighbors.

Boundary Conditions: For boundary cells, periodic boundary conditions are applied, allowing the edges of the grid to wrap around and connect to form a continuous surface.



Figure 3: Section of the scene background which is a dynamically composed texture from a Cellular automata.

3.6 Faust

The immersive audiovisual experience is enriched by an audio design that blends multiple sound waves to create a cohesive auditory atmosphere. This process involves mixing audio elements by adjusting their levels, frequencies, and spatial positioning. To manipulate the sound properties of each element, we utilize a FAUST plugin integrated into Unity3D. FAUST is a powerful programming language designed for sound synthesis and processing [8]. We model an audio synthesis and sound manipulation setup where parameters from LMA motion attributes and spatial position data dynamically influence various FAUST audio effects in Unity resulting in dynamic sound modulation. The FAUST code implements vibrato, phaser, reverb, and other audio processing controls, while a Unity script sets these parameters based on real time input data. Here is how this interaction is mathematically represented:

Panning Control (Stereo Balancing)

$$\text{pan}_L(\text{signal}, x) = \text{signal}\cdot\sin\left(\frac{(x+1)\pi}{4}\right), \quad \text{pan}_R(\text{signal}, x) = \text{signal}\cdot\cos\left(\frac{(x+1)\pi}{4}\right) \tag{9}$$

Vibrato Effect

$$\text{vibrato}_{\text{applied}}(\text{signal}) = \text{signal}\cdot\big(1+\text{vibratoDepth}\cdot\sin(2\pi\cdot\text{vibratoFreq}\cdot t)\big) \tag{10}$$

Phaser Effect

$$\text{phaser}_{\text{applied}}(\text{signal}) = \text{signal}+\big(\text{signal}\cdot\text{depth}\cdot\sin(2\pi\cdot\text{rate}\cdot t)\big) \tag{11}$$

Reverb and Filtering

$$\text{filtered}_{(L/R)}(\text{signal}) = \text{moogLadder}\big(\text{audio}_{(L/R)}, \text{normFreq}, Q\big) \tag{12}$$

Flanger Effect (with LFO)

$$\text{flanger}_{\text{audio}}(\text{signal}) = \text{inputAudio}+\text{depth}\cdot\sin(2\pi\cdot\text{lfoRate}\cdot t)\cdot\text{feedback} \tag{13}$$

A control script then sets FAUST audio parameters based on the LMA analysis data and positional data of body landmarks.

Frequency Control

$$\text{frequency}_{\text{faust}} = 800 + \text{LMA.direct_indirect} \tag{14}$$

Phaser Control (Ratio)

$$\text{phaserRatio}_L = |\text{Landmark.RightWrist.x}|\times 10, \quad \text{phaserRatio}_R = |\text{Landmark.RightWrist.y}|\times 0.5 \tag{15}$$

Reverb Control

$$\text{reverb}_L = |\text{Landmark.LeftWrist.x}|\times 2, \quad \text{reverb}_R = |\text{Landmark.LeftWrist.y}|\times 2 \tag{16}$$

Vibrato Frequency Control

$$\text{vibratoFreq}_L = |\text{Landmark.Nose.x}|\times 10, \quad \text{vibratoFreq}_R = |\text{Landmark.Nose.y}|\times 5 \tag{17}$$

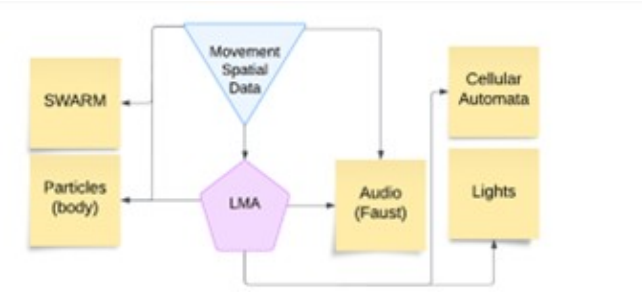


Figure 4: Diagram of the system's pipeline. The two central modules provide the core functionalities capturing movement spatial data and determining its qualities.

4 Discussion

The performative environment described in this work is one of continual adaptation — an ecosystem where movement and sound actively shape the space in real time. As the performer moves, the digital landscape responds and transforms, generating a living choreography that evolves through reciprocal engagement between human and machine. Here, aesthetics do not precede interaction — they emerge from it, co-constructed by the body and the algorithm in a continuous loop of action and response.

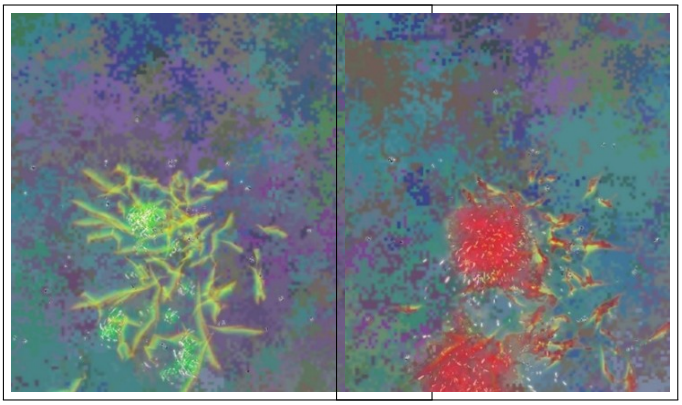


Figure 5: Two snapshots of the visual component captured at different moments during the show.

At the heart of this process is a recursive feedback loop: data flows from the performer to the system and back again, enriching the improvisational space with layers of responsiveness and surprise. Movement no longer functions as a simple trigger for predefined outcomes. Instead, gestures modulate and sculpt the audiovisual environment in real time, acting as primary compositional agents within the system. This transformation is made possible by the integration of real time motion capture via MediaPipe and the Laban Movement Analysis (LMA) interpretive lens. Together, they enable the system to assess not only the spatial coordinates of the body but also the quality of movement - its weight, flow, and time and spatial intent - allowing for a nuanced, semantic encoding of the performer's presence. These motion qualities then influence variables across multiple visual and sonic dimensions, opening a rich expressive vocabulary for generative modulation. The addition of real time sound synthesis through FAUST further deepens this multimodal feedback. Movement and sound become coextensive: gestures dynamically alter the sonic field, while auditory cues feed back into the performer's embodied choices. The result is a synesthetic fabric of experience, an interwoven field where motion, sound, and visual (graphic) transformation become interdependent modalities of expression. Simulation techniques such as cellular automata and particle based systems inject another layer of complexity and unpredictability. Microinteractions among visual elements give rise to emergent patterns that are not wholly authored by the performer nor by the algorithm alone. These self organizing behaviors create space for organic aesthetics to arise—performative gestures are

not overdetermined but instead invite the spontaneous co-creation of form. This stands in stark contrast to rigidly choreographed or static compositions, embracing flux over fixity. The result is a dialogic system in which performer, environment, and sound are not isolated channels but interwoven agents within a greater generative process. Rather than mirroring the human body, the digital system co-evolves with it — reactive yet autonomous, expressive yet unpredictable. In this shared authorship, the stage becomes a space of ongoing negotiation, where performance is never finished, only ever becoming.

5 Conclusions

In reimagining performance as a dialogue between body and code, this work suggests that choreography is no longer confined to the dancer's body nor composition to the artist's will. Instead, it emerges from a dynamic interplay — between biological impulse and algorithmic reaction, between intention and emergence, between flesh and technology. AVLMA (Audio Visual and Laban Movement Analysis) does not treat the dancer as an operator of a machine, nor the machine as an invisible tool, but invites both to co-compose a living ecosystem of gesture, sound, and image. In doing so, we shift the paradigm: movement is not merely interpreted by code — it becomes code. The body no longer performs for the system, but with it, producing a space where expression, autonomy, and uncertainty entwine. What results is not a spectacle of control, but a processual aesthetics—one where performance is continually negotiated in real time, and each gesture leaves behind a shimmering trace in the unfolding audiovisual landscape.

Through the use of various technologies, such as Google MediaPipe for capturing movement in real time, Laban Movement Analysis (LMA) for interpreting the quality of movement, swarm behaviors for generating dynamic interactions with particles, Cellular Automata for creating dynamic and constantly evolving backgrounds, generative audio systems in FAUST, and Unity3D to assemble the audiovisual elements together, the work reveals that when gesture becomes code, performance becomes a site of coauthorship between body and system. By replacing control with coevolution, AVLMA transforms choreography into computation, and computation into ephemeral, embodied experience.

Acknowledgments

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Liminal Landscapes

Generative Art as a Technoshanic Instrument in the Representation of Altered States of Consciousness

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Abstract

This article proposes a theoretical and practical reflection on the capacity of generative audiovisual installations to represent and evoke altered states of consciousness, based on the artistic project Liminal Landscapes. In a historical moment marked by crises of meaning, technological alienation, and symbolic disintegration, a new sensibility emerges that seeks to resume ecstatic and spiritual experiences, now mediated by digital devices. By cross-referencing from the visionary arts, the anthropology of ritual, technoshamanism and media arts, it is argued that certain contemporary artistic creations can assume functions comparable to those of ancestral shamanic rituals, enabling the public to have immersive, introspective, and liminal experiences. The installation Liminal Landscapes develops from organic and generative processes of image and sound, symbolically focusing on the element of water as a metaphor for the unconscious, crossing, and transformation. The circular structure of the work, combined with the enveloping sound and visual dissolution, invites the viewer to enter a meditative state, breaking with linear temporality and evoking ritual practices. Based on a practical research methodology, the project analyzes how the artistic gesture can function as a mediator between the visible and the invisible, the aesthetic and the spiritual. Art, in this context, is proposed as a technoshamanic instrument and a legitimate avenue for sensitive knowledge, capable of bridging the gap between the body, technology, landscape, and consciousness.

CCS Concepts

• **Applied computing** → Media Arts; Arts and Humanities.

Keywords

Technoshamanism, Generative Art, Altered States of Consciousness, Media Arts, Liminality, Immersive Installation

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1 Introduction

Contemporary society is experiencing a paradoxical trend: while it has advanced technological resources and unprecedented global connectivity, there is a growing sense of fragmentation, anxiety, and a loss of existential meaning. The overload of stimuli characterizes this scenario, the virtualization of human relationships, and the growing alienation of the body from direct experience with the sensible world. In this context, there is an urgent need to rediscover symbolic forms of knowledge that can integrate sensoriality, intuition, spirituality, and aesthetics in meaningful experiences. Liminal Landscapes project, the starting point of this article, starts precisely from this impulse of symbolic reintegration. It is a generative audiovisual installation conceived from immersive artistic practices, where the possibility of digital art working as a mediator of altered states of consciousness is explored. Instead of reproducing only conventional technological paradigms — based on efficiency, productivity, and objectivity — an epistemological inversion is proposed here: art as a symbolic, ritualistic, and transformative instrument. The developed installation proposes a sensory and symbolic journey through sound and visual landscapes centered on the element of water. Using generative processes, manipulated video techniques, and organic sound layers, Liminal Landscapes evokes liminal experiences, such as those described by Turner [1] in the study of rites of passage. The concept of liminality is fundamental in this work, as it refers to a transitional condition between states of consciousness, social structures, or distinct perceptual realities. Inspired by contemporary technoshamanic practices [2] [5], this article explores the role of generative art as a tool that can symbolically reestablish the mediating function once associated with shamanic rituals. Just as shamans used sound, movement, and narrative to induce states of trance and spiritual reconnection, today's digital artists can explore audiovisual languages to elicit aesthetic experiences that transcend the ordinary, promoting introspection, healing, or simply broadening perception.

The article, therefore, develops from the intersection between theory and practice, between critical reflection and artistic creation. Through a practice-based research approach [6] [7], it is proposed here to understand how the artistic gesture can be more than form or content: it can be a ritual space, a symbolic landscape, or a practice of reconnection. By exploring these possibilities, Liminal Landscapes not only represents an ecstatic experience, but an active

one — inviting the viewer to become a participant in a sensory and subjective journey.

2 Shamanism, ritual and symbolic mediation

Shamanism is one of the oldest forms of mediation between human beings and the invisible dimensions of reality. Present in various indigenous and archaic cultures, the shaman acts as an intermediary between worlds, channeling knowledge, healing, and revelations through altered states of consciousness [8]. Such states are not seen as deviations from normality, but rather as expanded modes of perception, accessed through rituals involving music, singing, dancing, sensory deprivation, the ingestion of entheogens, and visualizations. The shamanic trance, in this context, is a sacred and structured state of exception, where the body, sound, and image become instruments of passage.

Victor Turner, in studying the rituals of transition in African communities, described the intermediate phase of these practices as a liminal moment: an ambiguous, unstable, and fertile condition in which the individual leaves behind their previous identity but has not yet assumed the new one [1]. This phase of symbolic suspension is marked by disorientation, transformation, and openness to mystery — and is often led by a ritual master or guide. The shaman, therefore, is the liminal agent par excellence, leading the collective through a symbolic limbo to reorganize meanings and structures.

In the contemporary world, although many of the traditional shamanic practices have been marginalized or secularized, their symbolic structures continue to resonate in new languages and contexts. The emergence of what is conventionally called technoshamanism [2], represents an effort to rearticulate these spiritual practices through digital technologies. DJs, VJs, performers, and sound artists thus become mediators of liminal aesthetic experiences, manipulating sound, image, light, and space with objectives often similar to those of ancestral rituals: to provoke shifts in perception, to induce meditative or ecstatic states, and to promote a sensitive reconnection [3] [4].

In this new scenario, ritual is no longer an exclusively religious or tribal practice, but rather an artistic language of immersion and transformation. Symbolic mediation now occurs through algorithms, projections, sensory installations, and immersive environments — devices that, as in shamanism, operate subjective and collective transitions. Thus, it is understood that art, especially that which works with time, sound, and moving image, can assume a ritualistic function by creating symbolic spaces where other forms of consciousness can emerge.

3 Visionary aesthetics and the language of ecstasy

Visionary art is an aesthetic field that seeks to represent expanded states of consciousness, mystical experiences, lucid dreams, or transcendental perceptions. Strongly associated with the use of entheogens — such as ayahuasca, psilocybin, LSD, DMT or others — this art form emerges from the attempt to translate the ineffable into recognizable, but not ordinary, images, patterns, colors, and shapes [9]. Unlike traditional representational art, which depicts the tangible world, visionary art turns inward, to the inner world and dimensions of the psyche and spirit that escape verbal language.

Artists such as Alex Grey, Martina Hoffmann, Amanda Sage, and Android Jones have become references in this field, developing visual languages marked by symmetry, sacred geometry, fractals, mandalas, intense chromatic palettes, and fusions of bodies and landscapes. These compositions aim to convey the sense of unity, dissolution of the ego, and transcendence often experienced by individuals who undergo altered states of consciousness. As Huxley points out, such states break with the perceptual structure filtered by the brain and open the individual to a reality "more real than the real", where everything is interconnected, pulsating, and symbolic [10]. The visionary aesthetic is not limited to painting or digital illustration. It also finds expression in video mapping, interactive installations, immersive environments, and audiovisual performances, where movement, music, and multimodal synchrony amplify the ecstatic experience. These environments become true stages of perceptual transformation, where the spectator is summoned to abandon his passive position and immerse himself in a symbolic crossing. Ecstasy — understood here as the momentary suspension of the individual self toward the whole — is the sensory and spiritual goal of this artistic language. From an anthropological and phenomenological perspective, such manifestations can be viewed as continuities or contemporary reinterpretations of ancestral practices. Indigenous graphics, shamanic visions, and healing rituals with power plants have visual and functional parallels with digital visionary art. The difference lies in the support, not in the purpose: both cases involve symbols that mediate invisible realities and have an impact on the body and consciousness. This aesthetic, therefore, operates as a language of ecstasy — a visual and sensorial way of accessing, communicating, and sharing that which is beyond the visible and the verbal.

4 Generative art as a symbolic process

Generative art is distinguished by its mode of creation: instead of relying exclusively on the artist's direct gesture, it resorts to autonomous systems, algorithms, or processes to produce the work. In this context, the artist acts as a creator of rules, parameters, and conditions, allowing the machine, code, or dynamic system to generate the form [11].

It is an art that incorporates unpredictability, variability, and flow as its structuring principles, shifting the notion of authorship to an expanded and collaborative field between humans and machines. From a symbolic perspective, this mode of creation is akin to natural and spiritual processes, in which total control is relinquished in favor of attentive listening to emerging forces. Just as the shaman surrenders to trance to receive visions and messages that he cannot anticipate, the generative artist surrenders some of the creative control to the system, trusting that something new and meaningful can emerge from the relationship between intention and chance. This ritualized surrender, mediated by technology, is a symbolic act of ego displacement an openness to the unexpected. In immersive installations, generative art gains additional symbolic power. When sound, image, and movement are generated or modified in real-time, the aesthetic experience becomes alive, pulsating, and almost organic. This condition is capable of causing changes in the perception of time, inducing meditative states, and dissolving the boundaries between spectator and work. As Candy and

Edmonds argue, artistic practices based on algorithmic generation can function as instruments of deep phenomenological experience [6], challenging classical categories of representation.

In Liminal Landscapes, the use of video, inspired in generative processes of nature and sound manipulations creates a sensory environment that is constantly in a state of transformation. Water — a central element of the installation — is subjected to visual distortions that simulate streams of consciousness, blurring the boundaries between figure and background, between object and perception. These flows do not follow a linear narrative, but a rhythmic and symbolic logic, suggesting inner movements of the psyche. Sound, in turn, is composed of layers that oscillate between the natural and the abstract, between the audible and the sensed, reinforcing the idea that the symbolic can emerge from repetition, modulation, and immersion. By making room for the unpredictable and the flow, it refers to ritual practices and the dynamics of the unconscious mind. As a symbolic technology, it allows the viewer to access non-ordinary states of attention and sensitivity, creating a bridge between the visible and the invisible, between the conscious and the archetypal. In this sense, its function is not only to represent the world, but to open cracks in ordinary reality, evoking possibilities for inner transformation.

5 The liminal landscapes installation

The installation Liminal Landscapes was conceived as a result of a practical research process in the field of media arts. It is a generative audiovisual work, designed to function as an immersive, symbolic, and meditative sensory space, representing or evoking altered states of consciousness. Inspired by ancestral rituals, psychedelic experiences, technoshamanic practices, and visionary art forms, the installation seeks to create an aesthetic that transcends the viewer's everyday experience, guiding them into a sensitive landscape of introspection (Figure 1). The structure of the piece is based on a suspended circular projection, on which five videos are shown in a continuous loop, each representing a distinct phase of a symbolic journey: (1) initial confusion, (2) submersion, (3) crossing, (4) revelation, and (5) return. These moments are not presented narratively, but rather as sensory atmospheres that overlap and dialogue with one another. The fluidity of the transition between them suggests a cyclical experience, as the title of the work itself indicates: a liminal space, between worlds, between states, between consciousnesses. Visually, the installation features images of water, including rivers, oceans, drops, puddles, and liquid surfaces, captured on video. These materials were digitally manipulated through distortion techniques, overlapping layers, blur effects, and modulation of light and color, creating visual compositions that oscillate between the real and the abstract. Water, in this context, works as a metaphor for the unconscious, for the psychic flow, for the symbolic crossing. Its plasticity refers to the perceptual instability typical of ecstatic states, in which time, identity, and materiality seem to dissolve [12].

In terms of sound, the installation uses a multichannel system with headphones and ambient speakers. The soundscape is composed of a combination of field recordings (sounds of water and wind), ritualistic elements (didgeridoo), and electronic sounscapes.

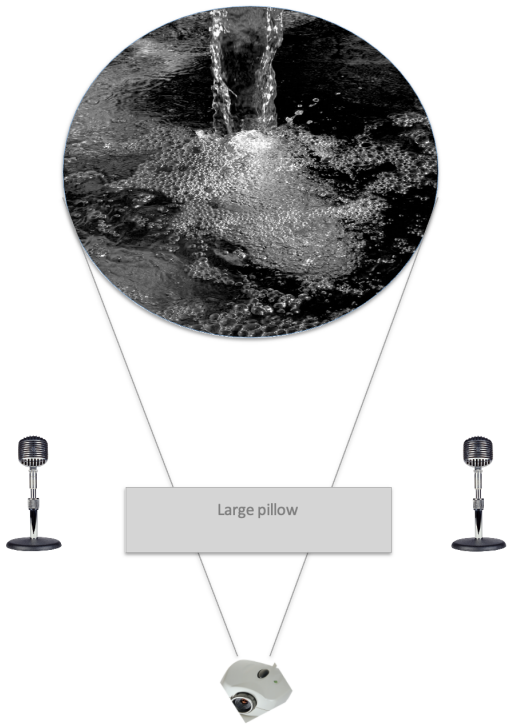


Figure 1: Initial model of the exhibition space. Source: Authors

The sound was created to induce a meditative state, with variations in frequency and intensity that accompany the visual flows. As Rouget observes, sound plays a fundamental role in inducing trance states and perceptual alterations, especially when organized repetitively and hypnotically [13].

The viewer's experience is projected as non-linear, individual, and subjective. The work does not provide explicit instructions or narratives; instead, it offers a hanging space where each visitor can design their own indoor experience. This intentionality aligns with the ritual function of sacred spaces, where silence and mystery are essential conditions for the emergence of the symbolic. Thus, Liminal Landscapes does not seek to "explain" altered states, but rather to suggest them, to provoke their emergence from carefully orchestrated sensory stimuli (Figures 2 and 3).

The work was conceived in a digital environment, with video editing and sound design. The creative process involved several phases: field research in natural environments, audiovisual capture, experimentation with digital manipulation techniques, multichannel composition, and exhibition tests in dark environments. Each step was documented and reflected in the context of an artistic practice as an investigation [7], allowing the creation of the installation to also serve as a process of knowledge acquisition. In the end, Liminal Landscapes presents itself as a "sensitive portal" — a space where the viewer can cross symbolic thresholds, not only contemplating images but also experiencing them with the body, with the ear, and with the breath. The installation challenges the

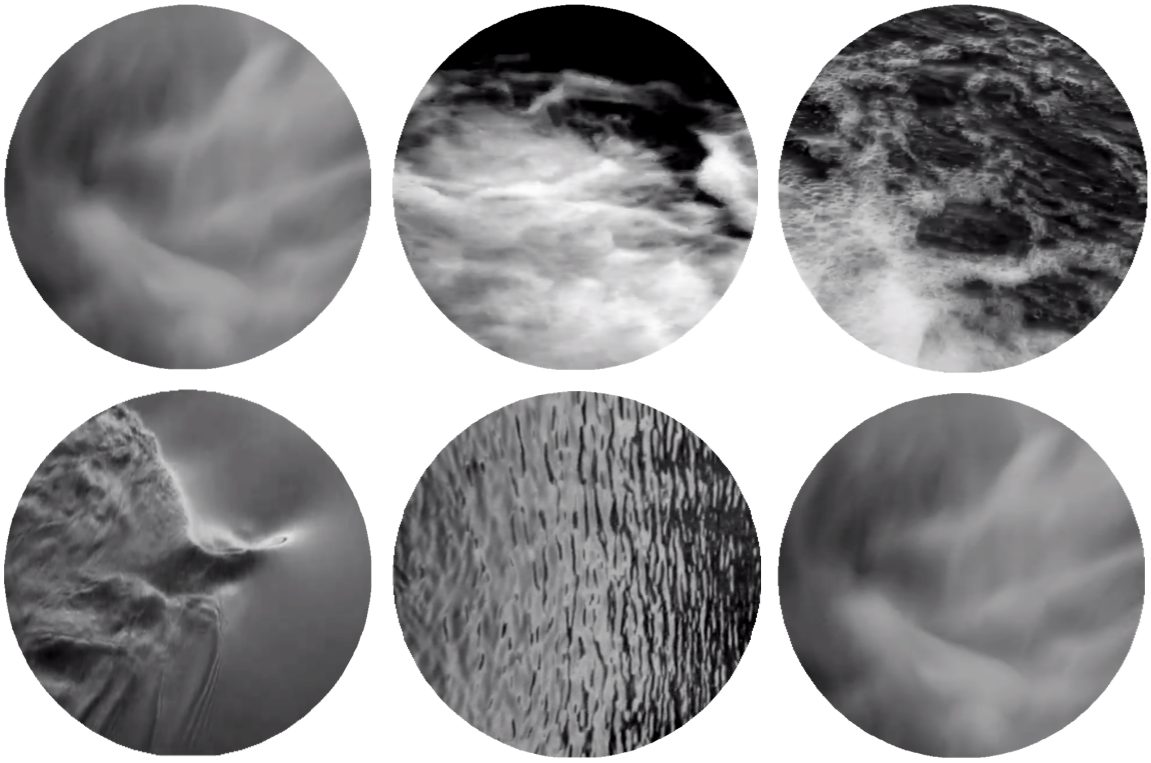


Figure 2: Liminal Landscapes: Stills from motion. Source: Authors

distinction between art and spirituality, technology and rite, aesthetics and transformative experience. It invites us to full presence, to inner silence, to crossing.

6 Water symbology and flows of the unconscious

The choice of water as the central element of the installation Liminal Landscapes is not merely aesthetic or technical — it is symbolic. Since the most ancient mythologies, water has been associated with birth, purification, crossing, transformation, and the unconscious. It appears as a universal symbol in the rites of passage, in the archetypal dreams, and in the spiritual narratives of different cultures [12]. Representing the flow of life and the depth of the psyche, water is the ideal vehicle to express that which escapes verbal language: emotions, ancestral memories, visionary states. In Jungian psychoanalysis, water is strongly linked to the collective unconscious. It is in the symbolic depths of the waters that the archetypes, the primordial images of humanity, reside — those that recur in different forms in myths, dreams, and artistic manifestations [14]. By using digitally manipulated images of rivers, oceans, droplets, and liquid surfaces, the installation invites the viewer to dive — literally and metaphorically — into this fluid and symbolic territory. The movement of the water, sometimes soft, sometimes turbulent, reflects the internal dynamism of the unconscious in flux.

Visually, the work employs distortions, overlays, and blurs to simulate the perceptual instability characteristic of altered states of consciousness. Just as the surface of water reflects and distorts reality, the installation invites contemplation of images that do not adhere, that escape definition, and that refer to the oneiric and the archetypal. The visual fluidity is accompanied by undulating and atmospheric sounds that reinforce the feeling of displacement and crossing — as if the viewer were being led by an inner river, towards unexplored areas of their consciousness. In this way, water becomes the symbolic and sensorial axis of the work. It is a means and a metaphor; an image and a presence. It acts as a mirror of the invisible, a channel of passage between realities, and an archetypal language of the unspeakable. In Liminal Landscapes, it is not just the element represented—it is the agent of experience.

7 Public reception and final reflection

The installation Liminal Landscapes was presented to the public in May 2025 at the gnration cultural space, in Braga, Portugal, as part of a group exhibition dedicated to digital and immersive arts (Figures 4 and 5). Despite sharing the exhibition space with other works, the piece managed to capture the attention of several visitors, who were deeply impacted by the proposed sensory experience. The testimonies collected throughout the exhibition point to an emotional and introspective reception, often associated with the feeling of ”disconnection from the outside world” and immersion in an expanded subjective time.

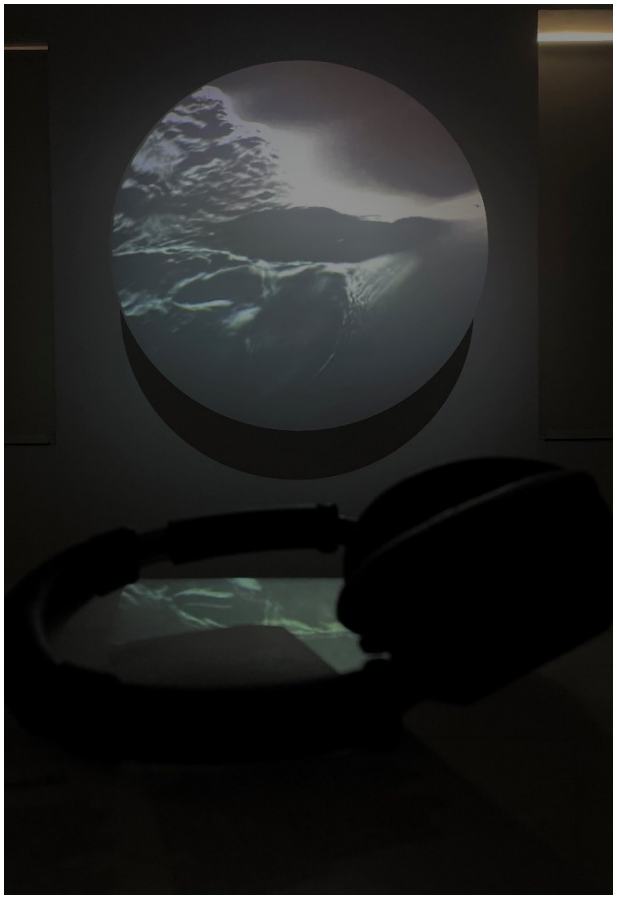


Figure 3: Gnration exhibition: Liminal Landscapes. Source: Authors

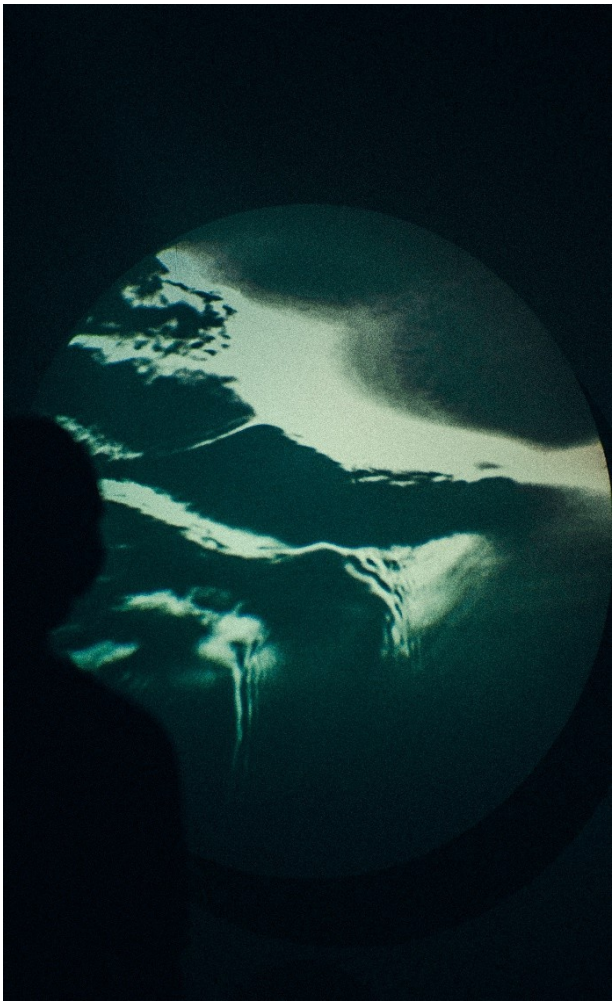


Figure 4: Gnration exhibition: Liminal Landscapes. Source: Gnration.

Some visitors reported feelings of calm, lightness, contemplation, and even transcendence. Most reported that the combination of sound and image evoked meditative states, facilitating access to memories, bodily sensations, and unexpected mental images. Many interpreted water as a symbol of renewal and healing, and expressed surprise at the intensity of the experience in an artistic space. Others, with greater familiarity with spiritual or psychedelic practices, recognized in the installation a structure similar to that of crossing rituals, comparing it to ayahuasca ceremonies or deep meditation sessions. However, limitations were also pointed out. The shared exhibition space, the absence of complete acoustic insulation, and the constant foot traffic interfered with the full enjoyment of the experience. Some visitors mentioned that they would like to stay longer in the installation, or to experience it in a space dedicated exclusively to immersion, with conditions closer to a ritual environment.

From a reflective perspective, the public reception of the work confirms the central hypothesis of this article: immersive aesthetic experiences, when carefully constructed with attention to sound, image, and rhythm, can serve as symbolic mediators of altered states of consciousness. Liminal Landscapes does not provide answers or closed narratives; it proposes a space of openness, of inner listening, of silent crossing. The work thus assumes a technoshamanic function — not in the literal sense of ancestral ritual, but as a contemporary evocation of a symbolic and spiritual practice mediated by artistic technologies. The presence of the spectator is essential for the activation of this crossing. Without it, the work remains latent. With it, it becomes a rite. In this gesture shared between artist, work, and visitor, the transformative potential of digital art as an aesthetic and spiritual practice is revealed. In a world saturated with stimuli and lacking in meaning, works such as Liminal Landscapes point to possible paths of symbolic reconnection and reencounter with mystery.

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Figure 5: Gnration exhibition: Liminal Landscapes. Source: Gnration.

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Immersive Meditation as Neuro-Art: Designing Sensorium's Dome at the Intersection of HCI and Neuroaesthetics

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Abstract

This paper presents Sensorium, an immersive meditation dome that operates at the confluence of neuro-art and human-computer interaction (HCI). By orchestrating spatial audio, 360° projected visuals, dynamic lighting, and vibroacoustic feedback, Sensorium functions as an interactive art-based meditative space designed to modulate brain and body states, fostering deep relaxation and altered aesthetic experiences. Drawing from neuroaesthetics and HCI frameworks such as presence, embodiment, and flow, we investigate how real-time multisensory environments actively influence contemplative states, emotional regulation and well-being.

CCS Concepts

• **Human computer interaction (HCI)**; • **Health care information systems**; • **Neural networks**;

Keywords

Immersive art, neuroaesthetics, multisensory environments, meditation technology, spatial audio, adaptive systems, biofeedback, wellbeing interventions, contemplative computing

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1 Introduction

The intersection of neuroscience, media art, and interactive technology has opened exciting new avenues for creating environments that actively shape both mental and bodily states. This convergence has given rise to the emerging field of neuroarts, which explores how artistic experiences engage and influence the brain and body. Drawing on insights from neuroaesthetics, psychology, and creative practices, neuroarts seeks to understand how multisensory, aesthetic encounters can affect cognition, emotion, and physiological regulation. Ultimately, this interdisciplinary field aims to take advantage of the power of artistic processes for human flourishing, mental health, social connection and new forms of embodied experience.

To leverage neuroart in support of wellness, a new permanent meditation space called Sensorium is being constructed in Vancouver, Canada. The term Sensorium refers to the entire sensory apparatus of the body and mind, the seat of perception where multisensory perception is integrated and interpreted [1]. This makes it an apt name for the meditation space, which is designed to immerse participants in a carefully crafted meditative experience that uses spatialized sound, dynamic lighting, visuals, and vibroacoustic resonance. Built upon principles of sacred geometry, the geodesic dome structure, used as the experiential space, is historically associated with harmony and resonance, further deepening its perceptual impact [2]. Unlike conventional meditation rooms or insular digital applications that lack collective connection, Sensorium serves as both a sanctuary for introspection and an experimental platform within neuroarts, examining how thoughtfully orchestrated shared multi-sensory art can shape cognitive and physiological states.

Emerging evidence increasingly suggests that art-based therapeutic interventions can serve as powerful tools for supporting mental health and emotional regulation, pointing toward a future where such approaches become integral to precision medicine. Sensorium stands at the forefront of this evolution, offering an immersive, neuroaesthetically-informed environment that has the potential to pioneer sensory-driven interventions for wellbeing. This paper, therefore, investigates Sensorium's design as a human-computer interaction (HCI) system intended to evoke presence, embodiment, and flow, exploring how such immersive experiences can be leveraged to advance wellbeing and neuroaesthetics research.

2 Background and related work

2.1 Immersive and Interactive Art

Immersive installations by artists such as Rafael Lozano-Hemmer, Refik Anadol, and teamLab have demonstrated how responsive environments can create compelling, often transformative experiences. These works serve as inspiration for Sensorium's aim to do more than simply engage; they seek to subtly shift perception and inner states. Projects like Urban Sun by Studio Roosegaarde, which utilize artistic light installations to sanitize public spaces and reduce airborne viruses, exemplify how art can have a direct impact on public health [3]. Similarly, initiatives like Reforester, which combines environmental restoration with multisensory experiences, demonstrate how creative technology can foster both ecological and psychological regeneration [4]. The concept of a "sound clinic," which employs multichannel audio to create immersive meditation



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environments, underscores the therapeutic potential of multisensory installations. These examples inform Sensorium's ambition to not only engage but also transform physiology and emotional state through carefully orchestrated light, sound, visuals, and vibrations.

2.2 Multisensory Integration and Wellbeing

A growing body of interdisciplinary research highlights the significant impact of multisensory environments on both mental and physical health [5]. The World Health Organization's comprehensive report on the role of the arts in improving health and well-being [6] compiles hundreds of studies showing how artistic, multisensory experiences contribute to stress reduction, emotional regulation, and social cohesion. These effects are mediated through complex neurophysiological pathways that connect sensory processing with autonomic function and emotion regulation.

Recent findings from the Spatial Sound Institute suggest that spatial audio environments can specifically increase alpha brain wave activity, a pattern associated with relaxed wakefulness and reduced stress [7]. Their studies also document decreases in heart rate variability during exposure to carefully structured spatial soundscapes, suggesting modulation of parasympathetic nervous system activity, the branch of the autonomic nervous system responsible for promoting relaxation, digestion, and recovery by counterbalancing the body's fight-or-flight responses. Additional work, titled *"The Power of Presence,"* explores how spatial sound enhances immersive presence and triggers beneficial shifts in the default mode network (DMN), a network of interconnected brain regions active during wakeful rest and self-referential thought, thereby supporting a sense of calm and groundedness [8].

Neuroimaging research further demonstrates that alpha oscillations increase during engagement with aesthetically rich, immersive sound environments. This correlates with subjective reports of tranquillity and improved mood. Such brain states are linked to improved emotional regulation and may even facilitate cognitive restoration by reducing the load on attentional control networks, a network of brain areas that directs focus, manages competing information and supports goal-directed behaviour [9].

Meanwhile, NIH-supported investigations into multisensory VR and sound-based interventions indicate that combining modalities such as light, sound, and vibration can produce synergistic benefits greater than any single modality alone [10]. Studies have shown that combined audio-visual haptic stimuli can significantly deepen relaxation and modulate autonomic responses. This aligns with multisensory therapeutic rooms and VR mindfulness systems [11, 12]. These interventions are shown to downregulate sympathetic arousal and support parasympathetic dominance, which underpins states of rest, recovery, and psychological resilience.

Taken together, these diverse findings establish a robust scientific basis for Sensorium's approach: leveraging an integrative, multisensory design to simultaneously engage neural circuits involved in emotion, reward, and bodily regulation. By doing so, Sensorium aspires not only to provide an aesthetic experience but also to become a prototype for precision neuroaesthetic interventions that support holistic well-being.

2.3 HCI Frameworks

It is often difficult to separate our awareness of internal experience from the physical environment because perception of space ultimately exists within the consciousness of the perceiver. Cognitive psychologist Jerome Bruner argued that the mind does not merely respond to environmental stimuli but actively interprets them in ways that are deeply personal and subjective [13]. Thus, stimuli do not directly cause responses; rather, they modify pre-existing cognitive states [14].

Perception is also fundamentally multisensory and culturally shaped. As Pink [15] suggests, our experiences are rarely dominated by a single sensory modality but are interpreted and maintained through all senses, embedded within specific cultural contexts. This view aligns with Rodaway's [16] concept of the senses as interrelated systems that integrate into both bodily and mental processes. The environment itself structures sensory stimulation, optical, auditory, and tactile, serving as an active source of meaning, not just raw data.

In the context of immersive multisensory environments like Sensorium, this means participants bring their cognitive histories, expectations, and even their states of discomfort or pain, which can dampen or heighten particular senses. For example, migraine sufferers may avoid light while becoming more sensitive to sound. Research on soundscape composition suggests that such environments allow for an outward artistic response to inward experiences [17] and that by carefully shaping the sensory field, one may restore disrupted perceptual balance.

This framework also relates to the concept of immersion, which is understood as the integration of perception and exploratory movement through space [18]. Virtual spaces, such as those created by multichannel sound, can function as surrogates for real environments [19], sustaining engagement by replicating spatial realities through auditory signal processing. Studies in gaming and VR demonstrate how structured experiences can progress from engagement to engrossment and ultimately to total immersion, as shown in Figure 1, characterized by time distortion, emotional investment, and a sense of being fully immersed in the virtual world [20].

Additionally, the concept of flow, as illustrated in Figure 2, is a state of deep concentration and optimal experience, as defined by Csikszentmihalyi [21], which overlaps with immersive engagement. Flow emerges when skill and challenge are balanced, goals are clear, and feedback is immediate, often leading to loss of self-consciousness and altered time perception.

Finally, presence—the subjective sense of "being there" within a mediated space—is closely tied to how well virtual environments engage sensory and cognitive systems. Proper spatialization of sound and the interplay of audio-visual cues enhance this sense of presence [22], facilitating deeper immersion. Together, these HCI concepts provide a robust lens through which to design and evaluate Sensorium, ensuring it not only orchestrates multisensory stimuli but does so in ways that meaningfully transform perception, cognition, and emotion.

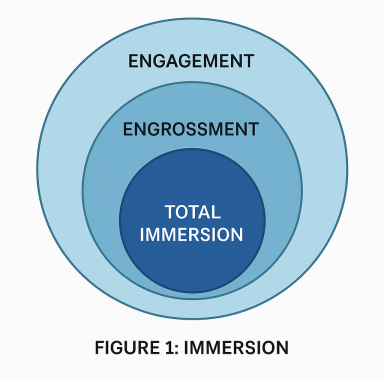


Figure 1: Immersion: This figure utilizes three concentric circles to illustrate the progression of immersion experience. The shading emphasizes the journey from initial interest to complete sensory absorption.

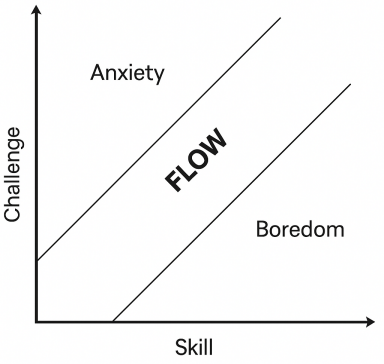


Figure 2: Flow: This figure illustrates how an optimal balance of skill and challenge leads to deep engagement and the immersive state of flow.

2.4 Neuroaesthetics and Bioadaptive Art

Neuroaesthetics is an interdisciplinary field at the intersection of neuroscience, psychology, and the arts, dedicated to exploring how aesthetic experiences engage and shape neural processes tied to perception, emotion, and cognition. Semir Zeki, one of the pioneers in this area, defined neuroaesthetics as the study of the neural underpinnings of artistic contemplation and creation [23]. Today, the field is advancing rapidly through initiatives like the neuroarts Blueprint [24], a global collaboration led by Johns Hopkins University and the Aspen Institute. This blueprint aims to establish neuroarts as a rigorous field of study and clinical practice, demonstrating how the arts and aesthetic experiences can measurably improve health and well-being. Through such initiatives, the field has since expanded to encompass how multisensory and emotionally powerful experiences, whether through visual art, music, dance, or immersive environments, can influence brain plasticity, support stress recovery, and even reshape patterns of thought and mood [25, 26].

Recent research from Kyoto University has demonstrated that creative art-making activates widespread brain networks, stimulating regions associated with memory consolidation, learning, and psychological resilience [27]. Likewise, the International Arts + Mind Lab at Johns Hopkins employs a model called "Impact Thinking," which studies how integrating artistic experiences into therapeutic contexts can aid patients with chronic stress, neurodegenerative conditions, and mood disorders [28].

Bioart stands as a provocative example of how living systems can be woven into aesthetic experiences with profound psychological impact. Artists have created sound compositions using the bioelectric impulses of fungi, effectively turning the living rhythms of mushrooms into evolving musical pieces [29]. This not only expands the boundaries of what is considered art but also fosters new forms of multisensory engagement that stimulate curiosity and wonder, key emotional states tied to neuroplastic benefits.

Sensorium builds on these neuroaesthetic foundations by carefully integrating chromotherapy, vibroacoustic therapy, and advanced spatial audio. Chromotherapy, or the use of coloured light, has been linked in multiple studies to the modulation of the autonomic nervous system, which helps reduce heart rate and blood pressure, and improves emotional balance [30]. Vibroacoustic therapy, which involves delivering low-frequency sound vibrations through the body, has shown promise in clinical contexts for reducing muscle tension, decreasing anxiety, alleviating pain, and improving circulation [31]. A recent study from MIT and other institutions reveals that vibroacoustic interventions can enhance certain cognitive functions by stimulating neural pathways involved in attention and memory, suggesting a broader impact on brain health beyond relaxation alone [32, 33].

Moreover, emerging approaches discussed at conferences such as Clerkenwell Design Week reveal that luxury wellbeing spaces are increasingly using scientifically informed light and sound to enhance mood, sharpen attention, and support mental restoration [34]. By merging these modalities into an intelligent, bioadaptive system, Sensorium creates an environment that actively responds to and shapes the participant's physiological and psychological states. This design not only recalibrates sensory pathways often disrupted by chronic stress or pain but also fosters deeper states of emotional regulation and embodied presence. In doing so, Sensorium represents a pioneering application of neuroaesthetic principles, translating them into immersive therapeutic experiences capable of addressing complex health challenges and advancing the broader pursuit of human flourishing.

3 System Design

The Sensorium dome is designed as a multisensory ecosystem that integrates sound, vibration, light, and immersive visuals to create deeply engaging neuroaesthetic experiences. Thirty-three speakers are strategically mounted on the dome's surface, employing a hybrid system of ambisonics and Vector Base Amplitude Panning (VBAP). VBAP is a spatialization technique that distributes audio signals to multiple loudspeakers based on vector geometry, creating the perception of a virtual sound source at any point within the listening space. By calculating gain coefficients for speaker triplets, VBAP

positions sounds precisely in three-dimensional space, enhancing realism and the sensation of movement [35].

This audio architecture enables sounds to traverse the dome, supporting cognitive engagement and facilitating meditative immersion. Embedded within the dome's platform are twelve vibroacoustic zones that deliver low-frequency vibrations to the body. These tactile signals work in harmony with the spatial audio and lighting systems, producing sessions that calm the nervous system while stimulating neural pathways associated with attention, memory, and emotional regulation.

Four high-resolution Barco projectors blanket the entire interior of the dome with generative visuals created in TouchDesigner and videos of natural environments. Around the dome's diameter, programmable LED lights offer fully saturated chromatic experiences inspired by the works of James Turrell. Turrell's installations reveal how subtle shifts in colour and light intensity can powerfully alter mood and perception [36], aligning with Sensorium's use of chromotherapy to encourage emotional balance and cognitive rejuvenation.

While the current system runs pre-designed sensory sequences, future versions will integrate HRV and GSR sensors, enabling bioadaptive adjustments to sound, light, and vibration to personalize the meditative journey.

Collectively, these technologies form an adaptive, integrative system programmed to support meditation, emotional regulation, and enhanced cognitive function. Grounded in neuroaesthetic principles, Sensorium moves beyond conventional wellness environments to actively shape sensory and neurological processes in service of holistic wellbeing.

4 Methodology

4.1 Study Objectives

Beginning in late fall 2025, we will explore two key questions through user testing:

- How does an orchestrated multisensory environment, framed through neuroaesthetic principles and HCI frameworks, facilitate altered states of consciousness?
- How do users engage with such an environment cognitively, emotionally, and physiologically, particularly through concepts like presence, flow, and psychological absorption identified in HCI research?

This study builds on existing neuroarts and HCI knowledge by examining how a technologically-driven ecosystem can deepen immersion and actively support emotional regulation and mind-body health.

4.2 Participants and Procedure

Thirty adults with varying meditation experience will participate in 60-minute Sensorium sessions as part of this initial user-testing phase.

4.3 Data Collection

Qualitative: Post-session semi-structured interviews will delve into participants' subjective experiences, focusing on their felt sense of immersion, shifts in attention, emotional resonance, and perceived changes in bodily state. Open-ended questions will allow for rich, nuanced narratives that capture the unique interplay of sensory elements.

Quantitative: Participants will complete standardized instruments, such as the Presence Questionnaire, to assess the intensity of their immersive experience, and the Flow Short Scale to evaluate the depth of their engagement. Physiological data will be collected through monitoring of Heart Rate Variability (HRV) and Galvanic Skin Response (GSR). HRV measures fluctuations in time intervals between heartbeats, serving as a robust indicator of parasympathetic nervous system activity and the body's capacity to regulate stress. GSR tracks changes in skin conductance, which are linked to sweat gland activity, reflecting autonomic arousal and shifts in emotional state. Together, these metrics will help quantify how the multisensory environment modulates stress responses, supports parasympathetic balance, and promotes emotional regulation.

4.4 Data Analysis

Data analysis will be designed to support the study objectives outlined in section 4.1 directly. Thematic analysis will be conducted on qualitative transcripts to uncover how participants describe altered states of consciousness and immersive experiences shaped by the neuroaesthetic environment. For quantitative data, correlational and regression analyses will examine relationships between subjective experiences (immersion, flow, presence) and physiological measures, providing insight into how a neuroaesthetic, HCI-informed environment can impact emotional and autonomic regulation. This integrated approach will help establish how a technologically orchestrated multisensory ecosystem can drive immersion, facilitate emotional regulation, and enhance mind-body health, thereby providing a crucial evidence base for future neuroarts applications.

5 Comparative evaluation and positioning

While existing meditation technologies such as Headspace, Calm, or Muse primarily engage auditory or cognitive modalities through guided instruction or EEG-based feedback, Sensorium expands the experiential and scientific scope of contemplative practice by unifying multisensory orchestration of sound, light, vibration, and imagery within an embodied architectural space. This integrated design situates Sensorium as a bioadaptive environment rather than a device or application, allowing for full-body entrainment and communal regulation rather than solitary digital engagement.

Empirical findings from virtual reality mindfulness systems and multisensory therapeutic rooms [11, 12] demonstrate that combining sensory channels can deepen relaxation and promote parasympathetic activation. However, these studies often remain limited by small-scale prototypes or headset-based isolation, lacking real-world architectural embodiment and collective interaction. In contrast, Sensorium employs ambisonic spatialization and vibroacoustic resonance distributed throughout a dome environment to engage interoceptive awareness and sensory synchrony among participants, a dimension not yet systematically examined in current immersive meditation systems.

Moreover, Sensorium's neuroaesthetic framework explicitly extends beyond virtual or app-based mindfulness by engaging principles of embodied presence and flow from HCI. The integration

of chromotherapy and generative visuals introduces a dynamic, affectively tuned light ecology that interacts with physiological measures such as HRV and GSR. This real-time coupling of neurophysiological feedback with artistic parameters positions Sensorium at the intersection of empirical measurement and aesthetic experience, an advancement over existing meditation technologies that typically lack adaptive or artistically informed feedback loops.

Projects such as Wavepaths, SoundSelf, and TRIPP provide useful benchmarks for understanding Sensorium's contribution. While these systems explore immersive sound or VR-induced meditative states, they often rely on limited spatial depth or purely audiovisual modalities. Sensorium advances the field by embedding spatial audio, vibroacoustics, and chromotherapy within a geodesic architectural structure, creating a coherent perceptual field grounded in both aesthetic theory and physiological regulation. Its approach thus bridges HCI, neuroarts, and environmental design, demonstrating how immersive spaces can serve as scalable neuroaesthetic laboratories for studying human affect and embodiment.

In this context, Sensorium provides a comparative benchmark for future research seeking to operationalize neuroaesthetic HCI systems that are both artistically expressive and clinically meaningful. It shifts the paradigm from personal meditation tools toward shared, multisensory ecosystems that harness architectural embodiment, adaptive design, and collective presence to enhance wellbeing and human connection.

6 Discussion

This study positions Sensorium at the forefront of neuroaesthetic research and human-computer interaction (HCI) by empirically investigating how a sophisticated, technologically driven multisensory environment can induce altered states of consciousness and support emotional and physiological health. The integration of ambisonics, VBAP spatialization, vibroacoustic platforms, chromotherapy inspired by James Turrell, and immersive generative visuals transforms Sensorium into a uniquely bioadaptive system that not only regulates the nervous system but also carefully engages the cognitive frameworks of perception, presence, flow, and absorption identified in HCI literature.

The anticipated findings will build on existing work in neuroarts and HCI by showing how these orchestrated sensory inputs can deepen immersion, sustain attention, and promote parasympathetic activity and emotional regulation—core elements of holistic mind-body health. By linking subjective experiences of presence, flow, and psychological absorption to physiological measures like HRV and GSR, this study will offer a more integrated view of how immersive environments simultaneously influence cognitive states and autonomic processes.

Ultimately, this research contributes to both the evolving neuroarts Blueprint and the design methodologies in HCI by illustrating how artfully constructed multisensory ecosystems can be programmed to facilitate wellbeing, resilience, and cognitive restoration. Sensorium thus stands as a compelling prototype for future therapeutic environments where art, technology, and embodied interaction converge to advance human flourishing.

As part of creating a sustainable model, several implementation challenges must be addressed as this work transitions from a research prototype to a scalable, deployable system. At the scalability level, extending Sensorium across multiple environments requires precise calibration of light, sound, and vibration fidelity, as well as synchronization across distributed sensory subsystems. Real-time data streaming and hardware interoperability will be essential to preserve consistency of experience and system resilience.

Personalization presents another major frontier. Individual variability in physiological responsiveness, such as heart rate variability, galvanic skin response, and sensory thresholds, necessitates adaptive algorithms capable of tailoring sensory inputs dynamically. Developing robust biofeedback systems that can interpret such variability without compromising aesthetic coherence remains a technical and theoretical challenge.

In terms of practical deployment, environmental and operational factors such as acoustics, lighting interference, accessibility standards, and maintenance can significantly affect user experience and reproducibility. Ensuring safe, inclusive design for neurodiverse participants and maintaining sensory precision over time are critical considerations for real-world application.

Finally, integration and interoperability remain central to future development. Maintaining low-latency communication between multiple subsystems (spatial audio, LED lighting, vibroacoustics, and sensor feedback) is essential to preserve perceptual coherence. A modular, extensible framework will be required for long-term sustainability and replication in other clinical, cultural, or educational contexts.

Together, these implementation insights not only outline Sensorium's immediate design challenges but also suggest broader implications for how future bioadaptive HCI systems might balance scalability, personalization, and practicality while preserving aesthetic and experiential integrity.

7 Conclusion and future work

This research positions Sensorium at the cutting edge of neuroaesthetics and human-computer interaction, demonstrating how a carefully orchestrated, technologically immersive environment can impact both psychological and physiological states. By integrating principles from neuroarts with HCI concepts such as presence, flow, and absorption, this study will advance our understanding of how multisensory ecosystems can facilitate altered states of consciousness and support emotional regulation and mind-body health. The insights gained from this user testing will not only refine Sensorium's design but also contribute to broader models for employing art, technology, and multisensory engagement as tools for holistic wellbeing and future therapeutic applications.

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Interwoven Realities: Exploring the Confluence of Embroidery and Biomaterials in Contemporary Art

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Abstract

This research examines a contemporary artwork that uniquely merges embroidery with innovative biomaterials, specifically bioplastics or biopolymers. In an era defined by the Anthropocene's ecological challenges and a growing imperative to decenter anthropocentric perspectives, this artistic practice serves as a compelling case study for investigating new materialities and relational aesthetics in art and design. Drawing on theoretical frameworks from posthumanism, new materialism, and ecosophy, the analysis delves into how the inherent properties and agential materiality of these bio-fabricated substances interact with the deliberate, intricate processes of embroidery. The study posits that these artistic fusion challenges conventional notions of artistic production, material hierarchy, and sustainability by integrating living or biomanufactured materials with a craft that historically emphasizes human touch and precision, the artwork fosters a deeper understanding of coexistence and radical intimacy between human and non-human entities. Furthermore, it redefines the role of the artist as a cultivator of processes and facilitator of encounter, moving beyond a product-oriented approach towards a fluid, dynamic, and ecologically conscious practice. This paper contributes to the emergent discourse on bioart and eco-design, demonstrating how artistic experimentation with biomaterials can reveal imperceptible ecological processes and provoke critical reflection on our profound interdependencies within an expanded, interconnected world.

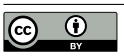
CCS Concepts

• **General and reference**; • **Document types**; • **General literature**;

Keywords

Biotextile, Bioart, Interdiscipline, Sustainability

ACM Reference Format:
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1 Introduction

The present time is marked by the harmful impact of human activity on Earth's ecosystems, leading to pervasive environmental crises and unsustainable linear economic models. In response to this urgent global context, the arts, particularly textile and design practices, are undergoing significant paradigm shifts, moving beyond anthropocentric viewpoints and embracing new materialities and ecological sensibilities. This paper explores a compelling intersection of these shifts: the integration of traditional textile arts, such as embroidery, with innovative biomaterials like bioplastics and biopolymers. This fusion represents not merely an aesthetic choice but a profound re-evaluation of artistic production, material ethics, and the relational dynamics between human and non-human entities.

Biomaterials, derived from biological sources or mimicking natural biology, offer a sustainable alternative to conventional materials due to their biodegradability, renewability, and often minimal environmental footprint. Key examples pertinent to this discussion include bacterial cellulose and mycelium-based compounds. Bacterial cellulose, a biopolymer produced by bacteria, boasts exceptional mechanical strength, low density, and biocompatibility, making it suitable for applications ranging from medical bandages to sustainable textiles and fashion. Artists and designers, such as Constanza Schmidlin and Suzanne Lee, have notably utilized bacterial cellulose to create membranes and experimental garments, exploring its properties as a second skin or a material that transforms dynamically in interaction with the human body and environment.

The integration of these living or bio-fabricated materials into artistic practices, particularly textile art, transcends mere material substitution. It aligns with contemporary philosophical currents such as posthumanism and new materialism, which challenge anthropocentric hierarchies and recognize the inherent agency of non-human matter. Thinkers like Rosi Braidotti emphasize relationality, positing that human existence is inextricably interwoven with a complex network of biological, technological, social, and environmental forces [1]. Jane Bennett's concept of vibrant matter further attributes an unintentional agency to materials, acknowledging their capacity to affect and be affected, participating actively in co-creating reality [2]. This perspective is central to contemporary art practices, which redefines art by integrating an ecological perspective that considers the complex web of relationships and processes, both visible and invisible, inherent in artistic practice.

Therefore, an artwork combining the intricate, human-centered craft of embroidery with responsive biomaterials offers a powerful lens through which to explore contemporary ethical and aesthetic imperatives. By engaging with materials that possess their own life

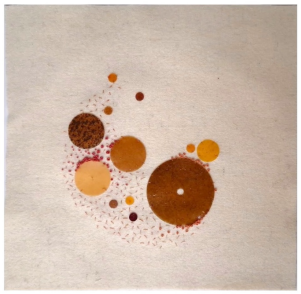


Figure 1: "Pulsion", Gabriela Farías Islas, embroidery and biomaterials on wool, 20x 20 cm

cycles and agential materiality, such art transforms the role of the artist into a cultivator of processes and a facilitator of encounters. This practice fosters a deeper understanding of coexistence and radical intimacy between human and non-human entities, making perceptible the otherwise invisible ecological processes that shape our world. Ultimately, such an artwork serves as a microcosm for reflecting on our profound interdependencies within a broader, interconnected planetary mesh.

2 Analysis of the Work "Pulsion": An Agency of Embroidery and Biomaterials

In the contemporary discourse surrounding art and its engagement with pressing ecological and philosophical questions, the concept of the agency articulated by Gilles Deleuze and Félix Guattari offers a powerful lens through which to understand artistic creations such as "Pulsión". This framework rejects conventional notions of art as mere representation and instead emphasizes its active, productive role in shaping reality.

An agency is fundamentally a multiplicity. It is not a fixed entity with an object or a subject, but rather a dynamic arrangement made of diversely formed materials, of very different dates and speeds [3]. It functions by connecting heterogeneous elements and flows, encompassing semiotic, biological, political, economic, artistic, and scientific linkages. In this sense, a work like "Pulsión", comprised of embroideries, biomaterials, and wool, can be interpreted not as a passive medium or resource, but as a vibrant agenc*y* whose elements and flows actively constitute an artistic machine.

This aligns with Deleuze and Guattari's concept of desire, which they view not as a lack but as a process of production [3]. "Pulsión" can thus be understood as a productive composition of desire, where the interplay of its diverse materials generates new connections and realities. The traditional view of materials as mere utilitarian resources is subverted; instead, they become entities charged with meanings, ecological impacts, and transformative potentials. This perspective suggests a horizontal and relational understanding of scenic creation, where human intention co-creates with the inherent agency of the materials themselves. An agency operates directly in the real, constructing a future reality, a new type of reality, rather than simply reflecting existing ones. The interplay between the artist's action and the materials' inherent properties, a process described by Tim Ingold as collaboration rather than domination, exemplifies how this material interaction creates its own unique reality [4].

The combination of embroideries and biomaterials in "Pulsión" powerfully evokes Deleuze and Guattari's concepts of the Body without Organs (CsO) and the Plan of Consistency. The CsO is described as intense and unformed matter, unstratified [3]. It is not an empty body, but one populated by intensities where organs appear and function only as pure intensities.

Biomaterials, by their very nature, embody this fluidity and mutability. As living organisms with their own temporalities that transform dynamically within artistic installations, they challenge the rigid distinctions between human and non-human or organized and unformed matter. They act as active agents whose condition of being alive can remain active, influencing and being influenced by their environment. This aligns with Merleau-Ponty's concept of flesh as an ontology that intertwines visible and tangible, human and non-human, through a continuous and interrelated fabric [5], which is profoundly relevant to how these biomaterials blur boundaries and foster relationality.

By incorporating such materials, "Pulsión" moves beyond traditional forms, creating an ecosystem where the material constantly transforms. This continuous transformation, the blurring of boundaries, and the active participation of living, unformed matter directly reflect the dynamic, non-hierarchical, and intensely real production that characterizes the Body without Organs and the Plan of Consistency, inviting us to perceive reality as a flux of interconnected becoming.

3 Visibilization of Ecological Processes

The artwork "Pulsión" distinguishes itself by making tangible the intricate, often imperceptible, interconnections within vital systems. In a contemporary context marked by the climate crisis and a growing interest in ecological practices, art becomes a key space for exploring new materialities. "Pulsión" leverages the inherent living condition of biomaterials, allowing their biological processes of growth and proliferation to continue dynamically within the artistic space. This active transformation of material constantly redefines materiality, challenging perceptions and highlighting the continuous interplay of life and non-life.

This dynamic material interaction makes visible processes that are often hidden or taken for granted in everyday life. The work evokes a radical intimacy, a concept where boundaries, like those of skin, are revealed as zones of constant exchange and transformation. As philosopher Timothy Morton suggests, the more we know about living beings, the less clear their boundaries are [6]. The mutable nature of biomaterials in "Pulsión," for example, how a membrane adheres to and then detaches from bodies, almost becoming an extension of skin, materializes this fluidity between human and non-human, inner and outer. This uncanny coexistence reveals transformation and mutual vulnerability as inevitable aspects of our shared reality. It foregrounds how organisms, including the human body, are not fixed entities but dynamic processes integrated into a vast network of natural interconnections.

4 The Transformative Role of the Artist

The creation of "Pulsión" exemplifies a significant shift in the artist's role to a mediator, facilitator, cultivator, and co-creator. This aligns with a horizontal and relational understanding of creation, where agency is distributed and not solely attributed to human intention. Artists working with biomaterials do not dominate the materials; rather, they collaborate with them, adapting to their changing properties and flows. This implies a profound interdisciplinarity, moving beyond mere methodological choice to become an ontological condition where the boundaries between disciplines and even subjects blur permanently.

This collaborative ethos is evident in how artists in bio art projects often disobey the rules of canonical artistic practice, scientific method, and technological advancement. By engaging with biomaterials, artists are compelled to understand and integrate non-human temporalities and behaviours into their creative process, transforming the traditional studio into a living laboratory where art, biology, and technology converge. This shift cultivates a deeper sense of responsibility and commitment towards both human and non-human elements, fostering a practice that is ethical, political, and ecologically conscious.

5 Challenges and Opportunities of Biomaterials

Biomaterials, present both unique challenges and significant opportunities for contemporary art. Their defining characteristic is their living condition, meaning their biological processes, such as growth and proliferation, remain active. This inherent mutability and ephemeral nature redefine the very materiality of art, challenging the traditional notions of permanence in art and compelling creators to confront the transience of their work.

The integration of biomaterials demands an early and continuous engagement in the creative process. While this may present practical challenges, such as the need for significant time, specialized resources, and interdisciplinary collaboration, it also opens extraordinary creative opportunities. What might be seen as technical limitations—fragility, change in colour, texture, or form—become extraordinary opportunities for experimentation and creative expression.

Moreover, biomaterials offer a path toward more sustainable and eco-friendly artistic practices. They provide alternatives to traditional resources, aligning with principles of a circular economy by integrating processes of decomposition and reutilization. This approach resists linear economic models, demonstrating how art can actively contribute to environmental responsibility and encourage a more balanced relationship with the natural world.

Link to descriptive video of artwork: https://drive.google.com/file/d/1-_2I9_WtcNOBSRWslZKz_Q1LWxLnuXUN/view?usp$=$sharing

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BeComposer: A Computer System For Musical Composition And Performance In Real-Time

A Computer System For Musical Composition And Performance In Real-Time

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Abstract

BeComposer is a software for real-time musical composition and performance, which allows for reading and generating sequences of materials in different types of musical notation, with the aim of structuring, mediating, and guiding the improvisation and performance of open-ended musical pieces in an interactive, collaborative, participatory, random, and controlled manner. These practices can benefit from computational mediation as a driver of collaborative and improvisational processes, creating new possibilities for sound exploration. As a dynamic system, *BeComposer* may play a structuring role in the relationships and ideas defined by the composers and performers. Its programming will be made available in open-source code so that user can continue to develop it.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Sound and music computing**;

Keywords

Real-Time notation, interactive score, real-time composition, collaborative composition, computer-assisted musical composition and performance

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1 Introduction

Experimental Music and New Music[1] are characterized by the exploration of new techniques, forms, and sound qualities, constantly challenging the traditional conventions of music – breaking away from established norms – to expand the boundaries of sound, language, and performance. This involves the use of both musical and non-musical instruments, conventional and unconventional, as well as innovative approaches to composition and musical execution.

In this context, practices of improvisation, collective performance, collaborative composition, and participatory interpretation play a central role. In improvisation, musicians interact in real-time and create music spontaneously, resulting in a unique piece with each performance. In collective performance and collaborative composition, this concept is expanded, encouraging the active participation of musicians in the creation of the piece, often without a strict plan for it. In participatory interpretation, the composer expects to receive input from the musicians to define the possibilities of the score they have conceived, always remaining open to news suggestions and interpretations.

In all these practices, "the score functions as a catalyst for musical collaboration, where decision-making is distributed among the composer, the conductor, and the performer" [1]. Instead of following the conventions of a traditional score, which precisely defines what and how it should be played, the graphic score uses visual symbols, lines, shapes, diagrams, phrases, or verses to suggest sounds or actions, without specifying exactly how or when they should occur. It offers a structure for action, without rigid impositions, allowing musicians to respond to each other in a sensory and creative way. It is often used to create collaborative moments, in which the meaning and interpretation of the composition can be shared and discussed, fostering the collective and dynamic process of musical creation, allowing for great freedom of individual expression.

Considering the impact and reception that computer technologies have had in the context of live musical composition and performance practices – even in those that use more conventional compositional and improvisational methods, and stochastic processes – we believe that their artistic purposes can be expanded and enhanced through the use of software that supports their structuring, guidance, or direction, such as the one presented in this article.

2 Theoretical and Historical Framework

Musical composition and performance practices based on a notation different from conventional musical notation date back to the second half of the 20th century. "Composers such as Mauricio

[1]The AACM - Association for the Advancement of Creative Musicians (founded by musicians Muhal Richard Abrams, Roscoe Mitchell, Lester Bowie, Joseph Jarman, Anthony Braxton, and Jodie Christian, among others) was one of the catalyst groups for what became known as "Free Jazz" and "New Music," the latter being characterized by creative freedom and sound exploration. This movement sought new forms of improvisation, fusion of styles, and had a more expansive view of what could be considered jazz. (Retrieved from Encyclopaedia Britannica https://www.britannica.com/topic/Association-for-the-Advancement-of-Creative-Musicians) [1]

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Kagel, Karlheinz Stockhausen, Krzysztof Penderecki, John Cage, Earl Brown, and Morton Feldman are often cited as pioneers in this type of practice" [2], having written scores that give performers a great deal of autonomy, leaving them with a substantial part of the musical decisions. "In giving meaning to a score, the performer follows a script created by the composer but decides how the journey will unfold" [3]. At the time, paper was primarily used as a medium for writing and reading. However, in the following decades, new generations of composers and researchers began developing systems and computing technologies "to create scores according to the specific rules of the composer [...] and act as a partner(s) in improvisation" [4], for the composition and performance of interactive real-time pieces.

In several works and projects by Anthony Braxton from the 1970s/80s, for example, the ensemble musicians respond both to graphic notation and to complex algorithms of reactive electronic patches that the composer designed using programming software such as SuperCollider. With his Language Music system, types of language function as parameters or stimuli in collaborative environments, which can be used to structure improvisation or guide performers [5]. "When considered individually, this system provides a structure for improvisation - breaking the stereotype of the stream of consciousness that can overwhelm free music" [6].

In the late 1970s, George Lewis began composing with computers and synthesizers, "mixing electronic sounds with traditional acoustic instruments. These early experiments were successful, and during the 1980s and 1990s, computer music became central to Lewis's compositional practice" [7]. His composition Voyager is pioneering in the interaction between a musician and a "virtual orchestra" powered by software (sharing the same name as the piece and project), in which both improvise together. "In terms of [Robert] Rowe, Voyager serves as the extreme example of a 'player' program, where the computer system does not function as an instrument to be controlled by a performer" [8].

In the 1980s, John Zorn became prominent in the avant-garde music scene thanks to a highly diversified body of work that employs 'jump cuts' between musical genres, like techniques used in film editing and music composition for animated cartoons, as well as Cubist aesthetics. Many of his works resemble smaller pieces of a game, which led him to create Cobra, which, in addition to being a piece and a project, is a system of graphic symbols and manual, facial, and bodily gestures, based on the handling of large cardboard cards with symbols and graphics directed at the musicians to perform in real-time. "The content of each event is entirely dictated by the musicians performing it" [9].

In 1996, Gerhard E. Winkler composed the piece KOMA for string quartet and live interactive electronics. Using the software Max/MSP, he created the program Realtime-Score, which generates scores in real-time, reacts to the sound produced by the musicians, and controls the live interactive electronics. The premise is that the "[...] score [...] should be read at first sight, with minimal preparation time for the musicians" [10].

In contrast to the previously mentioned software, which is more focused on human-machine interactivity, in 2012 the Decibel Score Player was introduced, created by a team of Australian researchers led by composer Cat Hope. This software, designed for iPad, enables the synchronized network reading of animated graphic scores. "It connects multiple devices to read the same score and keeps them precisely coordinated. It allows the visualization of independent parts and includes features such as pause, speed adjustment, and the ability to scroll through the score to find specific points" [11]. Initially developed to meet the technical and creative needs of the author's opera Speechless (2014), the Score Player is now available for purchase on the Mac App Store.[2]

In the composition and performance contexts presented here, the use of software in largely controlled procedures provides greater interactivity between the musicians and the computer, as well as more variable and unpredictable results. The scores can be flexible, granting autonomy to the performers for a substantial part of the compositional decisions. "The results of different performances of these dynamic systems are multiple versions of the same composition" [10].

These composition and performance systems changed the paradigm of musical composition, bringing composers new and prolific strategies of control over the music, without relinquishing their responsibility as authors and creators.

The use of electronic and digital technologies to read and write scores, as well as to generate music, dates to the second half of the 20th century. In 1965, Max Mathews and the Bell Labs developed a music notation program that, through algebraic language, generated and modified scores in digital format. The Score allowed composers to write scores and make changes to the notation in a more flexible way than with traditional methods, enabling the automatic manipulation of notes and rhythms, as well as producing visual scores to be printed.

In the following decade, the first computer-based music notation systems began to emerge, such as Music 1 (developed by Digital Equipment Corporation in 1973). This software allowed musicians not only to create music digitally but also to display graphic scores on the computer monitor, thus becoming the precursor to what would later become modern digital music notation systems. However, it was only in the 1980s that music notation programs began to gain greater acceptance and use, with the rapid and growing development of electronic and digital technologies.

Until then, new technologies were developed and used only in academic laboratories, but the 1980s and 1990s contributed to their popularization and accessibility on a global scale. With the emergence of the first personal computers, the way music was produced changed radically. Programs like Finale (1988) and Sibelius (1993) became important historical milestones. These software programs allowed musicians and composers to create scores in a more intuitive and faster way, and notation software became accessible to both professional and amateur musicians.

From the 2000s onwards, digital technologies evolved to the point where they enabled the reading of scores on mobile digital devices, such as tablets and smartphones, and the generation of scores through artificial intelligence software.

[2] *Decibel Score Player*, available at: https://apps.apple.com/au/app/decibel-scoreplayer/id622591851

It was then, inspired by the concepts of "extended rationality"[3] as well as "chance operations",[4] that we created BeComposer, using the Max/MSP visual programming language software for the final versions. This program is a reader and generator of sequences of materials in different types of musical notation, for musical composition and performance. The aim is for it to provide immediacy, fluidity, and effectiveness in a way that is equivalent to the practices of play and free improvisation in music, seeking to achieve a balance between preparation, automation, and manual control of instructions/orders and decisions in real-time. In this way, it will be possible to ensure a diversity of possibilities and unexpected, variable results (unlike human automatisms that tend to repeat), thus avoiding bias and mannerisms, and providing an exploratory network-based work within a conducted context.

In our view, *BeComposer* could contribute to the reconfiguration of the relationship between composer, performer, score, and software, allowing for greater flexibility, interactivity, and collaboration among the artists themselves, and between them and the computer. Designed as a dynamic system, it is expected to play a central role in establishing the relationships defined by the composer and performers based on their vision for the piece, generating new and multifaceted musical possibilities. It could provide spaces for innovative creative practices in composition and musical performance, where the artwork is the result of this working process, remaining open to continuous redefinition.

3 Development Methodology

The creation of *BeComposer* is based on a body of artistic work developed since the 1990s in the fields of experimental music and free improvisation, as well as personal contact with literature, works, and projects by other artists and researchers. From this, key concepts stand out, such as real-time musical notation, interactive scores, non-linear complex dynamic systems, real-time composition, collaborative composition, computer-assisted music composition and performance, improvisation, and stochastic music.

The genesis of the idea lies in the experimental music cycle Multiplismos, organized by the cultural association Granular in February 2005, at the Zé dos Bois Gallery in Lisbon. In one of the concerts of this cycle, an ensemble of electric guitars (which the author was part of) was conducted by one of its members using a deck of playing cards. The methodology employed at that time was inspired by John Cage's "chance operations" and John Zorn's Cobra project. Within the same sphere of influences, we also highlight the workshop and concert led by Carlos "Zíngaro", which took place in May 2014, during the 5th edition of the MIA Festival – Encontros de Música Improvisada de Atouguia da Baleia. In this event, this musician and composer used a system of hand gestures (previously systematized, presented and rehearsed) to conduct a small orchestra of professional and amateur improvising musicians in the collaborative creation of live music.

[3] "That designation by Marcel Duchamp refers to something that can make many movements and has multiple options, which is reflected in improvisation practices" [12].

[4] "Term introduced by John Cage for techniques that open the composition process to chance, such as tossing a coin to determine the pitch of the sounds" [13]. (Retrieved from Oxford Reference https://www.oxfordreference.com/search?q$=$chance+operations&searchBtn$=$Search&isQuickSearch$=$true)

We then thought that those practices and methodologies could benefit from computational mediation to guide, direct, or structure real-time music composition and performance, thus contributing to the improvement and expansion of the artistic purposes of aforementioned genres.

The basic programming and prototyping of what would become the BeComposer software began in March 2014. The first seven versions were developed using the programming languages HTML, CSS, and JavaScript, and were used to implement the operating logic, main action commands, and the wireframe designed for the software application.

The choice of those programming languages was based on the desire to provide a free universal service via the Web, which would be established through a WiFi network and supported by an Arduino Yún device as a WebServer.

It has always been intended that the instructions/orders to be executed by the musicians would be easy to load onto the computer and quickly accessible for the work session. Initially, we chose Adobe Illustrator software to prepare the images that would represent the instructions/orders to be used in the creation of the scores, but we quickly realized that this process was time-consuming, as the ongoing programming required images with very specific characteristics.

For this reason, and because the author wanted the development of BeComposer to involve programming that could also be done by him, in 2016 it was decided to port it to Max/MSP (a visual programming environment for music and multimedia, widely used by composers, researchers, programmers, and artists in the creation of interactive software). With the collaboration of three colleagues and friends highly skilled in this programming language, we were able to quickly reach a version (Figure 1) that solved the previously mentioned problems and already integrated operation commands and features that allowed us, in 2018, to test our proposal live in an artistic practice context, with musicians experienced in improvisation, collective performance, and collaborative composition, in order to assess its reliability and relevance.

4 Functional description of *BeComposer*

Being a real-time computer-mediated notation system, for use in the structuring and performance of musical pieces with open-form structures, *BeComposer* provides a space for innovative creative practices in music composition and performance. The interactivity and collaboration between the artists, the computer, and *BeComposer* challenge traditional notions of authorship and compositional control, enabling hybrid forms of music creation, where computing can act as a co-creator and facilitator of collaborative and improvisational processes, even reconfiguring the relationship between the composer, the performer, and the score.

For the construction of the score and graphical representation of the music to be performed, *BeComposer* must be loaded with segmented graphic materials, which can be composed of any types of languages or symbols. The images/instructions/orders (in JPG format) to be used, once created and selected by the composer, the musicians, or the conductor, should be identified and organized into six folders (referred to and named as Dice 1,...), with each folder typically containing twenty instructions/orders. Any of the

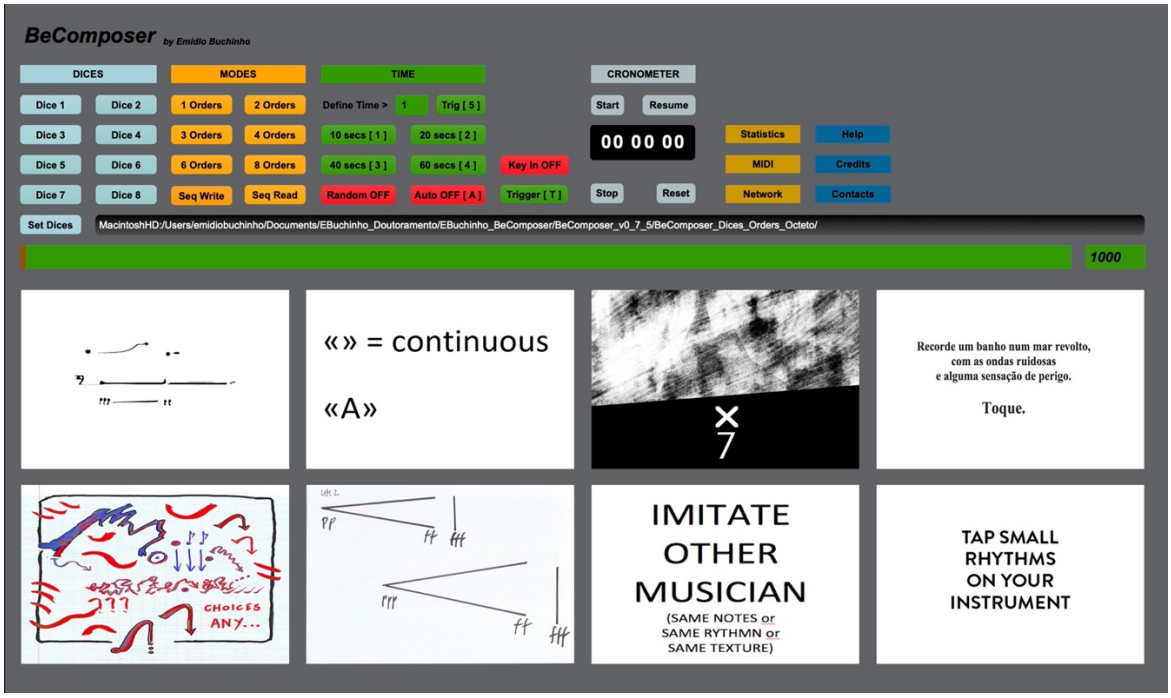


Figure 1: BeComposer, version 7.2 (programmed in Max/MSP). Source: author.

folders can be chosen and used indiscriminately, thereby directing the performance session toward its use.

The presentation and duration of the instructions/orders can be managed through time-conditioning features (available in the Time Mode and Time Set sections), which allow for the manual or automatic change of instructions at predefined intervals or randomly, combining the chronological time settings available in the Time Set section. In this way, a variety of unpredictable instructions can be generated, providing a certain fluidity in guiding the performance.

One can perform in formations ranging from solo to octet (selectable options in the Modes section), with each window provided on the dashboard assigned to a specific musician, for the musical performance of the images/instructions/orders presented to them.

The sub-modes Ensemble, Tutti, Solo Random, and Solo Last allow for the creation of working dynamics in which musicians respond to diverse instructions, thereby promoting interactivity and collaborative spontaneity in real time. In Ensemble, different instruction/order windows are shown on the Dashboard for each musician to perform together as an ensemble; in Tutti, identical instruction/order windows are shown on the Dashboard for all musicians to perform the same; in Solo Random, a randomly selected instruction/order window is displayed on the Dashboard for a specific musician to perform solo, while all other instruction/order windows are disabled and the remaining musicians remain silent; in Solo Last, the Dashboard displays the window of the musician who last performed solo, prompting them to play the given instruction/order again, while all other instruction/order windows are disabled and the other musicians remain silent. During the performance and testing concert of *BeComposer* with students from the Escola Superior de Artes Aplicadas, in 2023, the frequent manual use of the Solo Random mode fostered unique improvisations that heightened attention and interaction among the musicians.

Performers can interact in a synchronous or asynchronous network, through features such as Wi-Fi or Bluetooth, allowing them access to the workspace or an optional window for reading and/or controlling the score, presented on tablet screens, smartphones, computers, or through video projection.

Using MIDI commands, most of *BeComposer's* features can be remotely controlled with devices of that type.

A Stopwatch allows for visually monitoring the elapsed time of the performance, and a Time Countdown ruler shows the duration being used by the Automatic Time Mode for presenting the instructions/orders on the Dashboard, as well as a Countdown Hourglass that fills up, indicating the remaining time before new instructions/orders appear in the screen window(s).

Using MIDI commands, most of *BeComposer's* features can be remotely controlled with devices of that type.

A Stopwatch allows for visually monitoring the elapsed time of the performance, and a Time Countdown ruler shows the duration being used by the Automatic Time Mode for presenting the instructions/orders on the Dashboard, as well as a Countdown Hourglass that fills up, indicating the remaining time before new instructions/orders appear in the screen window(s).

The scores resulting from each performance can be recorded in video format (as a selectable option in the Utilities section) for future analysis or reinterpretation.

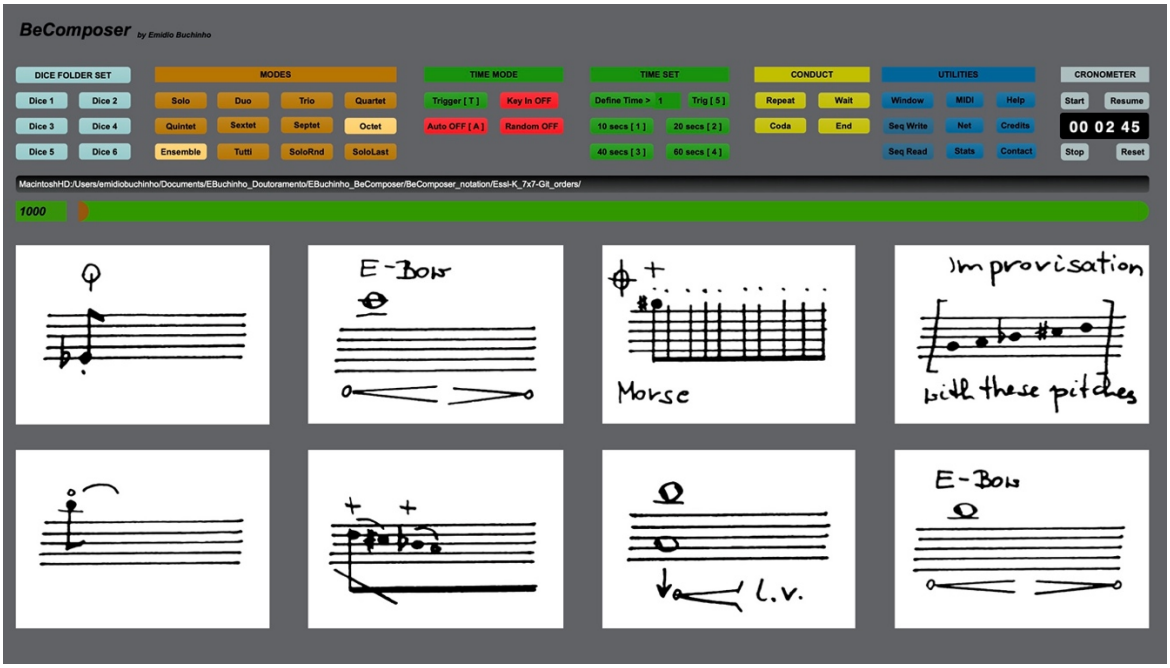


Figure 2: BeComposer, version 7.5.1, Workspace. Source: author.

The set of functionalities described above in brief will allow musicians, composers, and performers to explore new artistic possibilities for real-time composition, with expected results of greater variability and unpredictability.

5 Testing and case studies

For the presentation and testing of *BeComposer* and the subsequent collection of feedback and suggestions, we held an artist residency in 2018 with eleven musicians selected for their recognized experience in the field of improvisation and experimental music (with and without sight-reading practice), followed by a public concert at the O'Culto da Ajuda space in Lisbon. In 2023, we organized two masterclasses, two workshops, and two public concerts with students from the bachelor's degree in music (with and without improvisation experience) at Escola Superior de Artes Aplicadas and Escola Superior de Música de Lisboa. All participants were given a brief presentation of our software, as well as instructions for its use. For one week, the musicians had the opportunity to experiment with *BeComposer* and then responded to a survey we presented to them.

All participants were asked to collaborate in our experiment by bringing three or four images/instructions/orders that could be interpreted musically. The goal was not for it to be scores of the music to be performed, but simply ideas that would work together to collaboratively create the music.

Thus, with their collaboration and participation in the context of artistic practice, it was possible to test and develop *BeComposer*, which allowed us to analyze and assess the technological results, and the artistic processes experienced, to gain a more complete understanding of the transformative potential of what we set out to achieve.

The collection of feedback and suggestions from users, as well as from the audience, the reflection on the results, and the sharing of experiences, led to the compilation and analysis of the data obtained, resulting in the redefinition, optimization, and implementation of some features, along with the enhancement of *BeComposer's* potential (Figure 2).

Examples of this are the following cases: the Ensemble, Tutti, Solo Random, and Solo Last modes were implemented based on suggestions from the musicians who participated in the 2018 artist residency at the O'Culto da Ajuda space in Lisbon; the Conduct section will be implemented based on suggestions from music students at Escola Superior de Artes Aplicadas, who participated in one of the 2023 workshops, and will include four features (Repeat, Wait, Coda, End) that allow for further conditioning and guiding of the performance. These features will enable the conductor to instruct musicians to repeat the previous group of instructions, to have a specific musician refrain from playing and take a pause, to signal certain musicians to prepare to finish, or to instruct all musicians to stop playing.

The interest, participation, motivation, and feedback from the participants in our presentations, residency, masterclasses, workshops, and concerts held so far have been very high and relevant, allowing us to extract valuable contributions for the (re)programming and development of the dynamic system that *BeComposer* aims to be.

6 Critical discussion

The basic knowledge of programming languages and the author's reliance on third parties to implement more complex tasks and program advanced features in *BeComposer* have posed a challenge to our perseverance regarding its development and testing processes. The professional and personal commitments of the team involved have not allowed for the time necessary or desired for this. However, these challenges have become an asset to the results achieved.

Mobilizing musicians, composers, and students, who are used to established and deeply rooted composition, interpretation, and music study processes, methods, or routines, has been another notable challenge. However, their openness, availability, participation, and feedback have been constant and very valuable. When asked if "the use of this tool could impact their creative or work processes," some of them responded that "it's excellent for group work and gives direction to improvisation"; "it gives musicians the freedom to express themselves through what each image conveys to them, so different approaches emerge for the same image"; "with the guidance of the software, live composition and performance are facilitated"; "it can lead down new paths, unlocking moments of indecision"; "it is a useful tool for improvisation sessions with more people or even alone, precisely because it introduces a direction that guides the process." Some participants in our study expressed their acceptance of the shared creative authorship resulting from their participation in collaborative creative processes. They considered that *BeComposer* could contribute to their claim for more artistic freedom of expression, despite being involved in networked work processes.

> "It is not the wisdom of the crowd that is at stake, but the wisdom of someone within the crowd. The network, on its own, is not intelligent – but individuals become more intelligent by being connected to the network." [16]

In the work developed so far, we have found that *BeComposer*, as software designed for collaborative improvisation and composition, in line with contemporary trends in music for sound exploration, takes advantage of the current widespread accessibility to digital technologies. It can be used not only as a creative tool but also as a methodology for artistic research that can influence musical creation, as well as bring pedagogical benefits.

7 Conclusion and future perspectives

BeComposer opens new perspectives for the use of computer technologies and stochastic processes in the fields of improvisation, collective performance, collaborative composition, and reconfigures the relationship between the composer, performer, and the score, fostering greater flexibility and interactivity in composition practices within collaborative environments. In the contexts experienced, the scores and musical results presented proved to be of considerable pedagogical and artistic interest, and of notable contemporaneity.

While these practices challenge traditional notions of authorship and compositional control, they benefit from computational mediation in facilitating collaborative and improvisational processes, as well as fostering new possibilities for real-time composition, enabling the configuration of hybrid and open modes of musical creation.

This exploratory research should continue in the context of artistic residencies, academic seminars, concerts, and public talks, with the participation of more groups of musicians and students, with varying levels of experience in improvisation and sight-reading. The system will be continuously tested in various practical contexts to verify its effectiveness and relevance and will consequently be updated with the introduction of changes and innovations.

At the suggestion of a participant in the 2023 workshop held at Escola Superior de Artes Aplicadas, the functionality of the Solo Last mode section (where the window of the musician who completed their solo immediately before is shown on the Dashboard, so they can perform the solo instruction/order presented; all other instruction/order windows are disabled, and all other musicians do not play) may be replaced by the Solo Free mode (where a window of a specific musician is randomly shown on the Dashboard, with no instruction/order and left blank, so they can play freely; all other instruction/order windows will be disabled, and all other musicians should not play). We believe this option will be more stimulating for the collaborative composition environment, thus highlighting creative and interpretative freedom, as well as the individual contribution of each performer.

It is also of great relevance and urgency to program the MIDI, Network, Wi-Fi, and Bluetooth functionalities, as outlined in the Utilities section, for testing the remote control of *BeComposer* and collaborative work over a network. Access to the network should be ensured for users present in the same physical space through a QR code, using common technological resources such as computers and mobile digital devices.

We also aim to experiment with *BeComposer* in managing scores of well-known works, such as *Musikalisches Würfelspiel* (1792), attributed to Wolfgang Amadeus Mozart, *Klavierstuck XI* (1956) by Karlheinz Stockhausen, *Novara* (1962) by Earle Brown, *Variations I* (1958) by John Cage, and *Que Mon Chant Ne Soit Plus d'Oiseau* (1991) by Constança Capdeville, performed by a solo piano, a string quartet, and an octet of strings, winds, and percussion. We assume it will be very interesting to observe how performers relate to sight-reading familiar scores, but without prior preparation or rehearsal.

We will continue with user surveys (to gather more feedback), and documentation of the entire research process will be compiled, including descriptions of the methods and strategies used, as well as the presentation of results (also reflected in the developed software and the musical pieces performed or created), discussing the technical aspects (interactivity, MIDI control, automations) and the creative decisions that stem from them.

At the same time, *BeComposer* should be made available as open-source code on platforms such as its own website, Vimeo, YouTube, and forums for Max/MSP and Ableton Live users.

The analyses of the surveys and results should examine the effectiveness of the system in terms of usability, flexibility, and impact on real-time composition and performance.

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Institute of Hyper-Consumption: Traces of Excess

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Abstract

Dump-World is a two-channel installation by the Institute of *Hyper-Consumption* that examines how mass tourism and hyper-consumption reorganize Lisbon as a semiotic interface. Rather than representing the city from a distance, the project operates on its representational machinery: we collect metonymic urban signs, digitize them via photogrammetry, and recompose them into a walkable virtual layout (projection) paired with a rotating object catalogue (monitor). A spoken manifesto, printed on receipt paper and impaled after each line, functions as a performance of archiving, binding voice, image, and sound through timed cues so that critique is not only said but performed. Methodologically, we articulate an archival-speculative approach, keeping glitches, seams, and occlusions visible to materialize what we call an aesthetic of algorithmic ruin, the costs of visibility in a platform-ready city. Situated against Lisbon's recent touristification, the work contributes a replicable collect–transform–trace method for media art research; a design grammar that couples embodied drift with fetishistic inspection; and a public-facing archival stance that makes procedures legible.

CCS Concepts

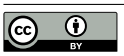
• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Mass-tourism, Consumerism, Hyper-consumption, Identity loss, Souvenirs, Collective memory, Globalism

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1 Introduction

The *Institute of Hyper-Consumption* is a transnational artists' collective that adopts the institution as both method and mirror. We call ourselves an institute not to claim authority, but to expose and repurpose, in a formal way, the organizational forms that already shape how cities are produced and perceived, research protocols, catalogues, audits. Our work proceeds publicly and with traceability, treating institutional procedure as material for art rather than a backdrop.

Our project, *Dump-World*, asks a direct question: how do mass tourism and hyper-consumption reorganize Lisbon as a semiotic interface, where symbols and souvenirs begin to substitute lived experience? We approach the city as a mediated archive: in a regime of simulacra, signs detach and circulate [1]; images act as infrastructure, allocating attention and value through circulation and compression [2] [3] [4]; a lens-mediated lifestyle privileges being-seen over seeing [5]. Rather than asserting these ideas, we stage them: a two-channel installation, *Dump-World* and *Objects,* and a spoken manifesto, printed on receipt paper and impaled after each line, operates as a performance of archiving, turning critique into accounted residue. With this, we offer an archival-speculative method for collecting, digitizing, and recomposing urban iconography under conditions of traceability; an aesthetic of algorithmic ruin that materializes the hyperreal as felt structure; and a voice-image-sound performance, binding critique to the visual economy it diagnoses. In doing so, the work contributes to media-arts and urban-studies debates by materializing hyper-consumption not as a theme but as an operational condition of looking and remembering. Subsequent sections develop context, influences, and project details before discussing implications.

2 Presentation and Context

2.1 The Mediated City

Contemporary cities like Lisbon are no longer shaped solely by architecture or policy, but increasingly by media flows and visual regimes. In this sense, the tourist city operates as a media construct, where every element, be it a facade, a pastry, or a tram, functions as a sign ready for circulation. The built environment becomes a backdrop for content creation, shaped by the desire to be seen, shared, and consumed. As such, the city becomes not just a space of experience, but a semiotic interface; a place where meaning is constantly manufactured and remanufactured. In this mediated context, reality is often subordinated to its representational value, echoing Baudrillard's notion of the *simulacrum*, where signs detach from their original referents and form a self-replicating loop of hyperreality [1]. In the contemporary media landscape, as Hito Steyerl argues, the image no longer simply represents reality but becomes infrastructure, a material and economic system that shapes how the world is organized [2]. Her concept of the poor image describes how digital reproductions, compressed and endlessly circulated, gain political force precisely through their degradation [3]. Our virtual Lisbon, our *Dump-World*, operates in this register: a Frankenstein-city built from low-resolution scans and media fragments. In *Ripping Reality*, Steyerl reads 3D capture as producing fractional space (a space between 2D and full volumetric representation) in which blind spots and occlusions become visible components rather than errors to erase [4]. In this light, the glitches and holes of our reconstructions are critical sites: absence and fragmentation render mediation's operations tangible, framing its distortions and gaps as active agents in the work's critique of tourism, memory, and mediated urban presence.

2.2 Touristification

In the past years, tourism was perceived as a solution to solve the economic crisis and recessions in Portugal and in other countries. Whilst tourism can benefit the respective countries' economies, it also oftentimes negatively impacts the quality of life for residents who must deal with overcrowding, extreme pressure on infrastructure, and increased environmental impacts. However, the negative impacts of this industry were treated as secondary and seemingly weren't taken into consideration by the Portuguese government. Recent research shows Lisbon's shift toward tourism-led redevelopment was not a spontaneous market correction but a state-enabled regime that absorbed redevelopment risks and opened central housing to short-term rentals (STRs), hotels, and luxury products. Between 2012-2019, hotels and airport arrivals roughly doubled, and STR listings expanded from ~900 to >19,000, driven by a neoliberal toolkit: fiscal incentives, tenancy liberalization, permissive licensing/zoning, and public-private rehabilitation programs [6]. This lens situates the experiential field we collect and recompose in *Dump-World*.

Because of that, in central Lisbon, where our artistic research is rooted, the identities of historic urban areas were constantly neglected, and the city has changed completely in just a decade. These transformations have dismantled cultural patterns, and there has been a touristification of habits and objects. At the neighborhood scale, Alfama exemplifies how platformed hospitality restructures everyday life: by March 2019, around 1,703 STR flats accounted for ~47.5% of all dwellings, with multi-listing/professional hosts dominating supply. This "Airbnbisation" turns the quarter into an "outdoor hotel", binds residents to precarious, tourism-dependent labor, and standardizes street-level aesthetics [7]. With that in mind, we can argue that tourism asks for authenticity, so it creates its own symbols and stories from the mix between the lived traditions and capitalism. Tourists now perform their own experiences for the camera, further entrenching the city as a media artifact. These conditions dovetail with our on-site observations of themed displays and reproducible motifs that we later digitize and recombine in the installation.

2.3 Branded Hyper-Consumption

The new Lisbon is becoming an entertainment park, where you can find sardine cans informing you of the year the *iPhone* was launched and pairing Leonardo DiCaprio's year of birth with the year of the Carnation Revolution. In Rossio, one of *Zara*'s largest flagship stores now sells pastel de nata alongside fashion, epitomizing how commerce, spectacle, and "authenticity" coalesce in a single display logic. In the same building, there was once *Pastelaria Suiça*, a well-known place to eat the best pastries, which was open from 1922 until 2018. A coffee shop with the same name was opened close by, but it has nothing to do with the old one. The new *Pastelaria Suiça* is a "reinterpretation" that brings back classics [8], illustrating how vernacular identity is reformatted as merchandise.

In the same vein, in 2023, during one week in April, Baixa has undergone a rapid turnover of century-old shops into hotels, souvenir chains, and global fashion flagships that often masquerade as tradition, producing surface-level diversity; the district "lost 261 years of history" in a single week as closures accelerated [9]. As the Portuguese newspaper *Expresso* reports, the Baixa de Lisboa lost most of its original identity. The majority of the old, traditional shops didn't survive the housing speculation, and we can now find a lot of hotels, souvenir shops, and big international brands lining its streets. In addition to that, recently these tensions have entered public discourse with coordinated actions across Southern Europe, including a Lisbon procession that symbolically "evicted" St Anthony towards a planned luxury hotel, explicitly named touristification (rather than mere "overtourism") as the problem: speculative models that externalize social and environmental costs while extracting value from heritage and labor [10].

2.4 Archival Practices Today

Over the last two decades, the so-called archival turn has moved from treating the archive as a theme to understanding archiving as an operation, a way of making and knowing that aligns artistic practice with research and institutional critique [11]. With time, what first appeared as a trend has revealed itself as a loose configuration of methods (collecting, annotating, reordering, restaging) that expand the archive from source to subject, from a container of facts to a structure that shapes what can be said and seen. In art, this has meant recognizing the structural kinship between the archive and the contemporary art system itself, and it has normalized practices that assemble counter-archives, fabricate speculative

archives, or expose institutional blind spots not to stabilize history but to activate it [11].

Callahan also notes how the archival vocabulary inflated and conflated, becoming a "must-have accessory" in the 2000s, and how its staying power relates to the rise of research-based practices and to the aesthetics of cataloguing, widely adopted by installation art [11]. More recently, the proximity between para-fictional archives and the post-truth landscape has prompted artists to recalibrate tactics: rather than relativizing everything, works can make procedures and provenance legible, renewing empiricism without abandoning critique [11]. *Dump-World* positions itself within this updated horizon. We treat Lisbon's touristic signs as material for an archive-in-motion, to be traversed rather than vitrified, trying to see among the idea of the *global village*: a homogenized, hyper-connected urbanity where differentiation dissolves [12].

These are precisely the signs we observed and collected. Some of us live in Lisbon or in cities similarly affected by mass tourism. We collectively developed the reappropriation of an archive as an artistic starting point. This practice of collecting, for us, derives from the touristic act of taking photographs of as many things as possible while on a holiday or trip. Almost as if taking a photo of said things were more important than actually seeing them, as Beiguelman writes:

> "The impact is unmistakable: a lens-mediated lifestyle is becoming the norm, where everything can be recorded and posted even before it has been experienced, as if documentation could do without the facts and the lived experience of things. The camera itself seems to legitimize one's very presence both on-site and in the scene."[1] [5]

The ways in which tourism packages and mediates the city, through photo opportunities, branded objects, augmented visuals, and curated experiences, are not just tools for communication, but the very forces reshaping the city's identity, resonating with McLuhan famous statement, "the medium is the message" [12]. In Lisbon, the representation becomes reality: symbols, souvenirs and imagery take precedence over the lived experience. Just as McLuhan foresaw, the form through which content is delivered becomes more influential than the content itself.

3 Influences and Most Relevant Works

This section situates *Dump-World* within a lineage of practices that understand the city not as a stable referent but as a mediated archive in continuous circulation. Our initiative is inspired by a selection of artistic and cultural works that offer a clear insight into themes such as memory, identity, consumption, and change. These influences that integrate immersive storytelling, archival methods, and critical analysis offer both conceptual frameworks and visual references that reinforce our sensibility to Lisbon's current complexities.

Wim Wenders's *Lisbon Story* [13] (Figure 1) established a method of errant walking and listening in which the city is assembled through contingent encounters with sound and image. Where Wenders's film belongs to a pre-platform moment whose Lisbon could still be found in analogue drift, *Dump-World* works in a city already formatted by platform-ready signs: vitrines arranged for repeatable photographs, objects pre-designed for circulation, façades tuned to go viral. Wenders' blend of documentary and fiction, alongside his focus on sound, image, and occasional acts of wandering, inspired our own method of collecting Lisbon's "trash," media fragments, and everyday objects. Like the film's protagonist, who drifts through the city capturing its atmosphere and hidden stories, our project treats Lisbon as a living archive from which we collect.

Flooded McDonald's [14] (Figure 1) offers a second canon: an immersive replica through which systemic collapse becomes tangible as water rises, and corporate iconography slowly breaks down. This project is relevant to our project because it offers a strong visual and conceptual critique of mass consumption and corporate impact, issues that also shape Lisbon through mass tourism. The film's slow flooding of a familiar *McDonald's* space symbolizes an environmental and systemic collapse. Similarly, our project gathers the city's discarded materials like trash, media, and objects, to build a digital space that reflects and questions the effects of constant consumption. As an influence, *Flooded McDonald's* helps us to think about how immersive environments can challenge viewers and highlight the transformation of contemporary life, making it a key influence in our exploration of Lisbon's changing identity.

The investigative practice of Forensic Architecture [15] (Figure 2), a multidisciplinary research group that provides another relevant reference point for our approach. Their projects use spatial analysis, open-source data, and digital modeling to reconstruct, among other things, events of political violence and ecological exploitation. Through these methods, Forensic Architecture exposes how architecture, media, and evidence intersect within complex visual regimes. Although their investigations are fact-based and juridically oriented, they share with our work a speculative dimension in using 3D modeling as a mode of critical reconstruction. In *Dump-World*, this methodology is reinterpreted within the cultural and touristic sphere, turning the evidentiary logic of reconstruction into a poetic and political commentary on consumption. Rather than rebuilding a crime scene, we rebuild the scene of gluttony and desire, questioning how the tourism image-economy frames what can be seen, remembered, or forgotten.

Ami Clarke's *The Underlying* [16] (Figure 2) extends this evidentiary sensibility to the entanglements of finance, platforms, and environment, articulating how risk models shape the conditions of life. In *Dump-World*, the tourist-platform complex is not an analogy to finance but another of its interfaces: a pipeline that turns memory into yield. Our receipt-paper manifesto, read aloud and then impaled on a spike, literally accounts for critique, staging how dissent is captured as paper residue within the logistics of commerce. Clarke's transmedia grammar resonates here, but we fold it into a two-channel architecture that opposes first-person drift (*Dump-World*) to fetishistic object inspection (*Objects*). Finally, the *Museum of Abandonment* [17] informs how an archive can be public, situated, and infrastructural. The museum models participatory routes through a distributed collection; we translate this visit ability into a virtual city where each scanned object retains provenance and manipulation notes, asserting the archive as both evidence and aesthetic operation. Transposed to Lisbon's center, it sharpens our focus on souvenir ecologies and display logistics,

[1] Translation from Brazilian Portuguese by the authors.





Figure 1: (a) Still from *Lisbon Story* (1994), (b) Still from *Flooded McDonald's* (2009) video installation, images used under Fair Use, 2025.





Figure 2: (a) Still of *The Underlying* (2019), (b) Screenshot of the interactive experience *Museum of Abandonment* (2025), images used under Fair Use, 2025.

how resources, labor, and attention are channeled into sign-objects that promise authenticity while accelerating extraction.

Taken together, these influences mark a clear shift in register. Rather than representing Lisbon as a topic or backdrop, *Dump-World* operates on its representational machinery. The installation is not an illustration but a procedure that folds our operations into one experience. The work aims to materialize the politics of touristification as felt form: an urbanism in which signs outlive the places they once named.

4 Project

We combine field collecting and digital city-making to interrogate how itineraries, branding, and everyday media reorganize Lisbon's identity. The outcome is a two-channel installation: *Dump-World* (projection), a continuous first-person drift through a reassembled urban layout, and *Objects* (monitor), a rotating catalogue of scans that invites a close, almost fetishistic look. A spoken manifesto (Appendix), printed on receipt paper and enacted live, punctuates the traversal with textual, sonic, and visual cues. Our process was driven by an archival method, collecting, digitizing and recomposing urban iconography under conditions of traceability; a two-channel grammar that juxtaposes embodied drift with catalogue-gaze, making the passage from street to commodity palpable; and a performative score that has voice, image and sound, converting critical statements into accounted residues (the spiked receipts) and binding discourse to the visual-sonic economy it diagnoses.

4.1 Methodology

Our goals are simple: gather the city's "trash" as a living archive and rebuild those fragments inside a virtual space that mirrors and questions the logic of endless consumption.

We started by acting like tourists. We undertook multiple field sessions across Baixa-Chiado, Rossio, and Terreiro do Paço with phones and cameras, walking, looking, purchasing, or collecting discarded items and recording images, short video loops, and ambience sounds. Inclusion focused on metonymic tourist signs (souvenirs, branded wrappers, image-ready displays), reproducibility (motifs widely echoed in vitrines and platforms), and legal accessibility (public-space capture; purchased or abandoned objects). We excluded identifiable faces, restricted interiors, and materials that posed privacy or safety risks. This selection process was not merely logistical but conceptual: each object functioned as a condensed narrative about how Lisbon is seen, packaged, and sold. Each element was uploaded as our devices created it to our digital archive in *Google Drive*, our "cloud-landfill". Our stance is interventionist: we deliberately stage instabilities to materialise hyperreality as both an aesthetic device and a critical hypothesis, while keeping the evidentiary trail visible.

4.2 Digital Process

We produced mid-poly scans in *Polycam* (typically 40 - 60 photos per object, high quality) and imported meshes into *Blender 4.1* for clean-up, decimation, and UV unwrapping (Figure 3). Inside *Blender,* we built a "dump-world". Piles of monuments, signs, and crumpled flyers sit beside streets that fade into nothing. We added deliberate glitches, meshes that overlap or melt, to make the scene feel unstable. Following Baudrillard's [1] idea of the hyperreal and Beiguelman's [5] work on digital ruins, the city looks real but has lost its reference point. The imperfect meshes, gaps, and distortions in our digital reconstruction mirror what Steyerl describes as wrecked data in 3D scanning, where the "missing itself becomes apparent" and blind spots surface as material features of



Figure 3: (a) Still from *Dump-World*, showing one of the points-of-view of the video. (youtube.com/watch?v=fUCyMwBrKqY) (b) Still from *Objects*, depicting one of the objects that we used in *Dump-World*. (youtube.com / watch?v=vB9wwOlwRjE), 2025.

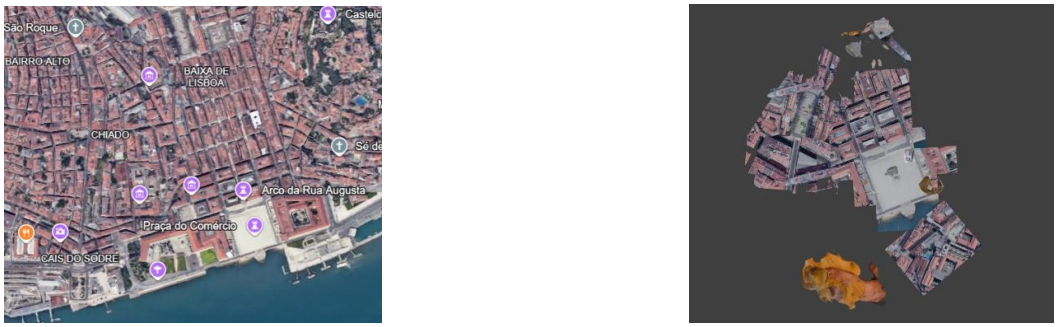


Figure 4: (a) Satellite view of Lisbon's Baixa district captured in *Google Earth*. (b) Photogrammetric 3D mesh generated by the authors from *Google Earth* scans, 2025.

the model [4]. Rather than attempting to fill these absences, our method embraces them: we allow partial geometry, fractured textures, and ambiguous voids to persist. This aligns with Steyerl's notion of the imperfect image as a site of resistance where breakdown and compression reveal the invisible operations of power. Rather than striving for photorealism, the work embraces instability to highlight how the tourist city's surface is itself a manipulated and economically charged construct [2].

The audio recorded, from the street vendors, transport, and shop interiors, was used to compose the path in the *Dump-World*. With this, the projection channel choreographs a continuous walkthrough; the monitor channel treats each scan like duty-free merchandise, rotating under neutral lighting to emphasize fetishistic inspection. The real scale of the city stayed intact even though we later rearranged parts of Lisbon. Below (Figure 4), we see a comparison of the layout of famous places and tourist attractions in Lisbon, as it is and how it was rearranged:

4.3 Performance

As a natural conclusion in our working process, after having mostly done "field work", the collective regrouped and developed a manifesto (Appendix) for the *Institute of Hyper-Consumption*. In the writing process, we found ourselves summarizing our feelings and collecting thoughts around the work's topic, as well as working improvisationally and associatively.

After entering the room, people displaced themselves to watch the videos. After some minutes, positioned perpendicularly to each other, each one of the artists read out four phrases of the manifesto, which has sixteen sentences, printed sentence by sentence on receipt paper. After each reading, the respective paper was ceremonially impaled on a metal ordering spike (Figure 5a), a device commonly used by restaurants to close orders. The act of isolating the lines one by one turns language into transactions, discrete entries that are counted, filed, and discarded, so that critique becomes accounted residue. The act of reading, the perforation of the paper, and the audio of the projection created a sound environment in which language, moving images, and urban scenes converged in such a way that the viewer, like on a city tour, was subjected to various stimuli, sometimes not knowing what to pay attention to first.

The room for the performance was dark, and the two videos almost overlapped (Figure 5. The cadence remained constant, so that the ritual itself carried meaning: words were made countable, attention was reallocated in small increments, and the remains of the speech gathered into a pile that the audience could see accumulating. In this way, the performance did not explain the installation; it operated it, aligning the manifesto's language with the installation's core procedures of selection, indexing, and disposal.

The live "spiking" ritual (Figure 6) enacted the passage of critical discourse from rhetorical claim to commodified symbol. As the pile of "receipts" accumulated (Figure 6) and became an object in its own right, the performance made visible the circuit through which authenticity is processed, labeled, and discarded. By breaking down the distinctions between archival record and performative events, the project extends the Institute's thesis that contemporary

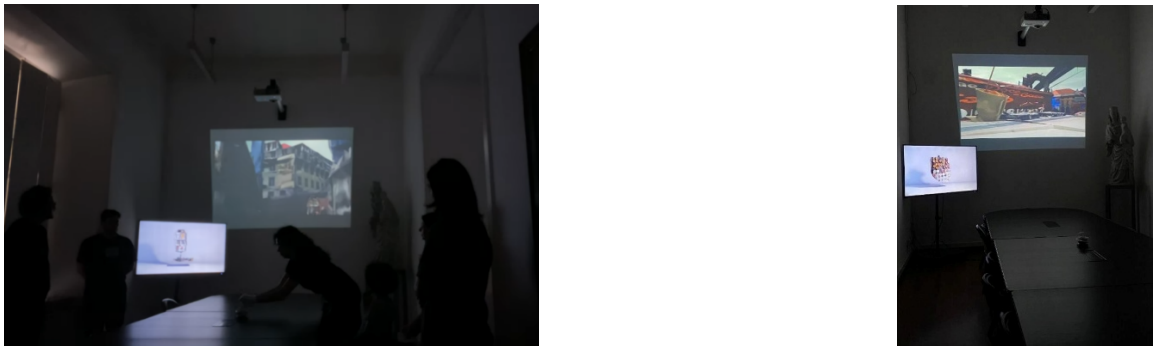


Figure 5: (a) Performance with the presence of the public, (b) Photograph of the installation setup, 2025.



Figure 6: The act of impaling the paper, 2025.

experience is governed by the same consumerist logic that once promised economic salvation.

At the beginning of the performance, each person received a receipt printed with one line of the manifesto. After the performance, they could choose to place it on the spike or take it with them. We like to imagine that, days later, someone might find the small slip in their pocket, just like any other receipt. This tactile interaction connects the performance to everyday experience, revealing how certain materials carry an inherent political charge. Most people chose to keep the paper. At the end of the performance, some visitors stayed, as there was the chance to engage in discussions with the artists and the other viewers.

5 Conclusion

The two-channel projection *Dump-World* and the *Institute of Hyper-Consumption* performance do not solely document transformation but also reenact it, using artistic speculation as a means of urban analysis. By merging fieldwork, data capture, and performative ritual, the work situates itself at the intersection of media art, critical urbanism, and post-digital archival practice. By materializing Lisbon's touristic features into a coherent virtual experience and choreographing the transformation of the manifesto into disposable fiscal matter, the project affirms archiving as an aesthetic and political act. It compels the public to confront the simultaneity of production and disposal, spectacle and ruin, foregrounding the challenges of urban heritage in an era of degenerative hyper-consumption. This work was developed within the Master's in Multimedia Art (Interactive Arts) at the Lisbon University Fine Arts Faculty during Transmedia Questions seminar classes.

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Appendix

Manifesto // Mission Statement

- The tourists love the can more than the tuna.
- Everyone loves the can more than the tuna.
- The city molts. We collect its discarded skins.
- The city of Lisbon, as well as any other mass-tourism-affected city, is in a state of perpetual change.
- There is no turning back in cultural development, and we can never see Lisbon as we have seen it before.
- Hyper-consumption is a culture in itself that creates its own stories and symbols.
- Hyper-consumption leads to multiple versions of the same city existing parallel to each other, having been generated by the consuming tourists' eyes and perpetuated by the photographic reproduction of the city.
- Hyper-consumption is preceded by the idea of perfection that is expected to be presented to the consumer.
- Tourism produces fiction.
- The experience is replaced by the picture.
- The tourist wants to consume memory without mourning.
- What was lost is not mourned – it is rebranded.
- Cruise Ships are ever-growing islands at the gates of the city, demanding to expand their territory.
- Elétricos are no longer modes of transportation, but they represent the desire to see and travel the city as it was in the past (which is impossible).
- Everything from the cultural past will be eliminated in time, and only the traces that can be sold will persist.
- Only in the apolitical end of everything will we all love the tuna more than the can.

Technodiversity, performance, and technical mediation in four creative projects exploring interactive and visual resources

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Abstract

In this paper we explore the relationship between technology, performance, and creative invention drawing on concepts of *cosmotechnics/technodiversity* and theories of performance and technical mediation. By opposing the hegemonic, universalizing view of technology/culture and the conceptualization of performance as an entanglement of technical systems and embodied actions, we discuss aspects of four artistic projects that integrate interactive and audiovisual elements. In conclusion, the paper asserts the importance for artists, particularly those in contexts considered peripheral, to resist the homogenizing force of a dominant "monotechnology". It advocates for a critical and creative appropriation of technology that fosters situated and contextualized artistic invention.

Keywords

Technodiversity, Cosmotechnics, Performance, Creative Processes, Technology Appropriation

1 Introduction

Technical mediation and *performance* are central aspects of artistic practices that engage with interactive means: they address the relations between humans, technical systems, and performative actions within creative processes. Nevertheless, these aspects are often taken for granted, potentially masking the cultural, social, and idiosyncratic dimensions inherent in any artistic and technical practice within a given context.

The present paper explores the interrelations between technology, mediation, invention, and performance within the creative processes of four interactive audiovisual works. This exploration is framed by Yuk Hui's concepts of *cosmotechnics* and *technodiversity* [12–17], which are articulated with a conceptualization of *performance* as a framework for understanding the entanglement of technical systems, expressive intentions, and embodied actions in creative works [22]. Following the introduction of these theoretical concepts, we address the technical and performative aspects of the four projects, each exploring interactive and audiovisual resources through personal appropriations of technology. These works are discussed by tracing the connections between their technical creation, expressive intentions, and performance dimensions. The pieces are divided into two groups: (1) two compositions involving the development of computer vision algorithms that retrieve and provide feedback on physical information from the musicians' performances; (2) two pieces in which the video capture of the performances—their mediatization—is explored as compositional material.

In the following section, Yuk Hui's concepts of *cosmotechnics* and *technodiversity* are introduced, highlighting their relationship to art and contrasting them with a hegemonic, monolithic notion of *technology*. These concepts are articulated with a conceptualization of *performance* in section three. By situating the works discussed in this text within this theoretical framework, this paper discusses the visions of *technology* in *performance* and explores their potential connections with Hui's concepts.

Sections four and five discuss some aspects of the four pieces taking into account the preceding theoretical framework. We first examine the diversity of techniques, software, and tools (technical objects) adapted, crafted, and explored in the creative and performative processes of each work. Then, we relate the performative, poetic, and expressive intentions of the pieces to the technical and research dimensions of their creative process.

The conclusion argues that, particularly for artists-researchers dealing with new technologies in contexts considered peripheral, it is crucial to resist the homogenizing force of hegemonic monoculture/monotechnology.

2 *Cosmotechnics* and *technodiversity*

> There is a general misconception that all technics are equal, that all skills and artificial products coming from all cultures can be reduced to one thing called 'technology'. And indeed, it is almost impossible to deny that technics can be understood as the extension of the body or the exteriorisation of memory. Yet they may not be *perceived* or reflected upon in the same way in different cultures. [16, p. 9]

In *The Question Concerning Technology in China: An Essay in Cosmotechnics*, Yuk Hui challenges the universalist conception of technology. He posits that our understanding of *technology* and *technics*, as philosophical concepts tied to the human activity of making and practice, cannot be assumed to be universal. Instead, Hui argues it is fundamentally shaped by the history of philosophy and, more importantly, by the specific cosmology of the culture in which it emerges: "in China, technics in the sense we understand it today — or at least as it is defined by certain European philosophers — never existed" [16, p. 9].

To highlight this distinction, Hui introduces the concept of *cosmotechnics*:

> I propose to go beyond the notion of cosmology; instead, it would be more productive to

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> address what I call cosmotechnics. Let me give you a preliminary definition of cosmotechnics: it is the unification of the cosmos and the moral through technical activities, whether craft-making or art-making. [11, p. 6].

Hui traces the hegemonic modern cosmotechnics to its Greek origins and its evolution into what contemporary anthropologists like Philippe Descola and Eduardo Viveiros de Castro call *naturalism* — a worldview that segregates nature and culture [8]. Although the seeds of this division are present in Greek thought through binaries such as man/gods, invisible/visible, and eternal/mortal, Hui argues that the definitive separation occurred during the modern period.

Through the concept of *cosmotechnics*, Hui critiques the multifaceted nature of this *homogenization*. While Viveiros de Castro and Descola respond to this problem with *multinaturalism* — a concept that itself requires questioning the *nature/culture* dichotomy — Hui's approach goes down another path. He argues that the nature/culture dichotomy is itself a symptom of a deeper issue: the universalization of a single, modern concept of technology. His critique therefore focuses not on ontology directly, but on technics as the mediating activity between a cosmos and a culture. Influenced by Bernard Stiegler, he seeks to dismantle the *nature/technology* divide, while also, echoing the foundational influence of Gilbert Simondon, challenging the separation between *technique* and *culture*. [6, 24, 29]

Against this homogenization — which we identify also, in a Gramscian sense, as a process of *hegemonization* — Hui connects the concept of *technodiversity* with those of *biodiversity* and *noodiversity* (the diversity of knowledge).

> In reality, what Vandana Shiva called the "monoculture of the mind" is omnipresent in the capitalist logic of globalization; we, therefore, end up having monotechnology, which recklessly views itself as the only option. The "monoculture of the mind", which endangers both biodiversity and noodiversity, suggests that the key to resolving this problem is to return to the discourse of technodiversity. Therefore, the matrix of biodiversity, noodiversity, and technodiversity form a more comprehensive framework than the dialectics between nature and technology for understanding the planetary condition. The question of bifurcation is central since, without differentiation and diversification, it is impossible to talk about difference and diversity. Diversity is not only to be maintained, but it also has to be *constantly created*. [17, p. 225-226]

The hegemonic cosmotechnics of our time, the "monoculture of the mind," is not merely an ideology of the homogenization of cultural practices and values, landscapes, social life, knowledge, and worldviews. It also hinders the diversity of ways of thinking and making. In the context of art, it restricts the plurality of the creative and aesthetic appropriation, reinvention, and exploration of technology, as well as technology's position in the world.

This is why Hui points out that it is not sufficient to maintain the plurality of cultural, technical, and natural idiosyncrasies. Indeed, there is always the risk of "diversity," "preservation," and "conservation" being articulated as *conservative* euphemisms for the status quo by isolating, hoarding, and exhibiting its trophies, both captured and designated: like 'exotic' plants in a botanical garden, or taxidermized animals and dioramas in a 'natural history' museum. Walter Benjamin already pointed out that these spoils, the so-called *cultural goods* [Kulturgüter], are at the same time a monument of culture and a monument of barbarism [1]. This ever-relevant lesson applies not only to the looted cultural goods exhibited in museums such as the Pergamonmuseum in Berlin, the British Museum in London, the Louvre in Paris, or the AfricaMuseum in Brussels, but also to a broader set of institutionalized practices towards nature and technology that are based on the same logic of *conservation* and *preservation*, on one side, and *innovation* and *technical progress*, on the other (two other terms that are often used as perverse euphemisms for *homogenization-hegemonization*).

Diversities and *pluralities* are to be constantly created in their living and situated relations with the world, within their multiple cultural, technical, and natural milieus. For biological, cultural, and technical differences — and *différances*, as this multiplicity is also related to temporalities [7] — have their own dynamics and contextualized *individuation* processes. The political position of taking the "matrix of biodiversity, noodiversity, and technodiversity" as an ethical standpoint is, we believe, to sustain and foster the conditions for the dynamic processes of the *individuation of diversities* [25–27].

This perspective must face contradictions inherent to the artistic practices and experiences of our time, including the *homogenization-hegemonization* of aesthetic experiences.

> To insist on the varieties of experience of art is not simply to identify the different aesthetic experiences that have become obvious today, but rather to penetrate into their variant forms of aesthetic thinking [...] This question, of course, applies to art, but also to thinking in its totality. The process of modernization qua technological globalization seems to have obliterated these differences. Like in Rem Koolhaas's generic city, a universal aesthetics arises out of the postmodern celebration of cultural rootlessness. [15, p. 27]

3 Performance and technical mediation

The question of *technodiversity* — and, in a more general sense, of *diversities* as discussed in the last section — intersects with the questions of *performance* and *technical mediation*.

Performance thought, articulated through the so-called performative turn of anthropology, may be a useful framework towards these diversities. At the same time, it might be related to similar celebrations of rootlessness and universality, while not in their most obvious and direct form.

Despite the numerous conceptions of performance, a certain unity exists among them. Conquergood identifies at its roots a *shift from mimesis to kinesis*, viewing culture as an active verb rather than a noun [5]. We can also consider a more general comprehension

of "humans, things and matter as not being fixed but in a process of changing and becoming" [22, p. xxx]. Or, more concretely in relation to art, as something that defies precise or easy definition beyond the simple declaration that it is "live art by artists" [9, p. 9].

While these notions do not account for the perception of hegemonic *cosmotechnics* or its effects on performance theory itself, both Hui's notion of *cosmotechnics* and the performative turn share a critique of static, object-centered views of culture, art, and technology[1]. Just as technics and technology exist only in relation to a specific cosmos, approaching art as performance can highlight the relationship between a performance's technics and its *milieu*.

A comprehensive definition of performance is a task that extends beyond the scope of this text[2]. Here, we adopt the definition articulated by Salter in *Entangled: Technology and the Transformation of Performance*: "the performing arts are really an unstable mixture amalgamating light, space, sound, image, bodies, architecture, materials, machines, code, and a perceiving public into unique spatiotemporal events" [22, p. xxii].

Acknowledging that performance resists strict definition, Salter also articulates its diversity of practices through seven characteristics that distinguish it from other artistic perspectives: (1) an interest in *enaction* or doing; (2) real-time, dynamic processes over static objects or representations; (3) engagement with the temporal moment of the present; (4) embodiment and materiality; (5) immanent experience; (6) the effect of both human and nonhuman presence; and (7) transmutation and reconstitution [22, p. xxiii].

Regarding the relationship between technology and performance, he first states that just as technologies are integral to the history of performance, performance is integral to the history of technologies. He then articulates the main questions of his book:

> It makes sense that we can put the artifice of technology on the stage to show the workings of the world and that humans can *act out* or *present* something in front of a spectator surrounded by that technology, but how can machines and substance, materials, and spaces perform, especially when they have no consciousness or intention? Why should we grant the human right of performance to inanimate things, especially ones that we have created? How can we confuse artistic performances with the performances of machines, not only in terms of their function or efficiency, but also through the attribution to them of embodied expression? [22, p. xxiii]

The questions raised by Salter point towards a deeper inquiry into the nature of performance and the human-machine dichotomy. Technical objects, since the advent of automata, have been perceived as having a certain degree of agency, even if not conscious or intentional. Furthermore, the divide between human, nonhuman, and technological beings has been blurred in contemporary artistic practices, where semiautonomous instruments/systems, prosthetically enhanced performers, mechanized human bodies, and synthetically/virtualized performers are increasingly common in diverse performance contexts.

These different *modes of existence* of technology and technics in performance, as well as the different relations between humans and nonhumans, contest pragmatic and utilitarian views of technology. They challenge traditional philosophical definitions of technology that see technical tools as "something to" [um zu], as neutral objects whose ready-to-handness [Zuhandenheit] would make them transparent to the human subject, who notices them only when their usefulness comes to be disturbed by a malfunction or breakdown [10, p. 66-70].

> Technologies are not simply inert or neutral artifacts that are, as Heidegger termed it, *ready to hand*: waiting for human presence to activate them and thus extend human action into the world, revealing and framing it in a particular manner. Instead, technologies are similar to Guattari's machine, constructing and ordering social-cultural-political relations. Technology does something in and to the world by modifying existing relations and constructing new ones between humans, tools, processes and the environment in which all are deeply entangled. [...] More to the point, the question I ask is how technology has mediated and scrambled meanings and categories among artists, events, and spectators, and in what specific contexts it has done these things. [22, p. xxxv]

Salter's perspective, here, relates to the discussion of *technical mediation* by Bruno Latour, who describes techniques not as mere *means*, "but mediators, means and ends at the same time" [19, p. 197]. Defying the widespread Heideggerian notion of technology, Latour, following a similar line of thought to Descola, Viveiros de Castro, and Tim Ingold, also disputes a central dichotomy in modern thought: the one between *humans* and *nonhumans* (in the sense, here, of technical beings). Technical action is a form of delegation that allows us to mobilize, during interactions, moves made elsewhere, earlier, by other actants" [18, p. 52] — an idea that strongly resonates with Simondon's notion of the *isodynamism* between the working mechanisms of machines and the dynamism of human thought:

> A relation of iso-dynamism exists between man who invents and the machine that functions [...]. The true analogical relation is in fact between the mental functioning of man and the physical functioning of the machine. [...] To invent is to make ones thought function as a machine might function [...] according to the dynamism of lived functioning, grasped because it is produced, accompanied in its genesis. The machine is a being that functions. Its mechanisms concretize a coherent dynamism that once existed in thought, which were that thought. During

[1] "According to performance studies, anything can be studied 'as' performance. That means asking performance questions of whatever is being studied. What happens? Where does it happen? How does it look, how does it behave, how does it change over time? What effects does the event or thing have on participants and observers?" [23, p. 12].

[2] For a more detailed discussion of this definition, see Carlson's *Performance: a critical introduction* [4].

> invention, the dynamism of thought converted itself into functioning forms. Inversely, the machine, in functioning, is subject to or produces a certain number of variations around the fundamental rhythms of its functioning, arising from its definite forms. [28, p. 11]

As Salter states, technology is integral to performance exactly because of this differed *mobilization*. Or, as Latour concludes in a more provocative way, because technical artifacts not only mediate our actions:

> ...if our challenge is to be met, it will not be met by considering artifacts as things. They deserve better. They deserve to be housed in our intellectual culture as full-fledged social actors. They mediate our actions? No, they are us. [18, p. 64]

4 Technical processes explored in four creative projects

In this section, we briefly present some aspects of four creative projects by the authors, highlighting the technical processes involved in their creation and performance: *aēr* (2024-...) and *afterlives* (2020), by José Henrique Padovani; and *facePiece* (2025) and *Toca* (2024-25), by Caio Costa Campos. Since each pair of pieces we have composed shares similar technical processes, we will discuss them side-by-side.

While the previous sections focused on *technodiversity* and *performance* from a critical-theoretical perspective, here we will concentrate on the practical technical-creative aspects that concretely engage with these concepts in our creation-research processes.

4.1 *aēr* and *Toca*: computer vision and real-time visuals

aēr (2024-...) and *Toca* (2024-25) are pieces that use interaction processes based on computer vision and real-time visuals to explore mediation and performance[3].

aēr is an ongoing creative project for bandoneon and a distributed interactive audiovisual system where separate computers handle the audio and visuals. The piece is performed by a bandoneonist whose movements are captured by a depth camera and processed by custom-built computer vision processes designed to track the instrument's varying features, such as its shape, inclination, and bellows compression. The visuals are projected onto a large screen behind the performer. The audiovisual setup includes two microphones, an interactive music system in Pure Data that also sends control data to the visuals, and a spatial audio system that spatializes the sound using *ambisonics*.

Two custom processes were developed for the piece: a computer vision process to track the bandoneon and a real-time control system for the game engine using network messages in the *Open Sound Control* (OSC) format.

For the computer vision processes, a Python script and a depth camera are used to capture the plane of the bandoneon bellows and the performer's hands. As the performer's legs are in this same plane, a predefined mask is applied to filter out irrelevant areas, yielding an image where only the instrument and hands are visible as a moving white blob. This image is blurred and thresholded to generate a clean binary (black and white) version that highlights the target shapes with less detail and noise. The subsequent processes are based on detecting features from the resulting white blob, particularly the shape, centroid, inclination, extrema, and compression of the bandoneon bellows (Figure 1). The extraction of these features follows a pipeline that begins by identifying the largest white area and simplifying its contour into a more manageable polygon. From this polygon, the system calculates the centroid to track the instrument's overall position, while a Principal Component Analysis (PCA) determines the main axis of the shape, which is used to infer the bandoneon's overall inclination. To analyze the bellows' state, the system identifies the two extreme points where this principal axis intersects the polygon. The line between these extremes is then virtually sliced by a series of perpendicular lines, dividing the main polygon into smaller segments. By analyzing the centroids and areas of these individual slices, the system derives advanced metrics, including the bellows' degree of compression and its curvature, which is quantified as a bend factor. Finally, all extracted parameters are continuously smoothed, normalized to a standard range, and transmitted in real-time to the game engine using OSC network messages, providing data to drive the interactive visuals and real-time audio processes.

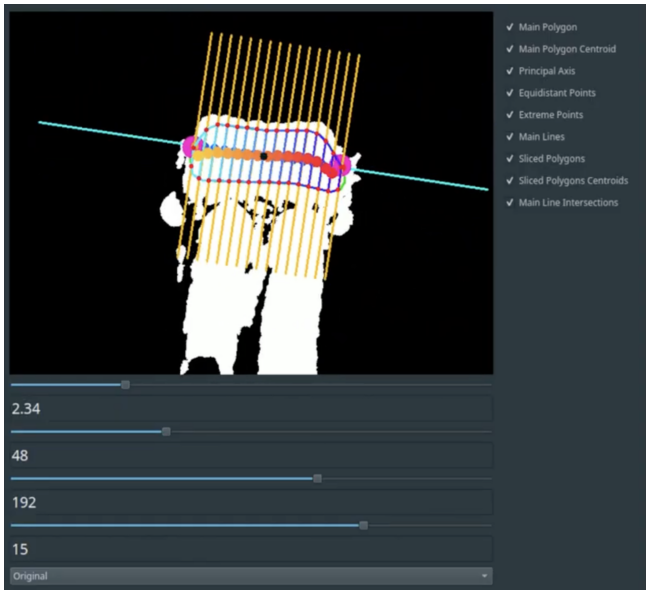


Figure 1: Computer vision processes explored in *aēr*

The visuals are programmed in the open-source game engine UPBGE, based on the open-source 3D suite Blender. As the game engine is not designed for *Open Sound Control* (OSC) messages, another custom Python script was developed to receive the OSC messages and convert them into the game engine's internal logic. This script allows, for example, the bandoneon's movement to change the properties of virtual objects in the game engine: for

[3]A video-performance of *Toca* (2024) can be found here. Its documentation, such as score and code, can also be found at eucaio.art



Figure 2: Visuals and computer vision interaction tests for *aēr*. Performer: Francisco Cesar.

instance, the bellows' compression and expansion can control the gravity of a scene, while the centroid position can control an invisible object that displaces leaves, creating wind-like effects (Figure 2).

Toca is a piece for guitar, hands, and interactive projection. It is performed in a blackout, employing an interactive system developed in Python and Processing that tracks and projects spotlights onto the performer's hands and parts of the guitar. At times, the spotlights follow the performer's hands or specific guitar parts. At other times, they illuminate parts of the instrument not being directly activated by the hands (Figure 3). This process creates assemblages of the performer's body, the instrument, their movements, the sounds produced, and their relations during the performance, which the piece explores as its primary material.

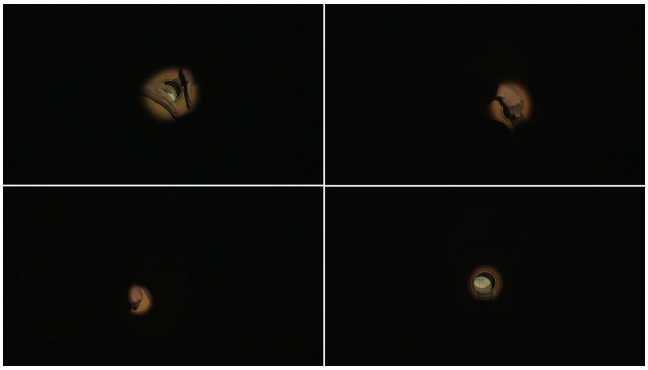


Figure 3: *Toca* frames, took from different moments of the piece

As in *aēr*, a depth camera is used in *Toca*. Instead of tracking the instrument's shape through custom set of instrument shape features, *Toca* focuses on tracking the performer's hands and parts of the guitar, particularly the soundhole. The strategy involves identifying blobs in the depth image that are closer to the camera,



Figure 4: Computer vision processes explored in *Toca*

as the performer positions their hands in front of the guitar during the performance. A similar strategy is employed to detect parts of the guitar, especially the soundhole (Figure 4).

This tracking data forms the basis for the projections, which are manipulated in real-time by a second performer using a MIDI controller. Following the score, this performer adjusts the size and position of the projected spotlights for two main purposes: first, to fine-tune the tracking and ensure the projections align correctly on stage; and second, to creatively alter the spotlight positions, occasionally illuminating parts of the guitar not being directly played, as specified in the score.

4.2 *facePiece* and *afterlives*: Tiling, Face Choreography, and Media-Specificity

facePiece (2025) is a piece for faces[4]. Fifteen performers were recorded individually, with a camera focusing on their faces as they followed a tablature detailing precise facial muscle movements and specific timing. All performers executed the same score, and their recordings are later synchronized and projected side-by-side with no sound (Figures 5 and 6). The projections feature the faces at the largest possible scale, constituting the work's presence as an installation.

The recordings were also compiled into a single video, with each face positioned in a grid. This alternative *montage* shapes the relationships between the faces differently, highlighting a key characteristic of the piece: its malleable articulation across multiple

[4]A video-performance of *facePiece* (2025) can be found here. Its score and other versions, such as documentation of its installation, can also be found at eucaio.art



Figure 5: *facePiece* frame, in its single video version for circulation online. Performers are doing their first open faces

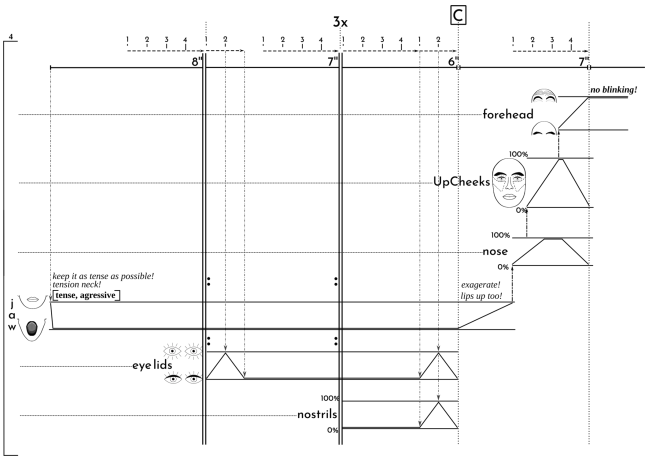


Figure 6: Fourth system of *facePiece*'s score, indicating which facial muscles should be activated at each moment. The score is accompanied by a video-score also indicating the timing of each movement with a click track.

contexts. This diversifies the potential relationships between the faces, the recording media, and the contexts in which it is presented.

afterlives (2020) is a piece for flute and an interactive audiovisual system, originally conceived for performance on a streaming platform, as it premiered during the first year of the COVID-19 pandemic [20]. In the original version, a flutist performs facing a webcam, and his image is displayed across 25 tiles on a screen resembling a video-call interface. The flutist's image and audio are captured and processed in real-time using continuously changing delay processes. These processes allow the performer's present image and sounds to be mixed with his past, transformed movements and sounds.

The video processing is achieved using a video buffer that stores frames captured by the camera. Each of the 25 tiles is programmed to continuously change its buffer position and brightness. Likewise, the audio is processed via phase vocoder and granular synthesis

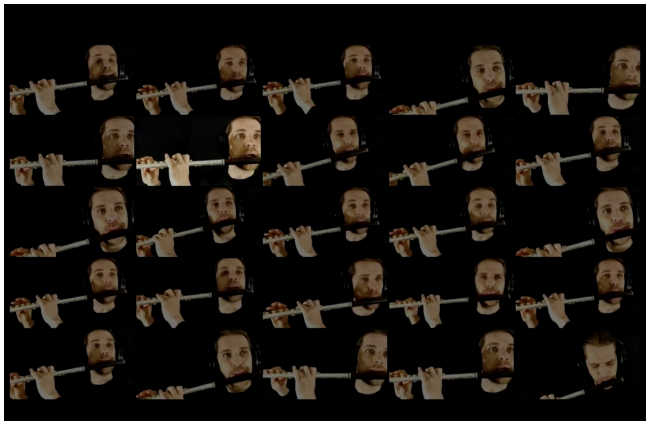


Figure 7: *afterlives* frame. Version for streaming platform performed by Gabriel Rimoldi.

techniques, which allow the live sound to be transformed in real-time by shifting it back and forth in time and altering its pitch and timbre.

The piece has also been adapted for the stage. In this version, the tiled screen is replaced by five distinct projection surfaces arranged on stage, onto which the performer's full-body image is projected in real scale. While the fundamental audiovisual processing system is unchanged, this adaptation incorporates video mapping techniques to precisely align the projections with the physical surfaces[5].

5 Technical mediation, performance, and technodiversity in the pieces

> Art is closely related to technology, and looking at technology from the perspective of art may be able to reveal something extraordinary. [15, p. 28]

The creative projects presented in the previous section are the practical and technical manifestations of the theoretical discussion in the earlier sections. As is often the case in research-creation processes and practice-based research methodologies, such aspects involve processes of technical and artistic imagination characterized by the need to create particular technical *artefacts* and strategies to enable the expressive intentions of each piece [2, 3]. Conversely, these technical mediation processes also inform and inspire new creative ideas.

Yet, such technical solutions and expressive intentions maintain a certain independence. While the first two pieces (*aēr* and *Toca*) share a similar approach in terms of resources and technical mediation strategies, mainly demanding the development of similar computer vision interaction processes, the expressive ideas that guide them are quite distinct: while *aēr* seeks to emphasize and make perceptible (in images and sounds) the malleable, sonorous, and airy qualities of the instrument and its manipulation by the performer, *Toca* explores the assemblages between the performer's body and the parts of the guitar in their articulations with its tradition of performance and idiomaticism.

[5]The "live" (stage) version of *afterlives* was not yet premiered.

In the creative process of *aēr*, this oneiric image of an instrument that bends and manipulates air guided the gradual and incremental process of experimentation, creation, and appropriation of algorithms and technical strategies. This involved researching depth cameras (Kinect versions 1 and 2, Arducam ToF Depth Camera), spatial plane segmentation techniques, developing techniques to extract visual features from the bandoneon's shape, and developing strategies to control the UPBGE game development environment via OSC commands.

On the other hand, *Toca* explores the poetic idea of composing a performance in which light projections onto the performer's hands and parts of the guitar guide the audience's perception in an automated and hyper-focused manner. In this case, the development of the computer vision processes was aimed to track these elements, enabling to project spotlights above them. While the tracking system articulates this automation, the presence of a second performer, who controls the size and position of the projected spots, diversifies the possible relationships between the generated assemblages.

In contrast, *facePiece* and *afterlives* explore different technical mediation strategies to achieve similar expressive intentions.

facePiece explores the time-deferred recording of each face following a precise temporality, prescribed in a tablature-like score, and synchronized in the installation's projection. *afterlives*, in turn, requires a fluid logic of real-time audiovisual processing, making use of video buffers, phase vocoders, and sound granulation processes.

While the technical mediation strategies are distinct, it is possible to say that both pieces have a similar "physiognomy": the performers' faces in *facePiece* and the flutist images in *afterlives* build textural relationships. Although the resources to achieve this are distinct, the continuous delay lines or the score prescription of facial movements allow for the creation of dynamic conductions and articulations based on the similarity and difference between the projected faces. This visual choreography not only articulates the media moment by moment but also reverberates in a formal/temporal dimension of the performances.

6 Conclusion and future work

The dissemination of technological objects and their use in different areas and contexts today is marked by the logic of capitalism and consumer society. In this context, *monotechnology* and *monoculture* tend to create a homogenization and a fetishization of technology, limiting its artistic and expressive potential. This tendency, in the field of art, points to a creatively sterile horizon in which the diversity and plurality of modes of imagination and artistic expressions are suffocated by a hegemonic, positivist, and one-dimensional view of artistic creation.

The ideas and practices related to the concepts of *cosmotechnics* and *technodiversity* allow us to think about these issues on a broader horizon and help overcome dualisms related to *culture* and *technology*, pointing to particular strategies of technological appropriation. Similarly, the rethinking of *performance* and *technical mediation* allows for a more active reworking of the relationship between technology and art and, at the same time, highlights that every creative project takes place in a situated and specific context. Espeicially in places regarded as peripheral in relation to the centers of technological development, these contexts demand their own technical and artistic articulations that, instead of merely following the latest trends and fashions from elsewhere, foster relational, situated, and diverse processes of techno-artistic invention [21].

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Digital Weight

The Invisible Environmental Cost of Our Online Lives

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ABSTRACT

Digital Weight is a research-informed media artwork that makes the "immaterial" internet materially legible. A looping video regenerates a near-identical image at a fixed cadence, while on-screen counters accumulate three quantities per iteration – electricity (Wh), carbon (g CO_2), and cooling water (mL). These values derive from published per-unit coefficients: energy per image for text-to-image inference, global grid-emission factors (≈ 480 g CO_2/kWh) [1], and data-center water-usage effectiveness (≈ 2 L/kWh) [2]. The method is simulation-based and auditable: verified coefficients are translated through transparent formulas into time-based perception, with impacts reported per fixed quanta (e.g., per million images) and illustrated through LOW/MID/HIGH scenarios. Conceptually, the work situates the cloud as material infrastructure (after Morton's hyperobjects [3] and Barad's entanglement [4]); practically, it turns technical metrics into an embodied, experiential form. The goal is not precision accounting but awareness – revealing the hidden physical cost of digital culture and inviting more responsible imaginaries for its future.

Keywords

Digital Infrastructure, Environmental Impact, AI Energy Consumption, Materiality of Data, Media Art, Techno-Ecology

1 Introduction

Modern life is increasingly digital, yet the perceived immateriality of "the cloud" is illusory: every stream, upload, or AI query triggers energy use, emissions, and water consumption across data center and network infrastructures. Peer-reviewed estimates place ICT's share of global GHG emissions at ≈1.8–2.8%, potentially ≈2.1–3.9% [5] when adjusting for supply-chain truncation – comparable in scale to aviation's direct CO_2 emissions [6]. Digital Weight responds to this awareness gap with a research-informed media artwork that renders digital externalities perceptible. The aim is to make digital sustainability both intellectually graspable and viscerally felt. By translating literature-based per-unit coefficients into a time-based artwork, the installation challenges the notion of "clean" or purely virtual technology and foregrounds our entanglement with energy, emissions, and water. The following sections cover theory, method (with per-unit coefficients), scenario bands and limitations, and the video implementation (Sections 2–8). This article documents the single-channel video version of Digital Weight; an optional on-site configuration with tablet interactions is described for completeness (Section 9).

2 Conceptual Overview

Our daily digital routines – a swipe, a search, a video stream or an AI prompt – seem weightless and ephemeral. **"The Cloud"** is an apt metaphor: nebulous, everywhere and nowhere at once, seemingly without substance. However, this *weightlessness* is a grand paradox. Philosopher Timothy Morton would call the global internet and data infrastructure a *hyperobject*, meaning an entity of such vast scale and distributed form that it defies our normal concept of a tangible thing [3]. Climate change is often cited as a hyperobject; in a similar vein, the internet's infrastructure is an unseen colossus humming in server warehouses and along undersea cables. We cannot directly perceive its mass, yet it has a massive physical presence and impact.

The convenience of frictionless digital activity belies the material entanglement behind every click. Karen Barad's theory of *agential realism* emphasizes that the virtual and material realms are deeply interwoven [4]. There is no strict boundary where the digital ends and the physical begins; rather, they *intra-act* as one system [4]. A simple web search or cloud photo upload triggers a cascade of physical events: light pulses traverse transoceanic fiber-

Published at Zenodo.org: https://zenodo.org/records/18762451

optic cables [7]; network gear and servers in data centers draw electricity and shed heat [8]; and cooling systems use water to remove that heat [2]. In Barad's terms, such processes expose the layered, relational nature of what looks singular on the surface – our "virtual" practices are materially co-produced [4]. In short, the digital **is** material. The climate impact of our gadgets and algorithms is not an externality separated from "real world" environmental issues; it is part of the same fabric of reality as melting ice or burning fuel.

Media scholar Kate Crawford underscores this point by describing modern artificial intelligence as *"an extractive industry"* [9] built on vast energy-intensive infrastructure. The mystical rhetoric of cloud computing often conceals its terrestrial roots. What feels like magic – asking an AI a question or instantly streaming a film – is actually enabled by mines, power plants, server farms and undersea cables. As Monserrate argues, the *cloud is material* [10]; a vast, resource-intensive infrastructure with tangible ecological effects. In reality, today's digital cloud is firmly grounded: IEA estimates data centers used ~460 TWh in 2022 [11]. In 2024, data centers together with AI and crypto are estimated to account for ~1.5% of global electricity, with rapid growth expected [8], placing them among the largest power users on the planet. These facilities are fed by electricity (often from fossil fuels) and water in enormous quantities. A recent MIT News explainer estimates that each kilowatt-hour consumed by a data center requires about 2 liters of water for cooling [2]. Multiply that by the millions of kWh used daily and the invisible water footprint becomes staggering. In 2022, Google's data centers used about 5 billion gallons of water, according to its 2023 Environmental Report, which lists a total water use of 5.6 billion gallons across all operations [12], a figure expected to grow with the rapid expansion of AI workloads. Likewise, the carbon footprint of "invisible" AI computations is massive. Training a single large AI model can emit hundreds of tons of CO_2. For example, creating OpenAI's GPT-3 model (175 billion parameters) consumed ~1,287 MWh of electricity and generated 552 tons of CO_2 [13] – equivalent to the annual emissions of over 120 typical cars (a typical passenger vehicle emits about 4.6 metric tons of CO_2 per year [14]). Yet these costs remain hidden from users, folded into abstract cloud "services."

By drawing on Morton's, Barad's, and Crawford's insights, Digital Weight frames our digital ecosystem as a planetary-scale system with very tangible impacts. We marvel at the sleekness of our apps and the marvels of AI, but the **weight** of these wonders is carried elsewhere – in remote server warehouses, in mining communities, in our atmosphere and water systems. The installation's conceptual mission is to make this paradox palpable. It asks: How might we experience the true scale of the cloud? How can we render its invisibility visible? The next sections describe how these ideas are translated into an artwork that pairs data with sensory experience, turning cold facts into an affective encounter with the cost of our online lives.

3 Methodology

The project employs a simulation-based, research-informed methodology. Each on-screen iteration is treated as one generative event, and three independent counters (electricity, CO_2, cooling water) advance in real time from literature-based per-unit coefficients. Concretely, the model maps: energy per text-to-image inference set to ≈ 0.0029 kWh per image, derived from Luccioni et al. (2024), who report 0.06–2.9 kWh per 1,000 inferences for multimodal tasks, with Stable Diffusion XL at the upper bound (≈ 2.9 kWh/1,000) [15], a global average grid emission factor of ≈ 480 g CO_2/kWh (Ember 2024, Global Electricity Review 2024 [1]), broadly consistent with the ≈ 438 g CO_2/kWh from Our World in Data [16], and data center water-usage effectiveness (WUE), communicated as ≈ 2 L/kWh [2], with methodological background and site variability detailed by Li et al. [17]. The aim is communicative clarity rather than precise auditing: order-of-magnitude reasoning is employed with disclosed assumptions and ranges. Methodologically, the work links ecological media art with scientific modelling by translating technical coefficients into an embodied, time-based experience; practically, units remain separate (no false aggregation across Wh, g CO_2, and mL), enabling viewers to inspect how values accumulate over time.

4 Method for On-Screen Counters

Let the loop run at rate r images/s for T seconds; total iterations are $N = r \cdot T$. We fix literature-based coefficients for clarity: e_img = 0.0029 kWh/image (≈2.9 Wh), EF = 480 g CO_2/kWh (0.480 kg/kWh), WUE = 2 L/kWh.

Electricity: $E = N \cdot e_img$
Emissions: $CO_2 = E \cdot EF$
Cooling water: Water = $E \cdot WUE$

Example (8-minute loop, $T = 480$ s; $r = 2 \Rightarrow N = 960$):
$E = 960 \cdot 0.0029 = 2.784$ kWh (≈2.8 kWh)
$CO_2 = 2.784 \cdot 0.480 = 1.336$ kg (≈1.34 kg)
Water = $2.784 \cdot 2 = 5.568$ L (≈5.57 L)

Because the equations are linear, doubling r or T doubles all totals.

Figure 1 shows two consecutive frames of the simulation (#001, #002). Each on-screen iteration functions as one generative unit; the electricity, carbon and cooling-water counters increment in real time according to the coefficients above.

5 Scenario Bands (AI images only, daily and annual illustration)

To give order-of-magnitude context where platform-level volumes are undisclosed, impacts are reported per one million images and illustrated with LOW/MID/HIGH activity bands. The MID band (10 million images/day) is a reasonableness check: it corresponds to ~10 million daily active users each generating ~1 image, which is plausible relative to ~5.5 billion internet users worldwide [18] and surveys reporting frequent daily interaction with AI (Pew Research Center, 2024 [19]). For context, Adobe reports that generative AI consumption reached approximately 29 billion generations in the quarter (Q3 FY25) [20]. Totals scale linearly and can be rescaled to alternative volumes.

6 Beyond Images

Still images provide a conservative baseline. Heavier modalities (text-to-video, upscaling/interpolation, live transcoding/CDNs, cloud gaming) often require substantially more compute and data per second, depending on the pipeline. Background loads (always-on LLMs, large-file e-mail/collab, sync/backups, 3D/NeRF/AR) add further demand. We therefore use images as the baseline and reference video via frame-equivalence as an upper-bound illustration.



Figure 1: Two consecutive frames (#001, #002) from Digital Weight. Each iteration represents one AI generation cycle; counters for electricity, CO_2, and cooling water increase cumulatively. AI-generated images created by Jekaterina Kaizere in Adobe Photoshop (Firefly, Generative Fill), 2025. Licensed under CC BY 4.0.

Table 1: Scenario bands for AI image generation (per day and per year). Results are illustrative and scale linearly.

Scenario	Images/day	Energy (MWh/day)	CO_2 (t/day)	Water (kL/day)	Energy (GWh/year)	CO_2 (kt/year)	Water (ML/year)
LOW	1 M	2.9	1.39	5.8	1.06	0.507	2.12
MID	10 M	29	13.9	58	10.6	5.07	21.2
HIGH	100 M	290	139	580	106	50.7	212

[a] Central coefficients fixed for clarity: $e_img = 0.0029$ kWh/image; $EF = 0.480$ kg CO_2/kWh; $WUE = 2$ L/kWh. kL = kilolitres, ML = megalitres. Totals are illustrative, not measurements; see §4 for method.

7 Limitations

Per-unit factors vary by model, accelerator, batch size, data-center design, cooling technology, and local grid mix. Platforms do not disclose global generation volumes; our LOW/MID/HIGH bands are illustrative and reported alongside per-million impacts and full formulas. The text-to-video factor uses a frame-equivalent upper bound and likely overstates pipelines with latent/keyframe reuse. Streaming/gaming factors reflect server-side and network averages. All totals scale linearly with activity; readers can rescale to alternative volumes or regional EF/WUE. Our objective is to communicate scale and uncertainty transparently, not to claim precise accounting.

8 Visual Installation Description (online screening)

Digital Weight is presented as a single-channel video loop. At first glance, the piece appears minimal – just a simple image with hardly any visible change – yet every frame is an actual generative pass. The current cut runs 8 minutes at 2 fps (0.5-second cadence), totaling 960 individually generated frames. To ensure methodological consistency and reproducible values, the loop is rendered as a fixed sequence rather than a live generative feed, so that numerical increments remain precisely aligned with the coefficients defined in § 3–4. Per frame, three on-screen counters advance cumulatively: electricity, carbon, and cooling water, computed from the fixed per-unit factors. Counters are simulation-based – no live telemetry is used. The aesthetic is deliberately minimal: an almost static image with steadily climbing numbers, making the previously invisible resource consumption perceptible. The video's slow cadence invites reflection on scales beyond human perception. An understated audio layer reinforces the infrastructural tone: a quiet low-frequency hum and a subtle tick marking each generative cycle.

9 Optional On-Site Extension (informative)

Note. This article documents the single-channel video version presented at ARTECH; the on-site configuration below is provided for future exhibitions.

Layout. Two zones: a large single-channel projection and a compact tablet area to the side. The projection shows a subtly changing loop at a fixed cadence; pre-rendered on-screen counters and simple gauges increment at the loop cadence. Aesthetic is intentionally restrained – near-static picture, steady numbers, legible typography. Sound is kept minimal to avoid interfering with conversation.

Tablet interactions (1–3 min each).

Your Digital Shadow: a quiz-like interaction invites visitors to enter everyday habits – e.g., cloud photo backups, email volume – and returns a simple, annualized footprint summary. Results are framed with relatable analogies to keep the tone eye-opening rather than accusatory. The outcome is a personal "shadow" card that turns invisible routines into something visible, making them open for discussion.

The Cloud Unveiled: an animated explainer asks: "What happens when you upload a photo or ask an AI a question?" A single "byte" is followed from device to server and back. Along the route, small counters illustrate the idea that networks and servers draw power, shed heat, and require cooling. Tap-to-learn hotspots briefly introduce components without technical overload.

2050: Digital Choices: a short interactive story places the visitor in a near-future scenario where digital demand meets environmental limits. Micro-decisions (prioritize comfort vs. conserve during a heatwave, allocate scarce water across competing needs) lead to immediate, visual feedback. The goal is to surface trade-offs and invite reflection on present-day habits.

Accessibility. High-contrast UI and large tap targets on tablets; projection text sized for room viewing.

10 Conclusion

Digital Weight combines art, data, and interactivity to emphasize a single message: our "light" digital lifestyle carries a heavy hidden cost. By making the invisible visible – through evocative imagery, theoretical framing, and personal engagement – the project encourages a more mindful relationship with technology. The installation does not argue for abandoning digital innovation; rather, its aim is to spark awareness and dialogue about the energy, minerals, water, and carbon bound up in our apps and clouds. In confronting the audience with the tangible scale of these impacts, Digital Weight aligns with emerging calls for "digital sobriety" and sustainability in technology. The hope is that

viewers leave with a newfound sense of digital responsibility and empowerment. Just as the artwork illuminates unseen connections between their screen and the planet, it also suggests that small individual choices – multiplied across millions – can lighten our collective digital footprint. By bridging conceptual understanding and emotional experience, Digital Weight illustrates that the future of our online lives must account for, rather than ignore, the environmental weight they bear.

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Espionage and Dataveillance Technologies: Perspectives on Sound Surveillance in Surveillance Art Practices

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Abstract

This article explores the relationship between art and surveillance technologies, with a particular focus on the sonic dimension of surveillance and its intrinsic connection to espionage. Beginning with an introduction to Foucault's conception of surveillance as a mechanism of control over bodies and behaviors, the paper argues that, in contemporary society, this practice has become increasingly sophisticated through the voluntary collection of digital data and what Rouvroy and Berns term "algorithmic governmentality." The second section discusses the development of surveillance technologies and their social impacts, illustrated by examples from surveillance art, including works by Bruce Nauman, Jill Magid, and Marie Sester. The third section addresses sound surveillance as a less explored domain compared to visual surveillance, analyzing it both theoretically and through artistic practices. Here, the studies of Dimitrios Pavlounis and Audrey Amsellem are highlighted, alongside artworks situated within the concept of surveillance art, such as Roslyn Orlando's and Kyle McDonald and Brian House's artworks, which critically examine the vulnerability of sonic privacy perpetuated by major technology and communication companies. The article contends that sound surveillance remains strongly associated with espionage and illegality, in contrast to the normalization of visual surveillance propagated by CCTV systems. Finally, the paper cautions that the increasing integration of AI and automation into everyday life entails the acceptance of more invasive forms of surveillance and bodily control.

CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts; Computer forensics; Surveillance mechanisms; Arts and humanities; Sound and music computing;

Keywords

Surveillance Art, Sound Surveillance, Artificial Intelligence, Espionage

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1 Introduction

This article presents a study on the art and surveillance technologies, aiming to advance a perspective on the role of sound within this scope to argue that sound surveillance is intrinsically linked to the act of espionage. For this understanding, it is first essential to define the idea of surveillance before proceeding to discuss how contributions in the fields of art and surveillance address surveillance technologies, as well as their sound dimensions. The understanding of surveillance here refers to the act of obtaining information about an individual or group of individuals, whether voluntarily, coercively, or through espionage, in order to gain some form of advantage over them. This understanding of surveillance is primarily based on Foucault's The History of Sexuality, Volume 1 [1], in which he explains how the act of confession imposed by the Christian Church since the Middle Ages functioned as a method of surveillance for the control of bodies, including the regulation of birth control. The act of confession, mandated as an obligatory practice for the Christian subject, functioned as a means of extracting intimate personal information, thereby enabling the exercise of power and control over the confessing body. It is possible to observe that this confessional methodology, once managed by the Church, has not been extinguished but rather transformed. Today, we are persuaded to voluntarily offer our personal information on websites and apps in exchange for connectivity, social interaction, or approval from others. This situates us within a technologically more sophisticated form of surveillance, as discussed in the theories of algorithmic governmentality by Antoinette Rouvroy and Thomas Berns [2]. Contemporary data surveillance via the internet is capable of knowing us to such an extent that those who control our data gain a significant advantage in influencing our behaviors and thoughts.

The approach used to argue that sound surveillance inherently embraces qualities related to espionage will be developed through bibliographic examples that discuss the contexts in which sonic surveillance technologies have been applied, drawing on the surveys by Steve Wright [3] and Audrey Amsellem [4]. Additionally, the dissemination of the collective imaginary about sound surveillance technologies through media will be examined based on the studies of Dimitrios Pavlounis [5]. Finally, artistic examples addressing sound within the realms of surveillance art will be analyzed

through the works of Roslyn Orlando and Kyle McDonald and Brian House.

These sources were selected for being consistent studies that specifically address sound surveillance within the humanities, a topic that remains less explored compared to surveillance studies focusing on the visual field, a premise that will be further discussed throughout this article. The same applies to artworks that engage with sound in the context of surveillance art, where only a limited number of examples currently exist. Both the bibliographic and artistic references on sound surveillance complement each other, allowing for a discussion of sound surveillance aspects related to espionage practices involving both institutional and techno-corporate power.

2 Surveillance Art as Technological

When positioned within the field of surveillance studies, artistic practice is, or may come to be, classified under terms such as art and surveillance, artveillance, or surveillance art. These designations all refer to the same phenomenon: artistic practices that critically engage with the subject of surveillance. The investigation into the relationship between contemporary surveillance art has been approached from the perspectives of visual arts, performance, new media, photography, cinema, surveillance aesthetics, and art activism. These approaches are reflected in key references such as the exhibition catalogue CTRL [SPACE]: Rhetorics of Surveillance from Bentham to Big Brother published in 2002, as well as in the ongoing discussions and contributions published in the journal Surveillance & Society.

As Andrea Brighenti [6] has stated, surveillance not only generates substantial social control or social triage, but also produces a collective imaginary of what constitutes security, insecurity, and control, as well as the landscape of moods and affects expressed by a surveillance society. According to Brighenti, surveillance art is a domain that considers art as technological, that is, it is always connected to a technology of production as well as a technology of mediation and remediation. This reflection can be followed through the extensive Michel Foucault's study Discipline and Punish [7], which analyzes the apparatus of surveillance, an activity comprising methods, procedures, and techniques carried out by humans supported by a panoptic architecture. Foucault offers a profound perspective on how surveillance can be understood as a strategy to maintain control over bodies, rendering them docile and disciplined. While Foucault did not explicitly address surveillance technologies such as cameras or electronic devices equipped with wiring and electronic components, the theoretical framework he developed around the panopticon has been widely applied in contemporary analyses of electronic surveillance. For example, Zygmunt Bauman's [8], concept of post-panoptic surveillance, characterized by invisible data monitoring in the context of the Internet era, demonstrates the continued efficacy of surveillance mechanisms in exercising control over bodies.

From the development of surveillance technologies, we can observe Brighenti's [6] assertion that surveillance art engages in discussions about how surveillance expresses a surveillance society according to its temporal and technological context. The term "surveillance society," coined by Gary T. Marx [9] in the 1980s, visualizes the full behavioral control of citizens through computer-based surveillance technologies employed by the state, raising critical concerns about the misapplication and abuse of power. It is important to highlight that, at the time Marx developed this concept, CCTV (closed-circuit television) surveillance technologies were becoming increasingly popular in both public and private spaces. This device subsequently became a technological symbol of surveillance within the field of art and surveillance.

The following section presents key examples of surveillance artworks exhibited in internationally recognized galleries. As Brighenti suggests, art and surveillance practices reflect the conditions of the surveillance society and the technological developments of a specific time and place. Since the 1970s, cameras have been integral to the field of surveillance art. In subsequent decades, artistic practices have progressively incorporated emerging surveillance technologies, demonstrating an evolution from optical observation toward more complex forms of data-driven monitoring that encompass Big Data analytics, algorithmic computation, and artificial intelligence.

In the field of surveillance art, numerous artworks employ surveillance cameras, such as the seminal piece in surveillance art Live- Taped Video Corridor (1969–70) by Bruce Nauman. According to Dörte Zbikowski [10], Nauman was one of the first artists to explore the use of surveillance cameras. This installation explores the technical potential of the surveillance camera through a spatial, emotional, and interactive setup, creating a tension between physical presence and real space, and the image of the real space surveilled and manipulated by the camera. Other examples of artworks that engage with surveillance through the scope of CCTV include works by the artist Jill Magid, such as *System Azure Security Ornamentation* (2002) [11], in which the artist subverts the security function typically attributed to the surveillance camera by assigning to this device a personal, intimate, and comic perspective, where the ornamentation of CCTV serves as a means to foster a connection between the surveilled person and the device that watches them. Perhaps one of the most renowned and recent examples incorporating CCTV within the field of art are the works of Banksy (Figures 1 and 2). In these pieces, Banksy employs cameras installed on walls to disrupt the banal perception of this device within the urban landscape, transforming it into a critical focal point that both recalls and reconfigures its presence and function as a mechanism for surveilling public spaces.

Beyond surveillance cameras, we find examples of surveillance art that relate to technologies that are more intrusive, such as genetic surveillance, as critically addressed by Heather Dewey-Hagborg in her work Stranger Visions (2013) [12]. The piece draws attention to the extent to which DNA samples can be used to infer a person's appearance, while also warning of the potential errors involved in treating such data as a reliable basis for developing facial prediction technologies in forensic research, where stereotypical projections could lead to forms of genetic determinism. The issue of stereotypical predictions generated by algorithms based on datasets captured through surveillance technologies (dataveillance on the Internet) is also explored by Trevor Paglen and Kate Crawford in their exhibition Training Humans (2019) [13]. In this exhibition, they reflect on and raise critical concerns about how AI and machine



Figure 1: Bansky, untitled. https://www.banksy.co.uk/



Figure 2: Bansky, untitled. https://www.banksy.co.uk/

learning technologies are trained to read the world, producing problematic interpretations and classifications of human beings. The artistic installation reveals how a massive quantity of images (datasets), collected from online sources, including social media platforms, serves as the basis for generating patterns of meaning, leading not only to misclassification but also to distorted forms of judgment, such as racism, misogyny, ableism, and sexism. It opens up a critical discussion about how such technologies can impact our daily lives.

The technologies of surveillance or *tracking technologies* as described by Levin, Frohne, Weibel [14], have transitioned from a military context to the domestic sphere. Foucault's panoptic surveillance paradigm has evolved into what Paula Sibilia [15] terms data-surveillance, a form of digital monitoring characterized by the invisible surveillance of data circulating through the global internet network. Today the enhancement of AI technologies for automation and profitability, or simply convenience, speed, and efficiency, the use of tools and services that rely on data surveillance has become indispensable. Such reliance is now a prerequisite for performing everyday tasks and communicating at a pace dictated by the compulsive scale of contemporary production and consumption. Within a contemporary discussion on how surveillance is intricately tied to the current capitalist mode of life, Shoshana Zuboff [16] reflects that user behavioral data from internet navigation has become an indispensable resource for companies to generate profit. She coined the term surveillance capitalism to assert that, through the constant monitoring of browsing data by companies managing websites, applications, and online services, this big data possesses immeasurable value, which, through algorithmic interpretation, enables the achievement of diverse financial objectives.

Profit generation is no longer the sole function of big data utilization by companies today. Alarmingly, with ongoing armed conflicts and the persistent advance of neocolonialism, we are witnessing a pronounced resurgence of the military context in the development of contemporary and sophisticated surveillance technologies, increasingly shaped by artificial intelligence. As Krzysztof Sliwinski explains.

> "AI is heavily used in systems that integrate target and object recognition and geospatial intelligence. Analysis of satellite images, geolocating and analysing open-source data such as social media photos in geopolitically sensitive locations. On top of that neural networks are used, for example, to combine ground-level photos drone video footage and satellite imagery." [17]

We are currently witnessing the use of warfare technologies developed with the assistance of AI, such as Lavender and The Gospel, employed by Israel to generate potential targets on an unprecedented scale. This raises a series of moral and legal concerns regarding the deployment of such technology in alignment with military operations. At the time of writing this article, no scientific bibliographic sources analyzing or specifically addressing the technologies The Gospel and Lavender have been identified. However, journalistic reports provide research into how these surveillance technologies operate and are being deployed. The report produced by Al Jazeera Media Network (2023) [18] describes that The Gospel identifies targets through multiple operational layers, which are briefly outlined as follows: The Alchemist, which collects information from a database of surveillance devices in both physical and digital spaces; Fire Factory, which analyzes the collected data; and The Gospel itself, which generates potential targets perceived as threats to the State of Israel. According to the same report, the targets generated by the AI are subsequently reviewed by human operators, who decide whether to authorize airstrikes on locations that include not only military infrastructure but also civilian buildings and public service facilities such as schools and hospitals. This process results in a high scale of collateral damage of the deaths of civilians.

The interactive installation Threatbox.us (2005–2007) [19] by Marie Sester is a notable reference in the area of surveillance art, addressing surveillance technologies that are present in both contexts of warfare and mass entertainment. The installation consists of a web-based surveillance interface, in which a robotic video projector and a computer vision tracking system identify a target and 'attack' it using a spotlight and a loud, startling noise. The spotlight follows the target if it attempts to escape. A montage of violent film excerpts, individuals using social media, and computer games unfolds in fluid patterns across the walls, ceiling, and floor, accompanied by immersive and aggressive audio. After a few seconds, the projector returns to the wall, resumes playing the videos, and becomes ready to detect the next person. Surveillance cameras

embedded in the installation stream the scene live to the web, displaying the space, its audience, and the attacks. Online users act as voyeurs, with no possibility of interaction or intervention.

Marie Sester's artwork raises important questions about the current facets of surveillance technologies, where the same medium, the web, serves simultaneously as a space for content creation, mediation, and surveillance. It also offers a critique of how social media exposes and disseminates information. As online users, or voyeurs, watch scenes that are both tragic and entertaining, the stark contrast between these types of content, rapidly scrolling through news feeds, causes emotions such as sadness, anger, joy, or amusement to become diluted in the short span of time during which content is consumed.

Beyond the visual-centric perspective of surveillance art, where image capture, reproduction, creation, and analysis are foregrounded, it is also possible to identify artistic practices that engage with surveillance technologies through sound. The following subchapter presents an overview of how sound surveillance technologies are currently being employed, as well as a discussion on how sound is explored by artists and artworks that critically address issues related to surveillance technologies.

3 Sound Surveillance and espionage

In the study of surveillance art, it becomes evident that closed-circuit television (CCTV) cameras have been extensively explored as a device for representing and critically examining the implications of surveillance technologies on human behavior and ways of living. Much of this is due to the increased use of surveillance cameras in urban contexts. As Julie K. Petersen [20] notes, since the 1980s, the growing presence of CCTV devices has spread across public spaces such as squares, subway stations, and parking lots, as well as private spaces including banks, commercial establishments, buildings, and residential complexes. This device became an element that integrated and still integrates the urban landscape today.

In contrast, sound surveillance technologies, also referred to as audio surveillance our sonic surveillance, have followed a different trajectory. According to Dimitrios Pavlounis [21], such technologies have existed since the 1910s, beginning with recording systems that employed dictaphones and magnetic tapes. The use of wiretapping technologies or microphones installed in private and public spaces has traditionally been associated with espionage, particularly by professionals such as detectives and security authorities who possess the technical expertise to operate such devices. These individuals are also trained to manipulate recorded audio by removing noise in order to better isolate and interpret the sounds of the surveilled subject. As a result, unlike video surveillance cameras, sound surveillance devices have not been widely popularized, since their use has remained largely confined to covert operations and cases of espionage carried out by specialized individuals or groups.

From this perspective, Petersen [20] explains that the technique known as "listening" is primarily associated with sound surveillance of the human voice. It involves covert, clandestine, and investigative access to conversations that may be intercepted through physical lines, such as telephone wiretaps, or wireless networks, including radio frequencies or microphones placed in specific environments. As Petersen [20] states, a listening device is any device designed to channel, focus, or amplify sounds to help the listener better recognize the characteristics or content of the sounds.

An example of the high level of sound surveillance capabilities can be observed in the existence of the international espionage network known as ECHELON, which has been employed by government intelligence agencies since the 1940s. Duncan Campbell [22], investigative journalist, made the existence of the ECHELON surveillance network public in 1988. As reported by Campbell, ECHELON was:

> "Originally established the vast international global eavesdropping network has existed since shortly after the second world war, when the US, Britain, Canada, Australia and New Zealand signed a secret agreement on signals intelligence, or "sigint". It was anticipated, correctly, that electronic monitoring of communications signals would continue." [22]

According to Steve Wright [23], ECHELON operates through a global infrastructure of facilities, including stations recognizable by their huge antennas. These are used by the U.S. National Security Agency (NSA) for the mass surveillance of electronic telecommunications, including telephone, fax, and email, through keyword and contextual filtering. By diverting messages transmitted via satellite, microwave relay links, or fiber-optic cables, this surveillance system is capable of operating at a prodigious rate, processing more than two million intercepts per hour.

The context of espionage and forensic activity related to sound surveillance is examined by Pavlounis [21] through the lens of popular imaginaries shaped by cinema. Films such as The Conversation (1974), directed by Francis Ford Coppola, and The House on 92nd Street (1945), directed by Henry Hathaway, portray scenarios in which sound surveillance is employed by professional detectives, law enforcement officers, and intelligence agents in cases involving murder investigations and espionage operations. These cinematic narratives often reflect real-world historical events, such as the Watergate scandal of the 1970s, which involved wiretapping under the administration of former U.S. President Richard Nixon. This scandal was dramatized in Alan J. Pakula's All the President's Men (1976), highlighting the characteristics contained in the popular imagination about espionage involving police investigation and scandals involving public persons through sound surveillance.

The espionage character of sound surveillance predates even electronic and digital technologies. As introduced by Dörte Zbikowski [24], the act of covertly listening, of lying in wait to hear secret sounds, has long relied on simple tools such as horns, seashells, or even hands cupped behind the ears to enhance auditory perception. This practice eventually evolved with the use of microphones, or what Zbikowski refers to as "bugs," a term that emerged in the 19th century to describe devices used for eavesdropping and information transmission. In this context, the term "bug" metaphorically conveys the invasive, unwelcome presence of an insect or fly that feeds off its host, being these bugs, sound surveillance technologies, increasingly smaller and portable. Borrowing from Zbikowski's interpretation, we may argue that today's 'bugs' are our smartphones: portable surveillance technologies whose presence is no longer unexpected. Instead, the rhythm of contemporary life embeds these

devices into our daily existence, making constant surveillance a normalized and mobile condition.

Artworks within the field of surveillance art that engage with sound surveillance enabled by smartphones and portable computers serve to raise awareness, denounce, and critically examine how such surveillance practices challenge notions of privacy or the lack thereof and reveal the power structures behind these technologies. One such example is Evasion Score (2021) [25], a project by artist Roslyn Orlando in which she develops an instructional score designed to help individuals evade the sound detection of words and phrases by their smartphones. The score, accompanied by a demonstrative video, teaches vocal modulation techniques that mask spoken language, thereby preventing detection by sound surveillance systems operated by corporations and tech companies, what the artist refers to as systems of power.

Another example is the artistic intervention Conversnitch (2013) by Kyle McDonald and Brian House [26], who developed a listening device disguised as a light bulb or lamp, which they installed in public places with Wi-Fi access, such as restaurants, libraries, and banks in New York City, Manhattan, and Washington, D.C. Fragments of conversations captured by the microphones embedded in these devices were recorded, transcribed, and posted to the social media platform Twitter (at present X). The transcription process was carried out using Amazon Mechanical Turk, a paid crowdsourcing service. Among the critical issues raised by this intervention, the artists highlight the ease with which illegal surveillance can be conducted with the aid of outsourced crowdsourcing services, as well as the concern over the loss of control individuals have over their own privacy. The work also requires reflection on potential illegal ways of using commercial products and services found online, particularly in relation to unauthorized audio surveillance.

The artistic works exemplified reveal the real potential for sound surveillance that can be managed by technology companies, highlighting how vulnerable we can be to this type of surveillance when using smartphones or gadgets. Practices of sound espionage through technology, as well as Internet of Things (IoT) devices like Amazon's Alexa or even the use of Facebook, have been increasingly discussed by researchers. Audrey Amsellem's recent study explores how this sound espionage is conducted via the Alexa virtual assistant and reflects on the experiences of users who notice signs that they are being spied on. Amsellem [4] clarifies that Amazon, the company behind Alexa, has been employing human workers to listen to fragments of voice commands from Alexa users in order to improve the machine's ability to better understand voice commands.

Although studies like Amsellem's confirm that Alexa users' voices are being monitored, these devices continue to be sold, with concerns about the potential for sound surveillance and privacy loss only arising when Alexa users encounter issues such as "bugs" in the device. These bugs include situations like receiving advertisements for products after talking aloud about needing the same product near the device or, for example, when Alexa unexpectedly starts laughing with a voice different from its own. When users lose control over the device, Amsellem [4] reflects that the fear of using this device, which users themselves have chosen to place inside their homes, creates a sense of anxiety and an uncanny encounter. This leads users to question: Is this device constantly spying on me? Unplugging the device may result from this anxiety.

However, despite evidence confirming the presence of sound surveillance in the devices we constantly carry with us, we continue to use them. The question that remains is whether the privacy concerning sound data, especially our voice, will lose its relevance as sound surveillance becomes increasingly normalized in the name of AI development.

4 Final considerations

We can observe in the discussions presented in this article that the field of surveillance art refers closely to a form of technological art, as discussed by Andrea Brighenti. The artworks cited here are developed through the use of, or reference to, technological surveillance devices. These works provoke reflection on the relationship between the subject and the surveillance apparatus, the behavioral changes these technologies induce, and the power relations between the watcher or listener, who holds access to information, and the watched or heard body. They also address the ongoing enhancement of increasingly invasive surveillance technologies, which are central themes explored by the artists.

Within the specific domain of sound surveillance, a close connection to espionage practices emerges. Historically, audio surveillance has been employed in closed contexts such as criminal investigations, high-technology surveillance operated by specialized labor, and illegal monitoring. This dimension is evident in artistic practices that focus on acoustic surveillance as their primary conceptual axis. In these artworks, "bugs", microphones embedded in devices, as explained by Dörte Zbikowski, are emphasized as receptive apparatuses that eavesdrop on conversations in order to extract personal information, which can later serve to benefit individuals, institutions, or corporations. While image-based surveillance may also operate in espionage contexts, it has been normalized to the realm of banality, specifically due to the common practice of sharing personal images on social media platforms. In contrast, the perception of being acoustically surveilled still evokes associations with a nature of espionage, illegality, and monitoring of intimate information.

We are increasingly asked to accept AI as the defining technology of the future and adapt to a lifestyle where automated systems will be widely integrated into our daily routines. This tendency is already visible in the widespread use of tools such as ChatGPT, which exemplify the ability of AI systems to produce a broad spectrum of predictive and generative outputs. Accepting such mechanisms of automation implies accepting the mass surveillance currently implemented, as well as its intensification, in order to sustain the functioning of artificial intelligence, machine learning, and deep learning systems. This prompts reflection on the potential future dynamics of control and power shaped by machines operating through data surveillance and what implications these might hold in contexts such as economic and political crises, environmental collapses, or even armed conflict.

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Reframing Surveillance: Generative AI and the Fictionalization of Machine Vision

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Figure 1: Left:*Synthetic Punctum* (2024) is an image-based artwork generated from surveillance content; Right: *Mirage* (ongoing) is an experimental video generated from surveillance content around the world.

Abstract

This paper explores how generative AI transforms surveillance imagery from functional documentation into narrative-driven visual content through two artistic projects: *Synthetic Punctum* and *Mirage*. We recontextualize surveillance footage into sites of imaginative fiction. *Synthetic Punctum* converts street surveillance into memory-like images evoking historical texture, while *Mirage* interpolates fictional sequences within real-world surveillance streams across global cities. These projects reveal generative AI's capacity to function as a cultural mediator that restructures visual authority and challenges boundaries between reality and fiction. By embedding fictional potential within surveillance imagery's non-expressive nature, we demonstrate how AI transforms surveillance into creative expression while revealing the cultural dynamics embedded within machine vision systems.

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CCS Concepts

• **Applied computing** → **Media arts**.

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1 Introduction

Generative AI has recently emerged not only as a tool for creating images but also as an approach that has reorganized and redefined systems of visual representation. While most creative applications to date have focused on generating fully synthetic visuals or replicating recognizable visual styles, this paper takes a different perspective by applying generative AI on a non-narrative visual category: public-facing surveillance imagery. These images, which capture views of streets, beaches, and transport hubs, resist narrative construction and emotional framing. Unlike other

forms of visual media, they exhibit functional neutrality and limited interpretive depth. Typically devoid of protagonists, causality, or expressive intent, such imagery serves primarily to observe, index, and archive.

Rather than treating surveillance imagery as data sources for analytical or documentary purposes, our two image-based artworks, *Synthetic Punctum* and *Mirage*, investigate how generative AI can function as a framework for constructing narrative fiction within the visual syntax of surveillance systems. These works transcend simple content synthesis or generation. By guiding AI to work with real-world surveillance imagery, altering atmospheric qualities, imagining narrative scenarios, or introducing storytelling elements, algorithms transform functional surveillance footage into fictionalized content with resonance and narrative depth, thereby reshaping how these images are understood and interpreted.

These artistic experiments explore how fiction can be activated within surveillance imagery originally designed to record and index reality. In our practices, we position generative AI as a structural force capable of reconfiguring machinic vision from within. Even functionally neutral surveillance imagery can thus be activated as a site for imaginative narrative invention.

This paper examines how generative AI operates beyond simple content generation, acting instead as a cultural mediator that reshapes visual authority, memory, and perception within surveillance contexts.

2 Background

2.1 Surveillance as Nonhuman Imaging

Surveillance imagery represents a form of machine vision that prioritizes recording over representation and operates outside human-centered photography. These images do not convey subjective meaning but instead serve to observe, capture data, and enforce control. Zylinska [28] describes this process as nonhuman photography, where autonomous systems like surveillance cameras, satellites, and monitoring networks take over image-making from human agency.

Surveillance footage avoids narrative structure and emotional engagement, functioning within a regime of functional visibility. Foucault explains that panopticism keeps subjects visible at all times, ensuring compliance through observation rather than dialogue [13]. Farocki's concept of "operative images" [10] highlights how these visuals, created for tracking and detection, follow a machinic logic that excludes human interpretation. Virilio adds that vision technologies reduce images to data, prioritizing speed and control over semantic richness [26].

These concepts describe surveillance footage as a medium driven by systemic operations, lacking narrative and semantic depth. However, these visuals may still carry narrative potential. Observers or specific viewing contexts can assign unintended meanings or emotional resonance to them.

2.2 Surveillance Narrative Transformations

Artists have explored three main strategies to transform surveillance imagery, each addressing its functional and aesthetic dimensions in distinct ways. The first strategy applies surveillance through narrative assembly. Klier's *Der Riese* [17] creates poetic sequences from CCTV footage, while Smith's *A Girl Chewing Gum* [25] subverts documentary authority by narrating mundane street scenes as if directing them. Similarly, Xu's *Dragonfly Eyes* [27] constructs fictional plots from found surveillance videos, weaving narrative meaning into otherwise functional recordings.

The second strategy emphasizes intervention rather than storytelling, focusing on the structural and aesthetic properties of surveillance imagery. Farocki's *Counter Music* [9] and Alÿs's *Guards* [1] manipulate rhythm, repetition, and spatial logic to critique systems of order, challenging the utilitarian origins of such footage. The third strategy integrates algorithmic processes to generate dynamic, individualized narratives. Coupe's *Swarm* [4] and *Jalousie Room* [5] embed generative scripts and classification algorithms within surveillance infrastructures, combining machine logic with creative expression to produce narrative flows that evolve in real time. Together, these strategies demonstrate the diverse ways in which artists reinterpret surveillance imagery, transforming its utilitarian purpose into forms of critical and creative engagement.

Nowadays, on social media platforms like TikTok and YouTube, creators often edit surveillance footage to reconstruct accident scenes, trace events, and transform functional recordings into dramatic stories. These practices reveal the inherent flexibility of surveillance imagery: originally intended for practical observation, such footage can be reassembled and repurposed for storytelling. These reinterpretations not only uncover new meanings but also raise critical questions about authenticity, context, and the power structures surrounding its use.

Unlike earlier approaches that focus on editing or reframing existing footage, we use generative AI tools to alter surveillance imagery, transforming its utilitarian purpose into forms of critical and creative engagement, where security footage becomes a canvas for social commentary, emotional storytelling, or aesthetic experimentation. By embedding fiction directly into the footage through generative processes, we challenge surveillance imagery's perceived objectivity while exploring its potential for aesthetic and narrative innovation.

2.3 AI Reshaping Imagery

While traditional approaches to surveillance imagery transformation rely on human intervention, generative AI offers potential possibilities for automated and algorithmic reinterpretation. Generative AI, including diffusion and large language models, is reshaping how images are structured and understood. Zylinska [29] views AI not as a creative force, but as a procedural system, where outputs depend on prompts and preset parameters. This highlights the algorithmic and conditional nature of AI. Similarly, Manovich [18] observes that AI-generated images replicate visual elements of reality—such as lighting, textures, and forms—through computational modeling. However, these images, despite their realistic appearance, represent a "statistical reality" constructed by algorithms rather than a direct index of the physical world. This challenges the traditional trust in photography as a medium for representing authenticity and truth.

Generative AI further blurs the boundaries between reality and fiction, compelling us to reconsider the fundamental nature of photography and imagery. Although AI-generated images do not directly capture the physical world, they skillfully synthesize

convincing visuals from datasets. This phenomenon aligns with Fontcuberta's concept of "post-photography" where the function of images has shifted from documenting reality to constructing it [12]. In our artistic practice, generative AI not only transforms street surveillance footage but also reimagines its narrative potential, imbuing it with new dimensions of meaning. By reconstructing narrative frameworks and temporal sequences, we intensify the tension between authenticity and fiction.

3 Synthetic Punctum - AI Reconstructing Surveillance as Lost Memory

3.1 Concept and Inspiration

Synthetic Punctum is a generative AI-driven experiment that explores how surveillance footage can be transformed into memory-like images. Rather than reconstructing specific historical events, the project engages archival aesthetics to evoke a visual atmosphere of temporal displacement. The inspiration originated from an anonymously authored black-and-white photo zine discovered by the artist in a London flea market. Its unclear provenance and 1960s urban scenes prompted reflections on the relationship between authorship, image context, and historical texture.

The project draws upon Roland Barthes' concept of punctum [2], the piercing emotional detail within a photograph that disrupts passive viewing. It extends this concept through Reinhuber's notion of "images not-seen" [22], which refers to images that exist solely in memory or imagination without physical manifestation. We investigate whether generative AI can transform imagery from a record of reality into a reconstructed architecture of memory, thereby reexamining the context between perception, fiction, and truth.

3.2 Technical Implementation and Outputs

Street-level surveillance footage was deliberately chosen as source material due to its inherent functional neutrality and anonymized perspective, which establishes a formal resonance with the tradition of street photography focused on urban strangers. However, unlike street photography, where the photographer exercises subjective selection, this project employs object detection algorithms to automatically detect and randomly capture frames from surveillance streams. This process eliminates human intervention, positioning the "moment on the street" entirely within a regime of machine vision and data capture.

The source material consisted of open-access street surveillance footage from SkylineWebcams [24], selected for their visual affinity with mid-century street photography. Frames were captured from live video streams using FFMPEG [11], and YOLOv5 [16] was applied to detect and isolate regions featuring human presence and environmental cues. These cropped sub-images served as the initial input for AI interpretation.

Two sets of prompt sequences were processed using GPT-4o: one extracted spatial and visual features—clothing, posture, lighting, architectural style—while the other structured semantic details such as inferred action, tone, and period-appropriate attributes. The resulting metadata was converted into structured JSON input, which guided image generation using a LoRA-fine-tuned version [15] of Stable Diffusion 1.5 [23]. The model was trained on approximately 60 analog street photographs taken by the artist, emphasizing tonal contrast, mid-gray range, and film grain characteristic.

Generated images were printed in square format onto transparent film simulating vintage slides, and mounted in standard frames for projection. This analog–digital–analog conversion reflects Elizabeth and Hart's notion of the photograph as both visual content and physical artifact [7]. Through the materiality of projection, the project reasserts the photograph not merely as an image but as a tactile device for staging memory.

While the visual output simulates historical texture, its origin lies in functional machine vision. By transforming non-expressive surveillance inputs into speculative visual documents, *Synthetic Punctum* positions generative AI as a mediator of affective fiction. It challenges the presumed neutrality of surveillance, revealing its latent capacity to participate in the production of memory, atmosphere, and temporal fiction.

4 Mirage - Fictionalizing Narratives From Surveillance

4.1 Concept and Narrative Framework

Mirage is a computational film sequence that explores how generative AI can interpolate fictional sequences within real-world surveillance footage. Unlike *Synthetic Punctum*, which focuses on static images and memory, this project engages temporal intervals between frames, using AI to generate fictional content, including visual and audio content that bridges time gaps in neutral surveillance streams.

The system utilizes footage from 8 public webcams hosted on the SkylineWebcams platform [24], each representing a specific hour of the day across global cities (e.g., Sapporo at 9:00, London at 10:00). From each location, six frames per hour were extracted at ten-minute intervals using FFMPEG [11], serving as structural nodes in a segmented timeline. For each ten-minute segment, the first and last frames remain unaltered, while the intermediate content (eight minutes) is AI-generated—comprising still images and corresponding voice-acted dialogue. Though not rendered in real time, the playback structure aligns with real-world clocks, simulating temporal continuity. The framework draws conceptual inspiration from Marclay's *The Clock* [19] and Marker's *La Jetée* [20], combining cinematic temporality with still-frame storytelling.

4.2 Technical Implementation

Each segment's narrative is authored by GPT-4o [21], prompted as a screenwriter given two surveillance images and a genre cue (e.g., thriller, noir, soap opera). GPT-4o analyzes the first and final images from the 10-minute sequence, then predicts the storyline and outputs minute-by-minute plot progression, which is then parsed into scene-level descriptions—including character actions, spatial orientation, and narrative tension. These scenes serve as structured input for subsequent image and dialogue generation.

In our tests, we preferred the recently updated GPT-4o integrated with an image generation pipeline over diffusion-based models like Stable Diffusion. This preference stems from GPT-4o's ability to maintain visual consistency across sequences, whereas Stable Diffusion, while effective in single-frame generation, often introduced inconsistencies in scene continuity.



Figure 2: Left: The technical diagram describes the workflow of *Synthetic Punctum*. Right: The selected samples of generated images of *Synthetic Punctum*.



Figure 3: In *Synthetic Punctum*, the AI-generated image is first printed onto a sheet of celluloid, and then projected onto the wall.

After completing the image generation phase, the project transitions into a voice synthesis stage, where AI generates both narrative scripts and voiceovers. Using the ten-frame sequences, GPT-4o creates oral narrative by imagining inner monologues or dialogues of individuals observing the scenes. Each script, lasting 10 to 50 seconds, provides concise yet engaging narrative. This approach moves beyond traditional descriptive voiceovers, offering diverse perspectives such as a standup comedian in Venice sharing humorous observations, a mother and son in London discussing TV plots, or a CCTV operator in Sapporo analyzing visual details. By interpreting and expanding on the frames' visual elements, the project enriches the narrative scope while maintaining a direct connection to the imagery.

Once the textual scripts are finalized, they are processed through ElevenLabs [8], a voice synthesis platform, to generate the corresponding voiceovers. The system is designed to select culturally distinct voices and emotional registers that align with the assigned personas.

4.3 Machine Aesthetics

In the final composition of the video, a custom real-time pipeline was developed in TouchDesigner [6] to simulate the emergence of AI-generated surveillance imagery. We import each hour's generated materials into a local library, and then a custom script plays them sequentially following real-time logic. Before the submission deadline, we had already constructed 400 images and plan to complete the construction of 1440 images (representing a full 24-hour cycle at one image per minute) and voice recordings in the coming period.

Each generated frame was first processed through MediaPipe's image classification module [14], extracting primary object categories and compositional elements. This semantic data informed the

visual parsing of the image, allowing subsequent layers to reference identified features during rendering.

To evoke the aesthetics of early machine vision and analog computing, a progressive line-scanning effect was applied: each minute of footage was revealed sequentially from top to bottom, simulating the incremental assembly of visual information. Simultaneously, a real-time clock module was embedded within the frame, advancing alongside the scan to reinforce the durational aspect of image construction.

While Text to Image tools can produce highly realistic visuals, this project intentionally retains machinic traces through a line-by-line scanning process and a visible, ticking timestamp. Rather than pursuing seamless realism, the aim is to foreground image construction as an act of machine vision. This approach aligns with the concept of "operative images" [10] —visuals generated for machine parsing rather than human viewing—and speculates on how machinic perception might structure generative narrative interventions.

Through temporal scripting and generative storytelling, *Mirage* questions how AI can interpret, extend, and fictionalize time and story within visual systems not originally designed for narrative use. It reveals how surveillance can become a medium for speculative time, challenging both aesthetic and epistemological assumptions about what such imagery is meant to convey.

5 Discussion

5.1 Restructuring Surveillance

The two practices demonstrate how generative AI systems, such as large language models and text-to-image models, operate as a structural system for reconfiguring time, meaning, and narrative potential in surveillance imagery. Rather than processing continuous footage, both works isolate minimal informational units—single frames or temporal fragments—and extend them through semantic inference. AI functions as a mechanism of reconstruction, enabling surveillance imagery to acquire narrative agency.

Synthetic Punctum compresses temporal flow into isolated frames, simulating photographic nostalgia. *Mirage* interpolates fictional events between surveillance stills, constructing time as a narrative continuum. These approaches reveal that surveillance footage harbors latent possibilities for fictional activation through AI mediation.

The artworks manifest distinct temporal strategies: one freezes time into nostalgic stillness, the other predicts narrative between gaps. Generative AI does not restore continuity but reorganizes temporality as fictional possibility. Surveillance shifts from passive documentation toward imaginative mediation.

These manipulations reveal how generative AI systems construct visual authority when operating on institutionally encoded surveillance footage, transcending aesthetic remixing to participate in constructing visual reality.

5.2 The Authority Construction of AI Vision

Generative AI redefines standards of visual authenticity by embedding cultural imagination at the technical level. These systems do more than create convincing images—they function as computational processes that influence our understanding of what constitutes visual credibility. As Chun observes, automation embeds cultural assumptions into infrastructure, making bias systematic rather than incidental [3]. Zylinska characterizes generative models as "programmatic agents" that perform cultural reasoning through statistical patterns rather than conscious interpretation [29].

When generative AI processes surveillance footage—a medium already encoded with institutional authority—it moves beyond simple remixing to systematically reconstruct visual narratives. The system operates through determining what gets rendered, how events are sequenced, and the familiarity of resulting images, all derived from visual conventions pre-embedded in training datasets and prompt structures. This process creates a form of computational authority that combines surveillance's institutional credibility with AI's learned patterns of cultural plausibility.

5.3 From Technical Authority to Cultural Politics

This technical construction of authority reveals broader cultural implications as generative AI technologies become increasingly photorealistic. The shift from technical mechanism to cultural impact becomes evident when we examine how synthetic media reshapes visual politics. By using surveillance as creative material, our work explores what visual cues we perceive as "real" when machines learn to simulate cultural truth through statistical inference.

The power of generative AI extends beyond its technical output to how it creates cultural authority through the familiarity of synthetic images. We do not attempt to resolve the ethical contradictions of synthetic vision but rather illuminate how generative AI recalibrates human belief, archiving, and memory. In the post-truth era, our reality is increasingly mediated by AI systems that mechanize contemporary cultural realism.

As generative AI continues to shape how visual meaning is made, remembered, and trusted, artists and researchers must grapple not only with aesthetic possibilities but with the structural consequences of synthetic vision as a mode of cultural power.

6 Limitation and Future Works

A limitation of *Mirage* lies in its inability to operate in real time. The original intention was to interface directly with live surveillance streams; however, during the writing and development phase, Open AI did not yet offer public API access for GPT-4o, restricting the system to a pre-processed dataset and delaying the implementation of automated generative feedback. Future iterations aim to reintegrate real-time surveillance data, enabling dynamic generation synchronized with actual temporal flows.

Due to the sensitive nature of surveillance imagery, particular care was taken in our production to avoid privacy violations: facial features were deliberately obscured or excluded in real world imagery, and all captured frames prioritized wide-angle, anonymized public scenes. While the project demonstrates the speculative capacity of AI in transforming surveillance into narrative space, future work must further engage with ethical consideration of data use, anonymity, and the socio-technical implications of fictionalizing real-world environments.

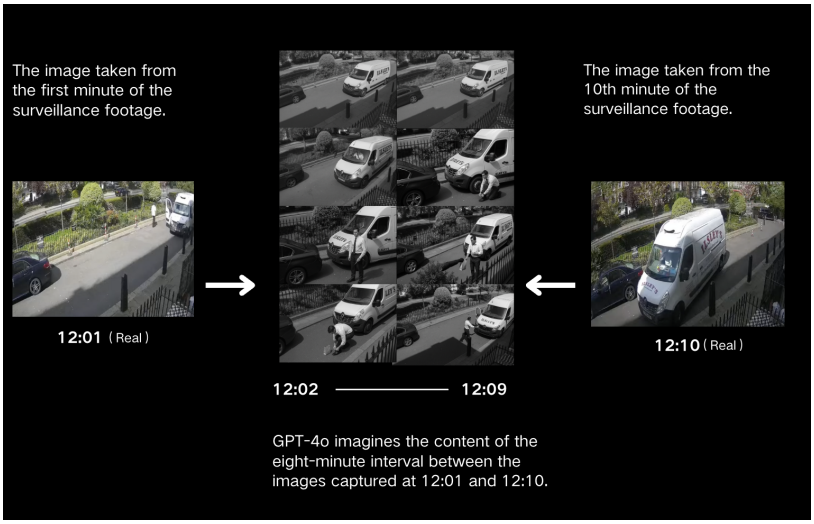


Figure 4: The image generation process of *Mirage* in every 10 minutes.

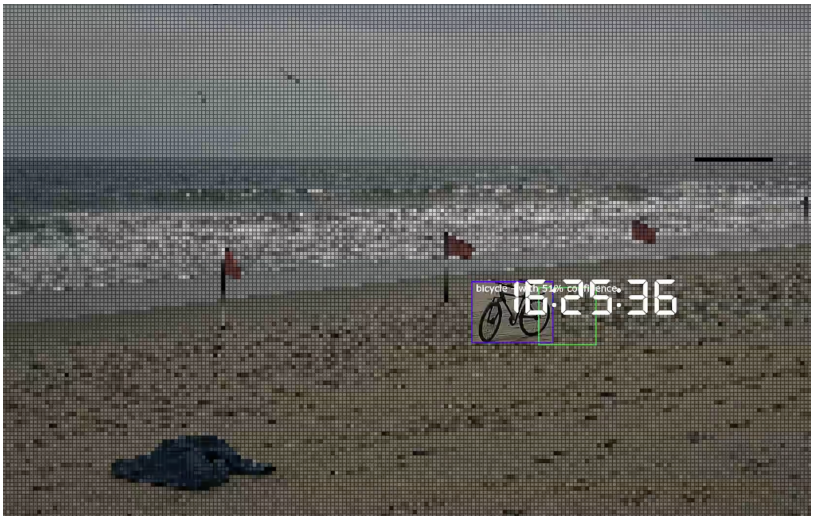


Figure 5: The final generated image simulates the effect of machine recognition and rendering, while also incorporating a timestamp.

Although the installation has not yet been shown to a large public audience, early internal tests and small-group viewings showed that many viewers experienced confusion about what was real and what was generated. These reactions highlight the importance of better guiding interpretation and clarifying the system's role in shaping the narrative. We will use this feedback to improve both the system and how it is presented in future exhibitions.

7 Conclusion

This paper explores generative AI as a structural agent that reconfigures surveillance imagery into new temporal and narrative formations. Rather than producing original content, the two presented projects embed fiction into functional image systems by simulating memory and interpolating imagined events. These experiments challenge the presumed neutrality of surveillance footage, revealing how AI can operate not simply as a visual generator, but as a mediator of perception, narrative logic, and time. As generative systems gain greater cultural presence, the artist's role shifts from authoring images to orchestrating systems—defining parameters through which meaning and realism are constructed. This approach foregrounds fiction not as an escape from reality, but as a method for interrogating how images are made, believed, and embedded in broader socio-technical imaginaries.

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Inclusive Soundscapes: systems for an accessible performance

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Abstract

This article explores multimodal communication in inclusive performative contexts, focusing on the potential of interactive systems for children with Special Educational Needs and Disabilities (SEND). Drawing on a theoretical framework that integrates the concepts of multimodality, new media, and inclusive education, it analyses the implementation of an interactive sound performance in an educational setting involving functional diversity. The performance, based on digital and sensory technologies, aims to provide accessible, adaptable, and cognitively stimulating artistic experiences, promoting the active participation of children with diverse sensory and motor profiles. The description of the performative system is accompanied by a critical reflection on the principles of accessibility, individualisation, and participation, grounded in direct observations and testimonials collected during its application. The results suggest that the combination of sound art, technology, and inclusive interactive design may represent a relevant pathway for the development of more equitable educational and performative practices. The article thus highlights the role of multimodality as a tool for artistic mediation and social inclusion.

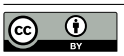
CCS Concepts

• **Human-centered computing** → Accessibility; Accessibility systems and tools; Accessibility; Accessibility technologies; Human computer interaction (HCI); • **Applied computing** → Arts and humanities; Sound and music computing; • **Social and professional topics** → Professional topics; Computing industry; Sustainability.

Keywords

Biossonification, EEG, Inclusive, MAD Clarinet, PolySonicBRAIN, SEND

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1 Introduction

Communication is an essentially multimodal process, involving a multiplicity of sensory channels that enrich the transmission and interpretation of messages. When translated into technological systems, this multimodality can acquire new expressive dimensions, particularly in performative contexts. This article is based on the hypothesis that interactive systems grounded in digital technology can serve as effective mediators of artistic communication for children with Special Educational Needs (SEN), enabling them to explore alternative forms of expression and sensory participation. The growing recognition of the importance of inclusion within the field of arts education demands the development of approaches that transcend standardised pedagogical models, favouring accessible, adaptive practices that are sensitive to functional diversity. Within this framework, the creation of performative systems that integrate sound, gesture, image, and physical interaction can serve as a bridge between art and inclusion, fostering meaningful and individualised experiences.

This article aims to analyse, based on a theoretical foundation centred on multimodality, new media, and inclusive education, the implementation of an interactive sound performance designed for children with SEND. The analysis combines a description of the developed system, direct observation, and testimonials collected during its implementation, discussing the role of technology as a facilitator of artistic participation and sensory engagement. The article is structured into three main sections: a theoretical review of the central concepts; the presentation of the performative system and its application context; and a final reflection on the pedagogical and inclusive implications of the experience, including the analysis of a questionnaire administered to participants. Finally, it is worth noting that the performances analysed were conducted at the Irene Rolo Foundation, an institution based in Tavira (Portugal) with extensive experience in training, empowerment, and support for people with SEN. Founded in 1982, the Foundation is widely recognised for its work in promoting the social and artistic inclusion of individuals with functional diversity [8].

1.1 Methodology

This article adopts a mixed-methods approach, integrating an exploratory case study as defined by Yin [25], and aligned with the methodological guidelines proposed by Benbasat et al. [2]. This approach allows for the analysis of a phenomenon within its natural setting, without manipulation of variables, drawing on multiple sources of evidence, namely interactive performances, direct observations, and surveys administered to participants and their

caregivers. The application of the case study method is particularly appropriate for investigating contemporary phenomena situated in real-world contexts, especially when the boundaries between the phenomenon under study and the context in which it occurs are not clearly defined. As argued by Yin [25] and Benbasat et al. [2], this mixed methodology enables in-depth examination of agents and processes, allowing for the exploration of complexity and the production of knowledge through empirical inquiry, data categorisation, and the preliminary formulation of interpretative hypotheses.

The research focuses on contemporary events, and the researchers assume an active role in both data collection and interpretation, within an epistemological framework that acknowledges the significance of interpretation in the study of social and cultural phenomena. The literature review thus plays a structuring role, providing the conceptual foundations on multimodal communication, bio-sonification, and inclusive design that guide the empirical analysis and support the construction of the study's theoretical framework. Finally, regarding the survey, it was designed to be accessible — using clear questions and emojis — so that individuals with SEND could respond to it, which they did after the performance, accompanied and supported by their educators.

1.2 Investigative Objectives

This research is guided by a central question that informs the exploratory case study: to what extent can the integration of interactive digital devices in performative environments enhance the sensory and emotional engagement of individuals with Special Educational Needs and Disabilities (SEND). Based on this question, the research team formulated a set of preliminary propositions to guide the qualitative analysis and interpretation of the collected data. It is assumed that the use of audience-oriented interactive systems provides stimulating sensory experiences for individuals with SEND, fostering their active engagement in the performative space. It is further assumed that the incorporation of non-evident biological elements, such as plants — which do not naturally produce audible sound — when digitally augmented, generates unexpected stimuli that awaken curiosity and promote participation. Lastly, it is considered that the interactive and responsive nature of these systems can trigger moments of autonomy and self-expression among participants with SEND, even within contexts mediated by educators and facilitators. These propositions reflect the epistemological stance of the research team, which views technology as a means to expand sensory experience, rather than an end in itself. The case study analysis will thus explore the extent to which these propositions are reflected in practice and how they may contribute to the design of inclusive artistic environments.

2 Literature Review

This article, while addressing interactive systems, focuses on their function as multimodal communication devices designed for individuals with Special Educational Needs and Disabilities (SEND), rather than on the technical aspects of innovation. For this reason, the literature review will centre on the concepts of multimodal communication, the definition of SEND, and projects that operate directly at this intersection.

2.1 Multimodal Communication

Multimodal communication is not a recent concept, as face-to-face dialogue between people naturally involves multiple communicative channels such as body movement, facial expressions, vocal intonation, and gestures, which complement and enrich verbal language [11]. In contemporary contexts associated with computational systems, a multimodal communication system is one that integrates a Human–Computer Interaction (HCI) interface, enabling the interpretation of multiple sensory stimuli and communication channels. These systems typically involve various modes of interaction — such as speech, writing, touch, gestures, gaze, and body movements — whose responses may be translated into different forms of digital media. What distinguishes such systems is the fusion of data from different sensory channels and their ability to process this information in real time [4]. Consequently, multimodal communication privileges the sensory and semiotic dimensions, allowing receivers to draw upon diverse cognitive and sensory capabilities in the decoding of messages [9]. Following McLuhan's distinction between hot and cool media [15], technological multimodal systems — by requiring greater participation from the receiver and articulating multiple sensory layers — may be understood as cool media, demanding more interpretive effort and thereby activating semiotic processing more intensely.

Technological multimodal communication — the central focus of this article — aligns closely with the principles for new media outlined by Manovich [14], including: numerical representation — the computer as a core element and digital medium in multimodal communication; modularity — the decomposition of communication into independent components; automation — incorporating some degree of autonomous behaviour; variability — interactions leading to different outcomes; and transcoding — the coexistence and interpretability of multiple formats. Thus, it can be affirmed that technological multimodal communication, as explored in this article, is fully embedded within the framework of new media.

In the musical domain, the experience of live performances is often inherently multimodal, as music communicates not only through sound but also through contextual, social, and aesthetic relations. Even in the absence of verbal elements, a musical work can acquire multiple meanings depending on the context and audience. For instance, a national anthem is highly contextualised and carries a socially shared meaning, whereas a contemporary instrumental piece may allow for more open interpretations. In such cases, multimodality operates across different layers — rhythm, timbre, image, text, colour, among others — which the receiver integrates individually, constructing their own meanings [9, 24]. It is precisely in this capacity to generate meaning through the interaction of sensory layers that multimodal systems reveal great potential for audiences with SEND, by enabling artistic experiences that are accessible, adaptable, and cognitively stimulating [1].

2.2 Characterisation of SEND

Special Education and Special Educational Needs and Disabilities (SEND) encompass a wide range of conditions that may affect children's learning and full participation in traditional educational contexts. The Salamanca Statement and Framework for Action on

Special Needs Education, adopted in 1994, advocate for the universal right to education, with particular emphasis on children with disabilities. This document promotes inclusive education as an essential means to foster diversity and equity within the educational system. According to UNESCO [23], responding to the educational needs of students with disabilities is not only a fundamental human right but also an ethical imperative, requiring the creation of inclusive learning environments that are adaptable to students' diverse needs. Although this article does not focus directly on formal education, the principles outlined are equally applicable to the arts, where inclusion should be seen as transversal and integrative.

Earle and Curry [5] identify a broad range of special needs, including: Asperger syndrome, attention deficit, autism spectrum disorders, behavioural, emotional and social difficulties, cerebral palsy, Down syndrome, fragile X syndrome, moderate learning difficulties, physical disabilities, semantic–pragmatic disorders, sensory deficits, visual impairment, multisensory impairment, severe or multiple learning difficulties, dyslexia, dyscalculia, dyspraxia, speech, language and communication difficulties, and Tourette syndrome. In this context, it is essential to ensure that artistic and performative environments are accessible, recognising human plurality and promoting communication that can be individually decoded, while preserving the integrity and quality of the artistic experience. This requires the development of strategies that dismantle barriers, fostering inclusive and adaptive performative practices.

Katz and Mirenda [10] highlight that the inclusion of students with SEND in small groups - as opposed to whole-class settings - significantly enhances their participation and learning, exposing by contrast the limitations of traditional approaches, especially in large-group settings. Inclusive strategies prove more effective when implemented in smaller environments, where content can be more sensitively tailored to students' specific needs. The presence of educational assistants is also essential to ensure the necessary support, particularly in contexts with lower participant density [3, 13, 18, 20].

2.3 Artistic and Technological Projects with Children with SEND

The combination of technology and sound art can transform the way children with Special Educational Needs and Disabilities (SEND) interact with sound, music, and society as a whole. An example of social inclusion through interactive sonic systems is offered by Drake Music Scotland [1] and the Drake Music Project Northern Ireland [2], which promote musical inclusion through the use of devices such as EyeGaze, touchscreens, and adapted interfaces. These technologies empower children and young people with SEND to compose and perform music. These projects demonstrate that the sensitive adaptation of musical technologies, combined with inclusive pedagogical practices and meaningful interaction between tutors, participants, and devices, serves as a powerful system for enabling active participation and collective creation by individuals with SEND. Another inclusive initiative is the Paramusical Ensemble [6], system that uses brain–computer interfaces to enable individuals with cerebral palsy to compose musical scores based on their neural activity, which are then performed in real time by a string quartet. A further example is the project by Anders Lind [12], which, although not specifically designed for individuals with SEND, proposes a colour-based musical notation system that is fully functional and adaptable to anyone, requiring no prior musical knowledge. Many other examples could be cited; however, the projects presented here sufficiently illustrate that technology — when combined with sensory stimulation and interactive design — can open up new pathways for communication.

3 Performance context

The performance under analysis involved three musicians, each equipped with a distinct interactive sonic device[3]. Although designed to function autonomously, these systems were integrated into a collective performance in which the musicians, rather than relying solely on their traditional instruments, explored an expanded range of sonic possibilities mediated by autonomous computational components that had been pre-configured. Each of the three devices will be described in the following subsections. It is important to note, however, that at a specific moment in the performance — common to all three sessions held — all students were given the opportunity to engage in interaction through bio-sonification, while some also interacted with the EEG-based system. The use of the latter was limited due to technical constraints, equipment availability, and hygiene considerations related to the physical contact required by the sensors. From a performative standpoint, these interactions added an expressive layer to the performance, contributing to a descriptive sonic environment in which the interplay between environmental, instrumental, and computationally generated sounds played a central role.

3.1 MAD Clarinet 3.1, New Set

MAD Clarinet [21, 22], is a performative system that takes the clarinet as its starting point and catalytic agent, integrating it with a computational component in constant evolution. The version used in this context explores the technological dimension as a means of sonic augmentation and as an autonomous partner in performance. The system combined two software platforms — Max/MSP and Logic Pro — interconnected via Loopback. The latter enabled the creation of multiple virtual audio channels, overcoming previous limitations in the separation of sound sources. The autonomous component, developed in Max/MSP, included three main functionalities: (1) a patch based on the *ml.markov* library, which captured pitch and duration from the clarinet to generate real-time sonic responses; (2) a continuous sine wave module with frequency controlled in hertz (Hz); and (3) a sequencer with adjustable parameters, allowing manipulation of the structure and density of the sonic output. Logic Pro, in turn, received the signals from Max/MSP and processed them with acoustic effects, timbral extensions, and real-time melodic transformations. It also functioned as a player for pre-prepared samplers, further expanding the sonic palette of the performance.

From an instrumental standpoint, a hybrid MIDI controller (with keyboard and launch pads) was used to trigger samplers and specific functions in both software environments. The clarinet was captured using a piezoelectric microphone installed on the barrel, connected

[1] https://drakemusicscotland.org/ accessed July 13, 2025.
[2] https://drakemusicni.com/ accessed July 13, 2025.
[3] https://postimg.cc/gallery/DK3gZRW accessed July 14, 2025.

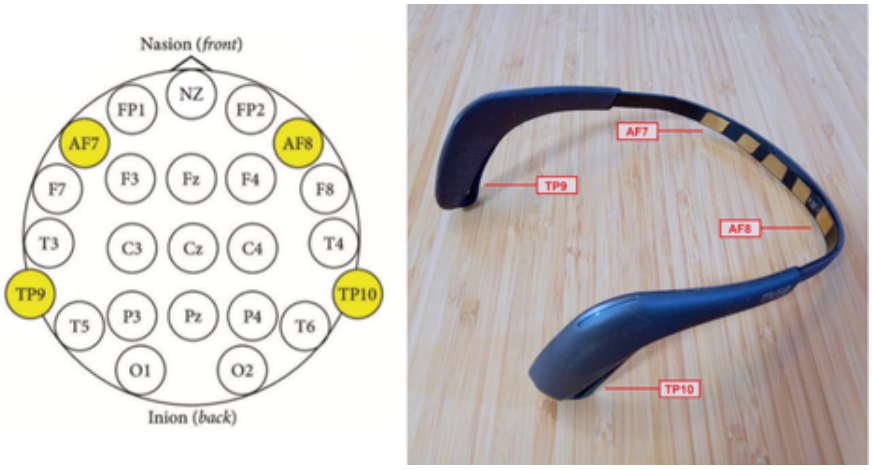


Figure 1: Electrodes position and Muse 2 headband

to an audio interface with output to an active speaker. Although incorporating a Human–Computer Interaction (HCI) component, this was accessible only to the performer, enabling the combination of traditional instrumental gesture with dynamic digital sonic responses. The resulting setup created an expressive performative environment, adaptable to the sensory participation context, in which sonic and visual elements converged in an integrated manner.

3.2 PolySonicBRAIN (v2.0.0-beta) - EEG Acquisition, Software Pipeline & Mapping Strategies (EEG → MIDI)

The PolySonicBRAIN system integrates real-time EEG signals into the construction of interactive sonic environments, exploring the potential of Brain–Computer Musical Interfaces (BCMIs) within inclusive performative contexts. Specifically, it enabled the active participation of several students with Special Educational Needs and Disabilities (SEND), who interacted directly with the performance by modulating sound using their own brain activity. Building upon previous research [7, 16], the system captures alpha-band brainwave oscillations (8–12 Hz), which are associated with states of attention and relaxation, transforming them into MIDI data that control sound synthesis parameters. EEG acquisition is carried out using a Muse 2 headband, equipped with four dry electrodes (AF7, AF8, TP9, and TP10) (Figure 1), which communicates via Bluetooth with a laptop. The BlueMuse [4] software streams the EEG data in real time using the Lab Streaming Layer (LSL) protocol.

Signal processing is handled in the BrainBay[5] environment through a custom patch performing three main operations: (1) band-pass filtering centred on 10 Hz, with amplification of alpha activity; (2) smoothing of the amplitude envelope using a moving average to eliminate abrupt fluctuations; and (3) continuous emission of MIDI messages, distributed across two channels, which control real-time synthesis and musical sequencing parameters (see Figure 2). This patch ensures low latency and also provides graphical visualisation of the EEG data through 3D spectra and real-time animations, offering continuous feedback to both the performer and facilitators.

The MIDI data generated coexist with the live performance on Portuguese guitar, which is equipped with a piezoelectric pickup connected to a Korg AX30G multi-effects pedal. The use of chorus, delay, reverb, and modulation effects creates sonic textures that engage in dialogue with the sonification of brainwaves, enabling the performer to explore both traditional repertoires and more experimental timbral zones. The combination of external instrumental gesture with internal sonic response generates a hybrid and sensorially rich environment, in which interaction with participants with SEND acquires an artistic and emotionally meaningful dimension.

The articulation between brainwave sonification and instrumental expression not only provided a unique aesthetic experience but also proved effective in the sensory and emotional activation of participants, reinforcing the potential of BCMIs in inclusive performative practices.

3.3 Plant Music - Acquisition, Software Pipeline & Mapping Strategies

The Plant Music performative system explores the bioelectrical activity of living plants as a real-time sound source, bringing together nature, technology, and interactive musical creation. Although plants do not possess a nervous system, they emit electrical signals in response to environmental stimuli such as light, temperature, or touch. These signals, captured using conductive clips placed on leaves or stems, were amplified with the Symbiotic Biodata device and converted into digital data transmitted via MIDI to a sound creation environment. The system integrated an Arturia Minifuse audio interface, Logic Pro software for sound processing and effects, and the Playtronica sensor, which introduced a tactile and interactive dimension. The bioelectrical data were mapped onto sonic parameters such as pitch, timbre, and rhythm, allowing the generation of musical patterns directly influenced by the plant's physiological state. This process was complemented by a trombone

[4]https://github.com/kowalej/BlueMuse accessed July 15, 2025.
[5]https://github.com/ChrisVeigl/BrainBay/releases accessed July 15, 2025.

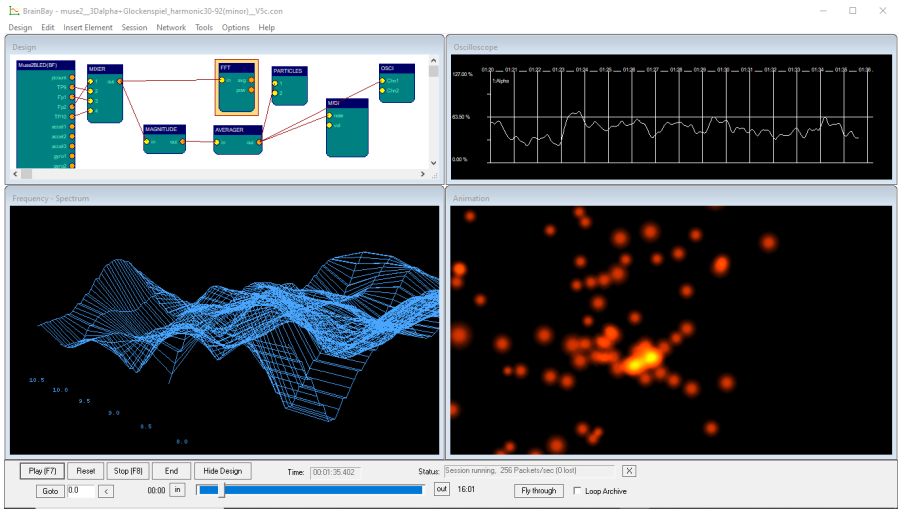


Figure 2: BrainBay

performance, using a Yamaha Silent Brass system connected to a Digitech RP360 XP effects pedal. The trombone sounds were manipulated in real time and integrated into a Boss RC-600 loop station.

The entire performance was amplified through a SONAR 12Xi portable speaker, enabling immersive listening in both indoor and outdoor spaces. The combination of plant bioelectrical activity, human instrumental gesture, and digital sound manipulation created a hybrid and sensorially rich experience in which the boundary between performer and living organism became fluid. Importantly, this performative system allowed all audience members — one at a time — to sonically interact with the performance by physically touching the plant and influencing the sound generation in real time. This dynamic proved particularly effective in the sensory activation and emotional engagement of participants, especially individuals with Special Educational Needs and Disabilities (SEND), offering them an alternative, accessible, and meaningful form of artistic expression.

4 Questionnaire

A questionnaire with two distinct branches was administered, designed to address both the students with Special Educational Needs and Disabilities (SEND) and the psychologist responsible for the group's support. Both versions began with a delimiting question to identify the respondent's profile — whether they were a student or a technical/educational staff member. The version designed for students employed simplified language and visual support through emojis, in order to facilitate comprehension and encourage responses. It included four questions: two closed-ended (yes / no / maybe) and two multiple-choice questions focused on the emotional and sensory experience during the performance. This structure aimed to ensure cognitive accessibility and foster the affective expression of participants, drawing on best practices in inclusive assessment. The branch addressed to the psychologist followed a more analytical structure and it was composed by five questions: two multiple-choice questions, one Likert scale item, one closed-ended question (yes / no / maybe), and one optional open-ended question to gather qualitative observations on the impact of the experience on the students.

The questionnaire was administered at the end of each of the three performance sessions, in a calm environment and with the support of specialised staff, ensuring that participants were in a suitable state for reflection and expression. It was conducted in digital format, with direct support provided to students, allowing for greater flexibility and individual assistance.

From an ethical standpoint, the process ensured informed consent from responsible institutions, confidentiality of responses, and respect for the cognitive specificities of the participants. The collaboration of the psychologist and staff members was crucial for the linguistic and visual adaptation of the content. Although the sample size was small and the performance setting emotionally engaging, the data obtained provide a meaningful basis for reflecting on the sensory, expressive, and inclusive impact of the artistic experience on participants with SEND. Figure 3 presents a summary of the questionnaire structure.

4.1 Sample Characterisation

The sample in this study consisted of a total of 17 participants, distributed across three distinct sessions, which were organised to maintain small groups and ensure closer and more controlled interaction. Sixteen students with Special Educational Needs and Disabilities (SEND), aged between 22 and 64, participated, along with one specialised professional — the institution's psychologist — who accompanied the students throughout the entire process. The students presented diverse cognitive and functional profiles, including conditions such as autism spectrum disorders, mild to moderate intellectual disabilities, communication difficulties, and global developmental disorders. This diversity allowed for the observation of differentiated responses to the performative experience, particularly in terms of sensory, emotional, and expressive engagement. As previously mentioned, the sessions were held at the facilities of

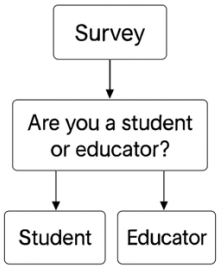


Figure 3: Questionnaire branches

the Irene Rolo Foundation in Tavira (Portugal), in a space adapted to the needs of the participants, and each session lasted approximately 30 minutes. The small-group format allowed for individualised support and more accurate data collection, while respecting the communication rhythms and modes of each participant.

5 Results and Discussion: Sensory and Expressive Impact

This section presents a self-analysis of the performances by the authors, along with an examination of the questionnaire results completed by the participants.

5.1 Self-Analysis

The authors reflected on the creative process and aesthetic decisions, emphasising that music is widely recognised for its therapeutic and cognitive potential in SEND contexts. Building on that foundation, the project's aesthetic proposal aimed to promote empowerment, sensory engagement, and social inclusion — objectives clearly outlined in the initial plans.

It was observed that students primarily responded to the sonic elements, interaction, and visual stimuli, confirming the multimodal effectiveness of the performance. During the sessions, many participants communicated non-verbally and expressed curiosity and surprise at the sounds produced. Most of them reported positive emotions (e.g., "happy", "surprised") and expressed a desire to repeat the experience. These preliminary results suggest that the multimodal activity supported moments of autonomy and expressiveness among the students. Notable moments included interactions in which environmental or musical sounds were triggered by the students, establishing playful dialogues between music and nature. For example, one student smiled upon hearing sounds emanating from the plants, highlighting the emergence of unexpected sensory connections. In short, the multimodal integration fostered student expression and autonomy, aligning with the idea that inclusive bio-sonic environments enhance sensory participation in both artistic and educational contexts.

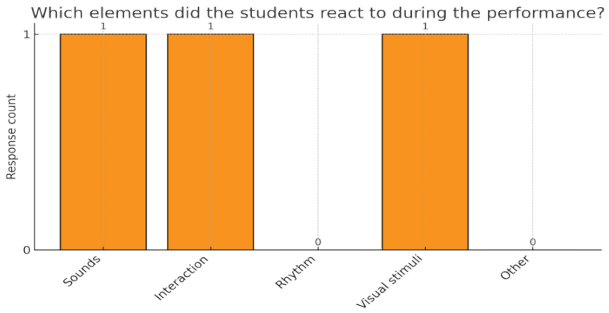


Figure 4: Question 1

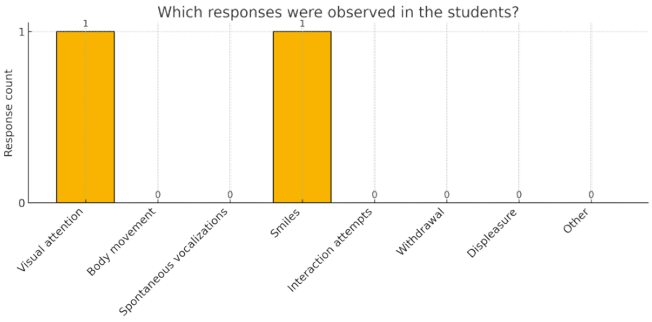


Figure 5: Question 2

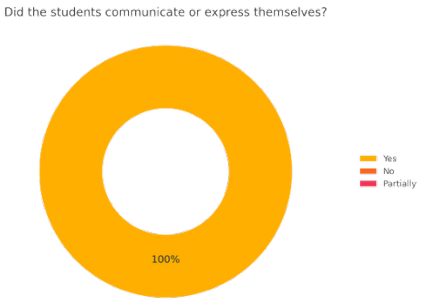


Figure 6: Question 3

5.2 Questionnaire Results

5.2.1 Psychologist. In the questionnaire addressed to the psychologist, the first question was: "Which elements did the students react to during the performance?" Five options were provided, of which she selected sound, interaction, and visual stimuli (Figure 4).

In the second question, which presented multiple options she was asked which responses she observed among the students. She selected *visual attention* and *smiles (*Figure 5*)*.

In the third question, which was another Yes, No, or Maybe item, the psychologist indicated that the students had communicated and expressed themselves throughout the performance (Figure 6).

The fifth question consisted of a Likert scale with four levels — *disagree*, *neutral*, *agree*, and *strongly agree* — regarding four statements, specifically that the computer-based music supported: non-verbal

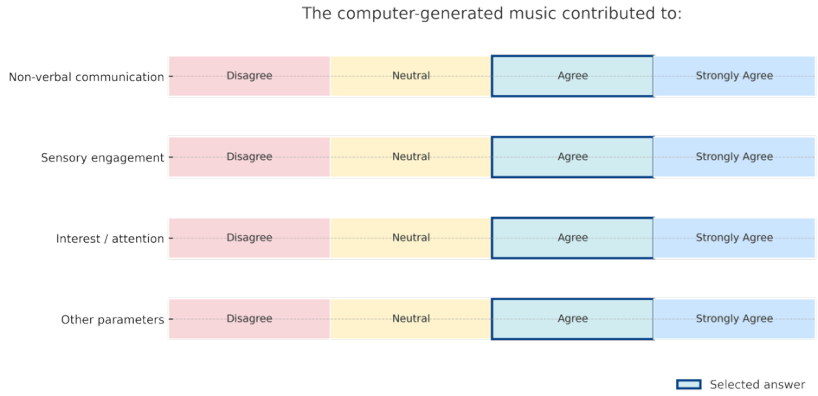


Figure 7: Question 4

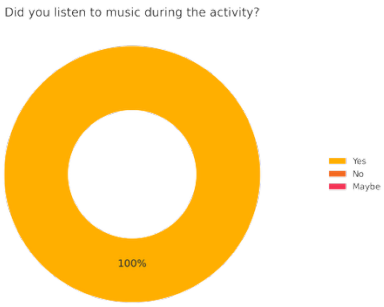


Figure 8: Question 5

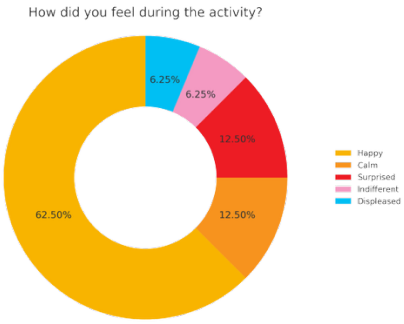


Figure 9: Question 6

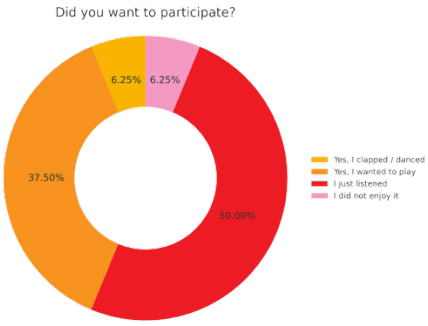


Figure 10: Question 7

communication; sensory engagement; interest/attention; and multiple parameters. To all items, the respondent answered *agree* (Figure 7).

Finally, the last question in the questionnaire was optional and invited an open-ended final comment. The respondent chose not to answer.

5.2.2 Students. With regard to the students, the first question asked whether they had heard music during the activity. All 16 participants responded to this question, and among the available options — *Yes*, *No*, and *Maybe* — all respondents answered *Yes* (Figure 8).

In the second question regarding how they felt during the activity, 10 participants answered happy, 2 answered surprised, another 2 answered calm, 1 responded indifferent, and finally 1 responded displeased (Figure 9).

In the question about whether they wanted to participate, 8 responded that they only listened, 5 said they wanted to play, 1 said they wanted to dance, and 1 stated they did not enjoy it (Figure 10).

In the final question, regarding whether they would like to repeat the experience, 13 answered *yes*, 2 answered *no*, and 1 responded *maybe* (Figure 11).

5.3 Data Analysis

Based on the questionnaire results, it is possible to confirm that the psychologist accompanying the students identified positive reactions to the performances, including cognitive aspects such as attention to the surrounding environment and attempts to communicate and interact. The students themselves reported similar reactions, perceiving the performances as a positive, distinctive experience that encouraged interaction and communication. These findings support the idea that corporeal or biological sonification

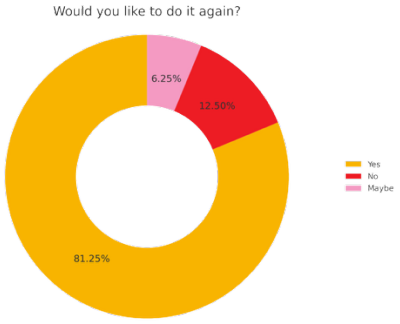


Figure 11: Question 8

fosters a more accessible and intuitive form of mediation, as anticipated by McLuhan's concept of *cool media [*15*].* The results also indicate that participants with SEND clearly valued the experience, particularly in terms of feeling they had actively contributed to the sound creation. This engagement — even when mediated by brain signal technology or biosonification — was perceived as both authentic and expressive, reinforcing the notion that BCMIs can function as communicative extensions of the body and mind. This observation aligns with previous research that highlights the potential of such interfaces not only as control tools but as mediators of meaningful aesthetic experiences, capable of transforming brain activity into perceptible and sensorially integrated sound expression. In this case, technological mediation did not hinder the emotional connection to the performance — on the contrary, it enhanced it, promoting a form of listening centred on the body itself and facilitating the integration of participants with diverse profiles into shared artistic practices [17]. Finally, emotional states reported by the participants — such as happiness and smiling — support the notion that multimodal communication is not redundant but complementary, conveying various forms of content through distinct yet interrelated modes [19]. his also resonates with Jewitt's [9] view of multimodality as a social practice that integrates visual, auditory, and gestural modes in the construction of meaning — which, in this context, was further amplified by the sonification of biological and brain signals.

6 Conclusion

This exploratory case study aimed to understand how the integration of interactive digital devices in performative contexts could enhance the sensory and emotional engagement of individuals with Special Educational Needs and Disabilities (SEND). Although preliminary, the collected data partially confirm the proposed hypotheses: the use of biosonified and interactive systems appears to have supported moments of non-verbal communication and autonomy among participants, stimulating curiosity and emotional involvement. While the limited sample size and the qualitative nature of the data preclude generalisations, the findings suggest that artistic environments based on biosonification and multimodal interaction may play a meaningful role in promoting sensory participation within inclusive educational and artistic settings.

7 Limitations

One of the main limitations of this study lies in the fact that the sample was drawn from a single institution, resulting in a narrow data scope. Although the response rate was 100%, the pool of respondents was small, particularly regarding educators — in this case, limited to the psychologist accompanying the students. In addition, because the performance involved three distinct HCI systems with different interactive paradigms and sonic models, it was not possible to disentangle the specific impact of each device on participants' responses.

8 Future work

Future research should consider expanding the sample and diversifying the application contexts, allowing for a more comprehensive analysis of the sensory and emotional impacts of these systems on neurodiverse populations. It will also be important to further develop biosonification and sound-mapping processes, and to adopt mixed methodologies that combine quantitative physiological measurements with qualitative analyses of behaviours and interactions over time. Lastly, implementing semi-structured interviews with educators, rather than relying on optional open-ended survey items, would provide more reliable and nuanced insights into their perspectives.

9 Ethical considerations

This study was conducted in accordance with the ethical principles established by the Declaration of Helsinki. All participants, or their legal guardians, provided informed consent prior to data collection. Confidentiality and anonymity were ensured, and all data were used exclusively for scientific research purposes.

Acknowledgments

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Protocol as Poetry: A Case Study of Pak's Smart Contract-Based Protocol Art

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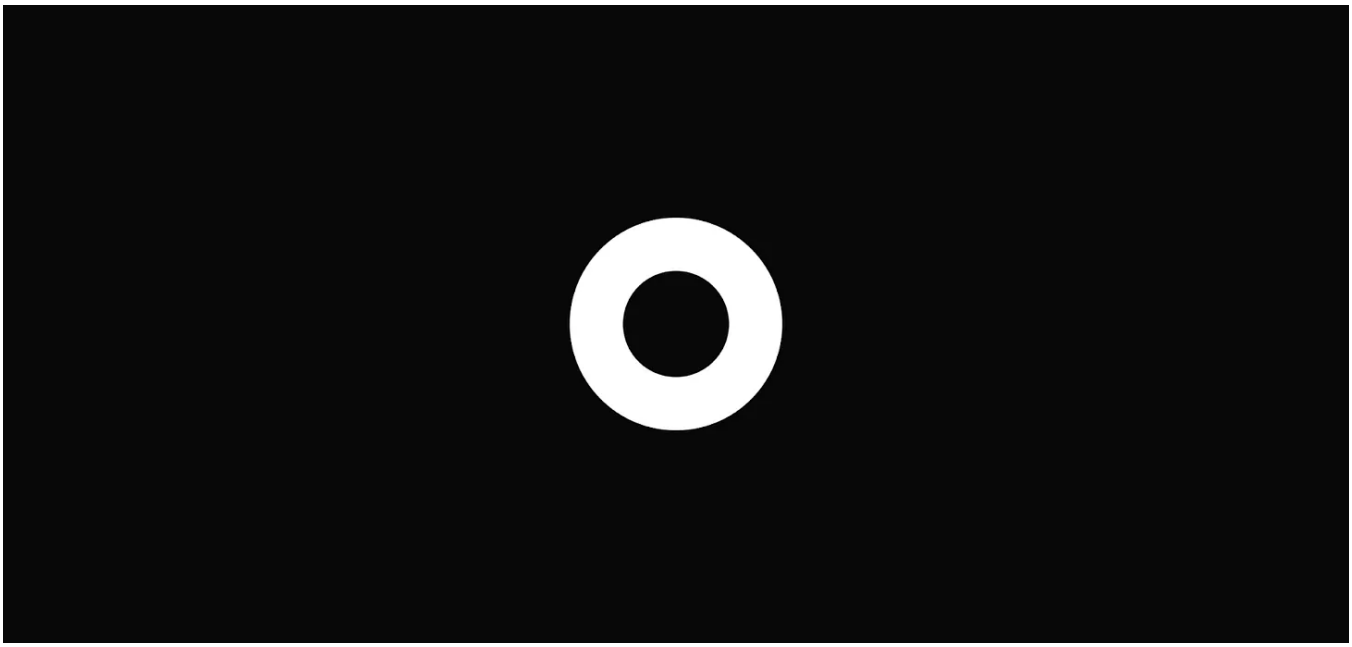


Figure 1: Pak's signature symbol, a minimalist white ring on black known as "The Nothing," used as the artist's persistent identity across social media and NFT platforms.

Abstract

Protocol art has recently proliferated through blockchain-based smart contracts, building on a century-long lineage of conceptual, participatory, interactive, systematic, algorithmic, and generative art practices. Few studies have examined the characteristics and appreciation of this emerging art form. To address this gap, this paper presents an annotated portfolio analysis of protocol artworks by Pak, a pioneering and influential pseudonymous artist who treats smart contracts as medium and collective participation through protocol as message. Tracing the evolution from early open-edition releases of *The Fungible* (2021) and the dynamic mechanics of *Merge* (2021) to the soul-bound messaging of *Censored* (2022) and the reflective absence of *Not Found* (2023), we examine how Pak choreographs distributed agency across collectors and autonomous code, demonstrating how programmable protocols become a social fabric in artistic meaning-making. Through thematic analysis of Pak's works, we identify seven core characteristics distinguishing protocol art from other art forms: (1) system-centric rather than object-centric composition, (2) autonomous governance enabling open-ended control, (3) distributed agency and communal authorship, (4) temporal dynamism and lifecycle aesthetics, (5) economy-driven engagement, (6) poetic message embedded in interaction rituals, and (7) interoperability enabling composability for emergent complexity. We then discuss how these features set protocol art apart from adjacent movements such as conceptual, generative, participatory, interactive, and performance art. By analyzing principles grounded in Pak's practice, we contribute to the emerging literature on protocol art (or "protocolism") and offer design implications for future artists exploring this evolving form.

CCS Concepts

• **Human-centered computing** → **Collaborative and social computing theory, concepts and paradigms**; **Interaction design theory, concepts and paradigms**; • **Applied computing** → **Media arts**; • **Information systems** → **Multimedia information systems**.

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Keywords

Protocol Art, Smart Contract, Blockchain, Decentralized Control, System Art, Generative Art, Participatory Art, Open-endedness, Protocolism, Systems Aesthetics, Collective Behavior

ACM Reference Format:

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1 Introduction

Over the last decade, the advent of blockchain networks, smart contracts, and non-fungible tokens (NFTs) has transformed digital culture by relocating trust from central institutions to cryptographic code—famously encapsulated in the motto *"code is law"* [24]. Beyond reshaping finance through decentralized finance (DeFi), these technologies have begun to reconfigure artistic practice. An emerging cohort of artists now treat smart contracts as their medium, designing works whose meaning unfolds through on-chain participation. Pioneering projects such as Paul Seidler's *terra0* (2016)[1] [33], which frames a forest as a self-owning economic entity [43], Sarah Friend's socially-driven on-chain *Lifeforms* (2021)[2] [19], and Primavera De Filippi's robo-botanical *Plantoid* series (2015)[3] [18] illustrate how smart-contract logic can serve as a medium to distribute creative agency through participation. In these works, *"the aura of the artist is on maintaining the process"* [15], as code and crowd together generate the artistic outcome. Recent exhibitions such as *World Computer Sculpture Garden* (2024)[4] [1] have further foregrounded this shift, showcasing smart contracts as sculptural pieces that exist immutably on Ethereum: *"This permissionless computing platform has been reimagined as one, functioning simultaneously as archive, gallery, and economy."* [39] Together, these examples signal the emergence of what is increasingly termed *protocol art*.

Yet the concept of protocol art remains theoretically unsettled. De Filippi [15] defines protocol art as an art form where *"protocols serve as the bridge between two pivotal figures: the original artist (i.e., the 'protocol artist') and a diverse array of executors (both human and non-human)."* These protocols *"comprise sets of instructions and constraints meticulously crafted to guide the production of unique artworks"* [15]. While evocative, this definition is very broad in practice. It is difficult to distinguish protocol art from other long-standing rule-based art forms. For example, instruction-based conceptual art—such as Sol LeWitt's [25] procedural *Wall Drawing* series [28], Yoko Ono's participatory *Cut Piece* (1964) [32], or Marina Abramović's durational *The Artist Is Present* (2010) [5]—relies on rules and audience action. Generative software artworks follow similar principles, including Vera Molnár's early algorithmic art and contemporary AI-generated pieces [29]. Recent blockchain-based generative NFT platforms such as Art Blocks[5] invite collectors to mint their own algorithmic editions—originally generated from art code in smart contracts. Although some pieces are interactive, allowing interaction through webpages, they rarely involve dynamic interaction and evolution at the smart-contract level once minted. *"The blockchain is not a distribution channel for images but rather the material of the art itself."* as curator Malte Rauch (@maltefr) argued in his introductory essay to *World Computer Sculpture Garden* [39]. A gap persists between broad definitions of protocol art and the specific protocol-art practices now emerging from the use of smart contracts as artistic medium.

Our research question is: *What distinct characteristics define protocol art as evidenced through real-world practices?*

We address this gap through an annotated portfolio analysis [14, 21] of the pseudonymous artist **Pak**[6], who is widely credited with establishing protocol art's foundational vocabulary. Our focus on a single artist is methodologically purposive rather than a sampling limitation: in emerging fields, paradigmatic cases—exemplars that establish the conventions and possibilities of a new form—merit intensive single-case analysis. Just as Duchamp's readymades warranted deep study to understand conceptual art's foundations, or as John Cage's compositions required close analysis to theorize indeterminacy in music, Pak's protocol artworks represent the paradigmatic instantiation of smart-contract-as-medium practice. Pak did not merely participate in protocol art—Pak effectively *invented* its vocabulary: open-edition time-scarcity (*X*, 2020), deflationary merging mechanics (*Merge*, 2021), burn-to-mint economies (*burn.art*, 2021), soul-bound protest tokens (*Censored*, 2022) [54], and tokenized absence (*Not Found*, 2023). These mechanisms have since been widely imitated across thousands of NFT projects but never surpassed in conceptual sophistication. Each work demonstrates how participatory on-chain interaction can deliver poetic meaning: collectors are not merely purchasers but co-authors who experience the artwork through its evolving mechanics—whether through token fusion, auto-merging mass, or hidden messages revealed only under certain conditions. This participatory design transforms algorithmic logic into a collective movement that prompts social reflection and generates significant cultural and economic impact. Notably, *Merge* realized $91.8 million in primary sales in December 2021, heralded at the time as *"the largest-ever public sale of an artwork by a living artist"* [7, 52]. By embedding metaphors directly in code while enlisting thousands of participants, Pak's oeuvre offers a fertile—and uniquely well-documented—corpus for examining the intertwined dynamics of protocol mechanics, collective engagement, and conceptual intent.

In the remainder of this paper, we analyze Pak's key works to derive common characteristics of protocol art. We present seven salient characteristics that recur across Pak's protocol artworks, which together form what we term Pak's *protocol aesthetic*. Then, we discuss how these traits distinguish protocol art from adjacent art movements such as conceptual, systemic, generative, participatory, interactive, and performance art, and we outline limitations of our single-artist study along with directions for future research. We conclude by reflecting on how protocol art (or "protocolism") expands the discourse of digital art and offers new opportunities for artists to engage code, community, and concept as one autonomous system.

[1] https://terra0.org/
[2] https://lifeforms.supply/
[3] https://plantoid.org/
[4] https://worldcomputersculpture.garden/
[5] https://artblocks.io/
[6] https://x.com/muratpak

2 Background

2.1 Emerging Protocol Arts

Web3 technologies—blockchains, smart contracts, and non-fungible tokens (NFTs)—reconfigure the terms of authorship by shifting enforcement from institutions to code [44]. Smart contracts are self-verifying, self-executing, tamper-resistant programs that guarantee rule compliance without a central authority [53]. NFTs assign cryptographic provenance and ownership to digital artifacts. Together, these technologies allow artists to publish works that run autonomously and invite permissionless participation. As collectors interact on-chain—minting, trading, or triggering contract functions—the artwork's state can evolve in real time, making the protocol, rather than any single static output, the true locus of creativity [22, 55]. Smart-contract infrastructure enables this participatory evolution at global scale. Chris Dixon argues in *"Read Write Own"* [16] that ownership distinguishes Web3 from Web2's write and Web1's read—blockchain networks grant power and economic benefits to communities of users. By reshaping ownership, web3 has revived and radically extended the lineage of participatory art [6]: art in which the public co-owns and co-produces the piece through autonomous participation governed by protocols.

Several early projects foreshadowed the protocol art paradigm. *terra0* (2016) presented a vision of an artwork that manages itself: a forest equipped with sensors and coded as a Decentralized Autonomous Organization (DAO) that sells its lumber rights to fund its own growth [33, 42]. Primavera De Filippi's Plantoid (first created in 2015) [18] embeds a robotic "flower" sculpture in Ethereum such that donors collectively "pollinate" the piece with cryptocurrency to fund the creation of new offspring sculptures. By 2024, exhibitions such as *World Computer Sculpture Garden* [1] showcased artists (among them 0xhaiku, Absent, Loucas Braconnier (Figure31), Sarah Friend, Material Protocol Arts, Rhea Myers et al., Paul Seidler) whose works exist solely as on-chain contracts, reinforcing the idea that the protocol itself can be the artistic material [39]. Rhea Myers's collected writings further document how smart contracts have been used as an artistic medium since 2011 [30].

The pseudonymous artist **Pak**—also known as Murat Pak—is best known for harnessing blockchain smart contracts as an artistic medium. Early work included creating the AI-curation bot Archillect[7] in 2014. Pak shifted to smart contracts in 2020 and quickly became one of the field's most commercially successful and conceptually adventurous figures. The artist's anonymity (some speculate "Pak" may be a collective) and code-driven practice challenge traditional ideas of authorship and ownership. Record-breaking projects such as Merge have placed Pak among the highest-grossing living creators in any medium [52]. Pak's projects innovate in protocol mechanisms, inviting thousands of collectors to fuse tokens, burn assets for new tokens, redact and reveal messages, or accumulate "mass"—demonstrating that participatory creativity can be both conceptually rich and commercially significant.

Collectively, these examples point to an emerging genre—protocol art—in which the rules encoded on-chain constitute the work, and the audience's transactions constitute its performance.

[7] https://archillect.com/

2.2 Defining Protocol Art?

Multiple disciplines offer definitions of protocol. In computer networking, a protocol is *"a set of rules for formatting and processing data,"* a common language that enables coordination among machines [49]. Media theorist Alex Galloway famously broadened this concept: "protocol" is the principle of organization that governs distributed systems—*"how control exists after decentralization"* [20]. Venkatesh Rao and colleagues, in the Summer of Protocols[8] research initiative, describe protocols as *"a stratum of codified behavior from which complex coordination can emerge"* [38]. The material embodiment of a protocol can range from written rules to cryptographically enforced software; what varies is the *"hardness of trust"*—i.e. how difficult it is to deviate from the rules [47].

Within the arts, in her essay *"Protocolism: The Evolving Landscape of Art in the Age of AI"* [15], originally published in *All Media is Training Data*, protocolism has been advanced by De Filippi to describe practices that use protocols to choreograph diverse human and non-human executors in the production of artworks [15]. However, as noted above, this umbrella definition can be too broad when applied to art. Are instruction-based conceptual works like Sol LeWitt's wall drawings "protocol art"? One might argue yes: LeWitt often did not execute his own wall drawings—he sold the "recipe" or instructions (a kind of artistic protocol) to be faithfully executed by others, meaning the artwork is essentially a set of rules carried out by participants. Similarly, is a classic participatory performance piece like Marina Abramović's *The Artist Is Present* (2010) [5] a protocol artwork? The piece had a simple rule: viewers took turns sitting silently across from the artist for a duration, exploring presence and connection. One could view this as a human protocol enacted in a gallery. Even modern generative NFT platforms such as Art Blocks, where collectors mint outputs from pre-written algorithms, involve protocols of creation. What, then, distinguishes protocol art in the context of Web3?

Following the essay *"Computation in the Expanded Field"* [39], Malte Rauch argues that true protocol artists *"are primarily concerned with foundational structures or sets of rules that precede and define a computing environment"*. In these works, *"The blockchain is not a distribution channel for images but rather the material of the art itself."* The artistic focus shifts from static outputs to the system of rules [35, 40]. In other words, what sets protocol art apart is that the rule-set autonomously generates and governs the art experience over time, without further intervention. Traditional conceptual or generative art [9] uses instructions or code to produce a finished piece—perhaps an interactive one. Protocol art, however, uses instructions or code to create an open-ended process or system that invites collective participation through co-creation of meaning and co-ownership of the piece. As we will show through Pak's work, protocol art emphasizes system-centric creation, persistent autonomy, communal participation, temporal evolution, integrated economic and social incentives, and cross-project interoperability—together resulting in a distinctive aesthetic and conceptual stance. However, the terrain of protocol art continues to be shaped as more artists join this movement, with emerging critical [34, 36] and ethical [12] perspectives enriching the discourse. Defining protocol art is still far from consensus and remains an ongoing process.

[8] https://summerofprotocols.com/

3 Method

To investigate the emerging characteristics of protocol art, we conducted an annotated portfolio analysis [21] of Pak's nine selected landmark protocol artworks, listed in Table 1. We compiled data from four complementary strata: (1) On-chain evidence—we examined smart-contract source code and transaction logs for every major Pak project (using resources like Etherscan[9] and Dune Analytics[10]); (2) Project interfaces—we reviewed official launch webpages, marketplace listings (e.g., Nifty Gateway[11] drop pages), and any interactive frontend elements; (3) Discourse layer—we gathered journalistic articles, critical essays, and high-signal social media threads (e.g., Twitter analyses) that captured community reception and interpretation; (4) Authorial voice—we collected Pak's own statements from archived interviews and tweets to understand the artist's intent in each project.

Corpus Selection. We assembled a portfolio of Pak's protocol artworks using purposive sampling with explicit inclusion criteria: (1) the work's primary medium is smart contract mechanics, not merely NFT-based distribution of pre-existing digital images; (2) the work involved documented collective participation, operationalized as more than 100 unique wallet addresses interacting with the contract; (3) the work generated substantial critical discourse, operationalized as at least three independent published analyses in art journalism, academic venues, or high-engagement social media threads. Nine works met all criteria (Table 1). We excluded Archillect (Pak's 2014 AI curation bot, which predates blockchain and lacks protocol art characteristics) and minor releases without significant documentation or collective participation.

LLM-Assisted Data Gathering. We broadened coverage by deploying a large-language-model agent (ChatGPT-o3, March 2024 version) to aggregate publicly available references to each artwork. The prompt template was: "Compile all publicly documented information about [artwork name] by Pak, including: official announcements, smart contract mechanics, critical reception, and participation statistics. Cite sources." LLM outputs served as initial summaries requiring human verification. The first author independently verified all factual claims against primary sources: smart contract code on Etherscan, official project websites, archived tweets, and transaction records on Dune Analytics. Discrepancies were resolved in favor of primary sources.

Thematic Analysis. Guided by theoretical sampling, we subjected the aggregated dataset to iterative open coding. Initial codes were generated inductively from the first three works (*X*, *The Title*, *The Fungible*), yielding 23 preliminary codes (e.g., "time-based scarcity," "collector-as-author," "economic gamification"). These codes were refined through constant comparison with subsequent works, guided by prior scholarship on conceptual art [25], systems art [11], generative art [9], participatory art [6], and interactive art [41]. After analyzing *Merge* (the fourth work), codes stabilized into seven analytical categories: (1) Concept; (2) System–mechanism dynamics; (3) Participatory interaction; (4) Artist's control; (5) Collective emergent behavior; (6) Poetic meaning-making; (7) Key statistics; and (8) Annotation. The LLM agent assisted in initial classification under the first seven lenses (see Appendix A for compiled entries), after which one human researcher manually verified, corrected, and enriched every entry with additional details from primary sources. The eighth lens, Annotation, was composed entirely by the human researcher, mapping each work to the seven characteristics identified in Section 4 and providing interpretive commentary grounded in the verified data.

During focused coding, we refined the properties and dimensions within each lens and constructed a comparative matrix of all projects (distilled in Table 1). We then performed axial coding to trace connections across lenses and identify higher-order themes and consistent patterns. This process yielded a grounded characteristic model of Pak's protocol art practice that structures the discussion that follows.

4 Results: Characterizing Pak's Protocol Arts

Our analysis reveals that Pak's work forms a coherent yet evolving family of protocol artworks. Their aesthetic power lies not in visual form but in the programmable conditions that orchestrate collective action. Across nine landmark projects—*X* (2020)[12], *The Title* (2021)[13], *The Fungible* (2021)[14], *burn.art* (2021)[15], *Lost Poets* (2021)[16], *Invisible Mechanism* (2021), *Merge* (2021)[17], *Censored* (2022)[18], and *Not Found* (2023)[19], we observe a noticeable set of characteristics. Together, these characteristics constitute what we call Pak's *protocol aesthetic*—a design grammar that transforms blockchain infrastructure into a stage for large-scale participatory meaning-making. We articulate this aesthetic through seven interlinked characteristics, elaborated in the subsections below.

4.1 System-centric rather than object-centric composition

Pak's practice exemplifies a shift from creating discrete art objects to designing dynamic systems. In a *"systems aesthetic"* as theorized by Jack Burnham in the late 1960s [11], the artist defines goals, rules, and interactions rather than crafting a fixed artifact. Unlike a static painting or sculpture with defined forms, a system-based artwork can evolve over time and respond to external inputs. Pak explicitly embraces this ethos. Pak has argued in interviews and on social media that an NFT's image is merely one element of a token's metadata, and that focusing only on the visual aspect is "*a naïve frame of view*" (implying that the structure and behavior encoded in the token are equally part of the art). The true medium for Pak is the underlying protocol—"*the structure of the NFT market itself*" [27], which Pak leverages as a creative material [35].

This system-centric approach is evident in works like *The Fungible* (2021). Rather than a singular digital image, *The Fungible* was presented as a three-day performative market game on Nifty Gateway. Buyers effectively co-created the outcome: they could

[9] https://etherscan.io/
[10] https://dune.com/
[11] https://niftygateway.com/
[12] https://opensea.io/collection/x-by-pak
[13] https://niftygateway.com/collections/thetitle
[14] https://www.sothebys.com/en/digital-catalogues/the-fungible-collection-by-pak
[15] https://burn.art
[16] https://lostpoets.xyz/
[17] https://www.niftygateway.com/collections/pakmerge/
[18] https://opensea.io/collection/censored-pak-assange
[19] https://opensea.io/collection/in-memory-of-the-absent

Project (Year)	Description	Participatory Interaction	System Mechanism	Artist's Control	Participants / Scale	Collective Emergent Behavior
X (2020)	Introduced time-based scarcity with a 24-hour unlimited open edition, shifting value from object to moment.	24-hour open-edition mint; collectors could mint unlimited copies within the time window.	Time-based scarcity: supply fixed by duration, not by a preset count.	None after launch (rules immutable once deployed).	15 NFT pieces; 13 open editions (61 editions minted) + 2 one-of-one auctions (unique pieces). Hundreds of wallets participated.	"FOMO"-driven rush as deadline approached; final supply decided by community minting behavior.
The Title (2021)	Identical image sold under differently priced on-chain names, showing metadata (title/pricing) can dictate value more than pixels.	Fixed-price and auction sales of visually identical NFTs, each bearing a different on-chain title and price; one piece intentionally left unsold.	Value experiment: image constant, metadata (title + scarcity) varies per token.	Only predetermined prices/titles; tokens immutable after mint.	9 token types (6 sold via various formats, 1 remained unsold, plus gifts); ~300 total editions; dozens of collectors across formats.	Community debate on what confers an NFT's value (image vs. narrative vs. price); social media buzz about who obtained "*The Expensive*," etc.
The Fungible (2021)	Sotheby's open-edition turned fungibility into spectacle: thousands of interchangeable cubes questioned uniqueness.	Hybrid drop: open-edition "Cube" tokens minted in large quantities + puzzle/leaderboard rewards during a Sotheby's event.	Fungible cubes could be aggregated into higher-tier NFTs; gamified rewards for top accumulators and puzzle solvers.	Rules and reward tiers fixed in contract; artist manually validated puzzle answers and distributed bonus NFTs.	23,598 cubes bought by 3,080 wallets → yielded 6,165 unique NFTs (after merging by quantity).	Competitive accumulation (to get larger cube clusters); cooperative puzzle-solving; viral social media tasks as part of the game.
burn.art (2021) / $ASH	Perpetual "creation-through-destruction": burn any NFT to mint the social currency $ASH, gamifying scarcity.	Ongoing: anyone can burn any NFT on the platform and receive $ASH (ERC-20 token) via a bonding-curve formula.	"Creation via destruction": burn an NFT, get fungible $ASH; token yield halves at supply milestones.	Contract rules fixed; artist later released drops purchasable only with $ASH, influencing demand.	Thousands of NFTs burned; thousands of $ASH holders emerged.	Emergent burn economy: holders strategized which NFTs to sacrifice; a subculture of "burners" formed, embracing destruction as creation.
Lost Poets (2021–22)	Multi-stage strategy game of 65,536 AI-generated Pages evolving or burning into Poets; collectors co-wrote an ever-shifting narrative.	Multi-stage narrative game: 65,536 "Page" NFTs sold; holders could burn Pages for $ASH or transform Pages into AI-generated "Poet" NFTs; on-chain naming of Poets.	Multi-act smart contract: burn-vs-mint branching, periodic airdrops of 1,024 special "Origin" Poets to top participants; progressive trait reveals over time.	Pak triggered each Act (I–IV) via contract calls and airdrops, but could not reverse user choices or outcomes once each phase started.	Approx. 8,000 unique holders; resulted in approx. 28,000 Poet NFTs (others remained as Pages or were burned).	Rich strategy debates (whether to keep Pages, burn for $ASH, or transform to Poets); "naming guilds" formed to coordinate thematic naming; puzzle-hunting for hidden clues in traits.
Invisible Mechanism (a.k.a. Hate) (2021)	Premiered a `move()` contract granting unilateral token relocation by the artist—an audacious take on creator sovereignty.	Airdrop performance: 30 of Pak's outspoken critics were invited to provide wallet addresses and received non-transferable "Hate" NFTs.	Custom Move contract: tokens soul-bound to recipient (non-transferable), with an admin-only `move()` function letting the artist seize or relocate tokens at will.	Absolute control: artist could reclaim or change tokens at any time; recipients had no control.	30 forced participants (recipients of the airdrop).	Sparked wide discussion on ownership and power asymmetry in NFTs; recipients tried and failed to remove tokens; community debated the ethics of an all-powerful contract.
Merge (2021)	312,686 "mass units" sold that algorithmically fused into larger single tokens after transfers—ownership as live sculpture.	48-hour open sale of "mass units"; every buyer received a single NFT whose "mass" automatically increased as they bought or acquired more units.	Self-merging deflationary tokens: all units in one wallet fused into one token; built-in leaderboard tiers (numbered 1–4 by color, with a dynamic "Alpha" class for the top holder).	Rules fixed in code; artist only involved post-sale via orchestrating an ARG and acknowledging top holders.	28,983 buyers; 312,686 total mass units sold ⟶ resulted in 28,983 NFTs at sale end (one per buyer).	Frenzied "mass hoarding" competition; after sale, mergers between wallets reduced token count ("extinction game"); a DAO ("Internship") even formed to collectively purchase the largest mass (Alpha).
Censored (2022)	With Julian Assange: DAO-funded 1/1 "Clock" counting prison days plus open-edition Messages—provenance weaponized for protest.	Two-part project: (a) a one-of-one Clock auction via DAO, (b) a 48-hour open-edition Message mint where anyone could submit any text at any price.	(a) Clock is a dynamic counter tied to Assange's status (days in prison, now days free since his June 2024 release); (b) Message NFTs initially showed each text as blacked-out and were revealed upon Assange's release.	Clock runs autonomously; reveal was bound to Assange's release (triggered June 2024); messages are immutable once written (Pak cannot alter or censor them).	Clock was won by AssangeDAO (10,000+ members collectively own it); 29,766 Message NFTs were minted (one per wallet).	Grass-roots mobilization: a global DAO formed to bid for Clock; thousands minted censored messages creating a "censored chorus." Shared anticipation of the potential reveal unites participants; project bridged crypto art and political activism.
Not Found (#404) (2023)	A 1-of-1 NFT deliberately devoid of metadata (token ID 404), transforming "page not found" into a meditation on digital absence.	Single 1-of-1 charity auction; NFT token has no image or metadata (only token ID "404" visible).	"Deliberate absence": token's metadata contract returns the string "In memory of the absent" instead of standard metadata, referencing the HTTP 404 error via its token ID.	Designed absence: artist coded the contract to return only a memorial string in place of metadata; the metadata contract is technically mutable but left empty by intent.	1 owner (noted collector WhaleShark won the auction).	Community reflection on owning "nothing"; sparked discourse on whether a void can be art. Served as a memorial tribute (for the late Alotta Money) that many in the community shared and discussed.

Table 1: Comparative overview of selected Pak projects

purchase unlimited open-edition "Cube" tokens, and *"the more they bought, the more unique their NFT would be"*. The artwork unfolded through rules of supply and demand, competition, and reward, blurring the line between artistic composition and economic system. Similarly, Pak's earlier collection *X* (2020) consisted of "infinite editions" available for only one day, such that scarcity was determined by time and participation rather than a predefined edition size. In all these cases, what constitutes the artwork is not a static file but the entire process governed by protocol: the contracts, algorithms, and user interactions that generate the final outputs. This aligns with Burnham's notion that in system-based art *"all phases of the life cycle of a system are relevant"* and there is *"no end product that is primarily visual"* [11]. Pak's art finds its form in the living system of relationships and behaviors, not in a singular immutable image.

4.2 Autonomous governance for open-ended control

Many of Pak's projects foreground autonomous processes and decentralized control, resonating with concepts of generative autonomy in both blockchain and artificial life. On the blockchain, smart contracts act as self-governing *"digital physics"*—immutable rule sets that execute without centralized oversight [26]. This allows artworks to behave like autonomous entities. For example, *Merge* (2021) implemented a self-contained rule whereby all purchased units automatically "merged" into singular tokens in each wallet at the close of the sale, without any manual intervention. The final form emerged from the contract's code and collective user actions, illustrating open-ended control dictated by an algorithm. Pak often cedes such control to the system itself or the community, allowing outcomes beyond a single author's full prediction.

This ethos connects to emerging *"autonomous worlds"* [26] in crypto art, and is exemplified by projects like Primavera De Filippi's Plantoid, an art piece that lives on a DAO and *"reproduces itself"* via smart contract governance. In Plantoid, people who hold "seed" NFTs fund and vote on the creation of new instances, effectively making the artwork a self-propagating entity. Pak's work incorporates similar principles of shared or automated governance. In *Censored* (2022), the one-of-one *Clock* NFT was auctioned not to an individual but to AssangeDAO, a collective of over 10,000 people pooling funds to bid. A decentralized community thus became the owner, blurring the line between patron and curator through collective governance. Moreover, Pak's *burn.art* platform runs as an ongoing autonomous mechanism: anyone can send an NFT to be burned at any time in exchange for $ASH, which in turn can be used in future projects. This *"never-ending 'Buy–Burn' game"* can continue indefinitely by design, illustrating how the artwork's evolution is handed over to participant actions and blockchain logic. Such autonomous, perpetual systems align with the idea of art as an "unstoppable" process—a *"complex living system"* on chain that *"no single entity can halt"* [23]. Pak's protocol art thus moves toward open-endedness, where creation and control are distributed across code and community rather than centralized in the artist.

4.3 Distributed agency and communal authorship

Pak's protocol-based artworks distribute creative agency among many participants, inviting communal authorship of the art. This follows a broader trend in generative and participatory art where creators *"collaborate with users—either collectors or other artists—to distribute control,"* effectively denying any single central author. In Pak's projects, collectors and players are not passive owners but active co-creators of meaning and content. *Lost Poets* (2021) makes this clear: after minting their AI-generated Poet NFTs, collectors were empowered to name their poets and even invent backstories or verses for them, literally inscribing personal creativity into the work's metadata. As Pak's team noted, the *"discoverers of this civilization will shape it,"* meaning the community of holders defines the cultural narrative of the piece. Indeed, many participants wrote original poems and titles for their Lost Poets tokens, blending their own literary voice with Pak's conceptual framework.

Similarly, *Censored* (2022) turned its audience into co-authors. During the 48-hour open edition, nearly 30,000 messages were tokenized by users and added to the Censored collection. Each participant essentially created a piece of the overall artwork by embedding a personal message on the blockchain. The final collection is thus a mosaic of voices from the community ("Pak & Assange & You," as the creators billed it), rather than a singular narrative. Even *Merge* can be seen as distributing authorship: almost 30,000 buyers collectively determined the supply and composition of that work's outcome, making the *"most expensive NFT"* [13] a product of crowd dynamics as much as Pak's initial concept. This radical dispersal of agency recalls Umberto Eco's idea of the "open work," extended into the tokenized realm—the artwork is an evolving network of contributions. By building frameworks that require audience input to complete the work, Pak positions the community as co-creators—enacting what Zeilinger terms *"structures of belonging"* beyond mere ownership [56]. The artistic authorship becomes plural and emergent from the group, rather than originating solely from the individual artist.

4.4 Temporal dynamism and lifecycle aesthetics

Pak's works are not static snapshots; they unfold over time, embracing change, ephemerality, and defined life cycles as core aesthetic elements. In classical systems art, the *"consistency of a system may be altered in time and space"* and all stages of its life cycle become material for the artwork. Pak's projects exemplify this temporal dynamism. *Lost Poets* (2021) was structured as a narrative in multiple acts—from the initial sale of "Pages," to a delayed Reveal where pages transformed into Poet NFTs, through daily drops of special "Origin" Poets, and onward towards a planned "Twist" and final Epilogue after 365 days. The piece lives and evolves across an entire year, its full meaning only emerging gradually as collectors engage over time. This built-in lifecycle—birth (minting), maturation (naming and interacting), and an end-state after one year (when burning for $ASH is enabled)—turns time into an artistic medium.

Other Pak works similarly rely on temporal structure. *Censored*'s *Clock* is explicitly a time-based artwork: a dynamic counter tethered to Assange's real-world status—it tallied his days in prison until his release in June 2024, at which point it began counting days of freedom. The open edition portion of Censored was also time-limited to 48 hours, highlighting the urgency and performative moment of the audience's participation. In *X* (2020), each NFT "moment" was only available during a one-day window, making *"one single day of infinite existence"* the defining limit of each edition. Scarcity and content in X were thus time-contingent: the fewer people who acted within the day, the fewer copies existed. Even Pak's market dynamics often have temporal phases (for instance, The Fungible's escalating price tiers each day). By designing pieces with evolving states and deadlines, Pak *"recreates the cycle of life"* in digital form, acknowledging that in a systemic artwork, impermanence and transformation are not byproducts but the very substance of the art.

4.5 Economy-driven engagement

Pak's projects deliberately intertwine economic mechanisms with artistic interaction, turning market dynamics into part of the artistic experience. In many cases, the engagement of the audience is driven by financial gameplay—bidding wars, token burns, price competition—such that market participation becomes a form of performance. The Sotheby's sale *The Fungible* is a paradigmatic example: it deployed a complex auction structure with open editions, surprise price hikes, and contests for unique rewards, effectively a "gamified" economic performance. This not only generated approximately $16.8 million in sales, but also created a frenzy in which *"more than 3,000 individuals decided to join,"* drawn in by the competitive game itself. The mechanics of scarcity and reward (e.g., top buyers receiving special NFTs) were designed to incentivize maximal participation. Here the market behavior was the art: once *"the game and competition incentives disappear,"* what remains are tokens whose value was defined by that performative context. Pak thus highlights, even cynically, the extent to which economic structures confer meaning in crypto art [36].

In Pak's oeuvre, the act of buying or transacting becomes a critical ritual and medium. *The Title* (2021) consisted of identical images sold at different prices, making price itself the distinguishing feature of the artwork. One edition titled "Unsold" was listed for $1 million and intentionally left unsold—a conceptual gesture underlining how value in art can be a product of hype and perception. This recalls Yves Klein's 1957 exhibition of identical blue canvases sold at varying prices; as Klein observed, *"the price… legitimately changes the experience of the work"* despite no physical difference. Similarly, Pak has argued that an NFT is like a currency—judging it by the image alone is as foolish as picking a banknote. By merging art and economics, Pak invites collectors to reflect on their own motivations—are they driven by aesthetic appreciation or speculative gain? The economy around the artwork becomes integral to its narrative, effectively turning collectors into players in a financial drama. In Pak's protocol art, market engagement is not a byproduct but a core feature that actively shapes the work itself.

4.6 Poetic message embedding in interaction rituals

Beyond the technical and economic layers, Pak's works often carry metaphorical or poetic messages that are realized through the audience's interactive rituals. In other words, the process a participant must follow is itself laden with symbolic meaning. Critic A.V. Marraccini notes that Pak treats the NFT medium as *"a way to engage audiences in participatory conceptual art"*—the concepts emerge through what the viewers or users are made to do. For instance, burn.art turns the destructive act of burning NFTs into a creative ritual. The platform's mantra *"Burn art to get ashes to get art to burn art"* is a circular poem in itself, invoking themes of death and rebirth. Participants enact a cycle of sacrifice and renewal: by destroying one token, they generate another (the $ASH token), which can then be spent on new art or even burned again. This cyclical interaction is a performative allegory about value and transformation—literally illustrating creation-through-destruction in a way that words alone could not.

Pak's collaborations also embed messages in their structure. *Censored* (2022), created with Julian Assange, is explicitly about free expression and censorship. The project had two parts—one a dynamic single edition (Clock) counting Assange's days behind bars, and the other an open invitation for people to speak. By telling users that *Censored* is "about you" and allowing them to tokenize any message they wish, Pak made the audience's personal expression the core of the piece. The very name *Censored* reminds participants that their recorded messages might be obscured or blacked out, forcing reflection on the power of speech under observation. In *Lost Poets*, Pak evokes Jorge Luis Borges's Library of Babel: an infinite library of all possible texts. The project *"enlists participants to imagine"* the lost contents of that library by naming their Poet NFTs and eventually inscribing words onto them. The ritual of naming and writing thus becomes a meditation on how meaning is generated—each user's creative act is a fragment of a larger, hidden poem. Pak uses these game-like interactions not just as gimmicks but to convey ideas: the audience realizes the "poetic" concept by performing it. This approach recalls aspects of Fluxus or conceptual art, where simple actions (publishing a message, paying an exorbitant sum) become symbolic acts. The blockchain in Pak's work provides a global, participatory stage for such rituals, ensuring that each interaction—each burn, each tokenized word—is both an artwork and a narrative gesture in Pak's conceptual universe.

4.7 Interoperability enabling composability for emergence

Finally, Pak's protocol-based approach leverages the interoperability of blockchain tokens to compose complex emergent ecosystems that transcend any single artwork. In blockchain terms, assets and smart contracts are composable: they can interact, integrate, or build upon each other permissionlessly. Pak exploits this composability to create an interlinked network of projects. The clearest example is the $ASH token ecosystem. After *The Fungible*, Pak introduced $ASH as a cryptocurrency earned by burning NFTs on burn.art. This token was not confined to one piece, but became a connective thread between works—a meta-artwork in its own right. Owners of $ASH were rewarded in subsequent projects: before launching *Lost Poets*, Pak took a snapshot and airdropped 7,586 Pages to collectors holding at least 25 $ASH, thus bridging the burn.art economy with the new literary NFT game. Conversely, once Lost Poets concluded, those Poet NFTs could be burned for $ASH, feeding value back into the burn.art system. In this way, Pak created a feedback loop: one artwork's output becomes another's input. The emergent whole is an ecosystem of NFTs and tokens co-evolving across Pak's oeuvre.

This interoperability enables creative "combinatorics" that yield unforeseen outcomes. Smart contract platforms allow *"multiple 'worlds' to intertwine,"* as researchers note, forming a *"persistent, yet sufficiently complex environment"* where artworks can coexist. Pak's art inhabits this multiverse. A token like $ASH grants access to exclusive drops and collaborations (a composable utility), while the act of burning or merging tokens can spawn new forms and communities. By giving participants portable assets that carry value and function across different contexts, Pak encourages emergent behavior. Collectors speculate, strategize, and invent new

use-cases (for example, pooling $ASH or devising burn strategies), effectively participating in the evolution of the creative system. As one commentator observed, Pak's project proved that on blockchain *"individuals can exercise personal control over value, create niche ecosystems… without the sluggish constraints of fiat,"* demonstrating the *"power of creative tokenomics"* in art.

5 Discussion

5.1 Characteristics of Pak's Protocol Artworks

This study's exploration of Pak's protocol artworks reveals seven interlinked characteristics that distinguish protocol art as a practice. **(C1)** These works are fundamentally system-centric rather than object-centric. Their artistic meaning emerges from dynamic interconnectedness via protocols instead of static artifacts. **(C2)** As Galloway claimed *"protocol is how control exists after decentralization"* [20], protocol arts employ autonomous governance for open-ended control, often via self-executing code or decentralized mechanisms, so that the artwork's evolution is not predetermined by a single author but can continue to unfold indefinitely. **(C3)** This leads to distributed agency and communal authorship, as creative influence is spread across many participants and technical actants rather than residing in one creator, aligning with the idea that agency (and thus authorship) is shared among human and non-human actors in a network. **(C4)** Moreover, these artworks exhibit temporal dynamism and lifecycle aesthetics: they develop through time, with phases of growth or change designed into the experience, so that process and feedback become central to their aesthetic. **(C5)** Engagement with such works is often economic-driven, integrating incentive structures (for example, token rewards or market dynamics) that actively shape how audiences interact—a phenomenon noted by art scholars observing the immediate economic incentives at play in crypto art. **(C6)** At the same time, there is a deliberate embedding of poetic messages in interaction rituals: the very actions participants perform (trading, voting, combining elements, etc.) are imbued with symbolic meaning, turning user interactions into ritualized performances that carry the artwork's conceptual message. **(C7)** Finally, protocol artworks leverage interoperability enabling composability for emergence, meaning they are designed to plug into larger ecosystems of code and community; like modular components, they can be reconfigured or linked with other protocols, allowing unexpected behaviors and creative outcomes to emerge from these combinations. Collectively, these seven characteristics illustrate how protocol art shifts the locus of art-making from singular objects to evolving systems of interaction, value and meaning.

By situating these findings in broader intellectual contexts, we can appreciate protocol art as part of an interdisciplinary conceptual lineage. The system-centric focus strongly resonates with complex systems theory and the "systems aesthetics" tradition in art: as Jack Burnham observed, modern art increasingly *"does not reside in material entities, but in relations between people and between people and the components of their environment"*. In protocol art, the artwork is essentially a complex adaptive system [10]—with inputs, outputs, and feedback loops—which accords with theoretical models where adaptive behavior and emergent order arise from networked interactions over time. Its open-ended governance and temporal evolution connect to the field of artificial life, which seeks systems that continually produce novelty rather than reaching a fixed end state. This open-endedness [46], coupled with deliberate feedback mechanisms, echoes the temporal dynamics of complex adaptive systems studied in complexity science, reinforcing how unpredictable, ongoing change becomes an aesthetic virtue. Meanwhile, the ethos of distributed agency and communal authorship in these works finds precedent in media theory and anthropology: for instance, actor-network theory contends that creative agency is distributed across a web of human and non-human actants, not concentrated in an autonomous individual. Similarly, in interactive and participatory art literatures, authorship is often viewed as an emergent, collective process—the community of participants effectively co-creates and continually reshapes the piece [6]. The inclusion of economic-driven engagement situates protocol art in dialogue with social computing and crypto-economic systems: just as Web3 platforms rely on token-based incentives to drive user participation and loyalty, protocol artworks harness economic game dynamics as artistic material, blurring the line between aesthetic experience and market behavior. This integration of economic and social incentives also invokes evolutionary game theory within complex systems, where value-based choices influence the system's trajectory. Furthermore, the poetic messaging through interaction rituals can be interpreted via performance studies and ritual theory in media. Even routine or rule-bound interactions carry expressive and symbolic weight—indeed, ritualized acts are *"anything but purposeless"* and can *"constitute social reality"* through shared symbolic action. In protocol art, the choreography of user interactions (such as collective decision-making or repetitive transactions) functions as a form of narrative or commentary, akin to a ceremonial performance that conveys meaning beyond its practical function. Finally, the principle of interoperability and composability aligns with discussions in software and platform studies about modular design and emergent behavior. In blockchain-based art, for example, smart contracts are conceived as interoperable building blocks, combinable like Lego pieces to create novel structures [48]. This composability not only reflects a technical design philosophy but also fosters creative emergence: new artistic forms and communities can arise by linking protocols together, much as complex behaviors emerge when simple units interact in networked ecologies. Linking these characteristics to established frameworks thus shows that protocol art is not an isolated novelty but converges with long-running threads in complexity science, new media art, and socio-technical theory, reframing them in a unique artistic context.

5.2 Distinction from Adjacent Movements

Pak's oeuvre inherits strategies from Conceptual, Generative, Participatory, Interactive, and Performance art, yet the blockchain protocol gives those strategies a qualitatively different reach. What follows parses each genealogy and shows where Pak's "protocol art" outruns its nearest relatives.

5.2.1 Beyond Conceptual Art. *"The idea becomes the machine that makes the art,"* wrote Sol LeWitt in 1967 [25]—a formulation that conceptual art could only fulfill metaphorically, since LeWitt's wall

drawings still required human execution and institutional presentation. Pak's protocol art literalizes this aspiration: the smart contract *is* the machine, and the idea—encoded once as immutable bytecode—executes itself without further authorial intervention. Joseph Kosuth's *One and Three Chairs* (1965) established that an idea can eclipse the physical object when reframed through language and documentation. Pak embraces the primacy of ideas but transports them into a rule-executing substrate. *The Title* (2021), whose only variables are price and on-chain title, echoes Kosuth's linguistic gambit, yet its value is continuously arbitrated by decentralized markets rather than by academic discourse or institutional framing. Because the smart contract is immutable, its "statement" cannot be re-contextualized by curators; it is enacted in perpetuity by the network. Thus Pak's work is not merely an illustration of a concept but a permanently operational logic that strangers must literally transact with. The artwork lives as executable code—a self-verifying proposition—rather than a documented proposition that awaits institutional re-presentation.

5.2.2 Beyond Generative Art. Early computer artists such as Vera Molnár treated algorithms as mechanical aides that output static images; even later real-time generative pieces, like Casey Reas's *Process* series, run autonomously but remain visually contained. Pak's generativity is socio-economic: the code sets only the initial fitness landscape, while thousands of human agents supply the variation and selection pressures that drive the system forward. In *Merge* (2021), the merging rule is trivial—add two integers—yet the competitive hunt for "Alpha Mass" steers the macro-form in ways no solo algorithm could predetermine. Where classic generative art is a dialogue between artist and machine, Pak's field is a triadic ecology of artist, code, and market actors; the emergent aesthetic includes price curves, social memes, and token topologies—materials that lie outside the scope of conventional algorithmic art.

5.2.3 Beyond Participatory / Crowdsourcing Art. Relational-aesthetic projects of the 1990s (Bourriaud) invited viewers to co-produce meaning through convivial encounters, but those encounters were typically ephemeral and locally bounded. Pak's participation is *ledger-bound*. In *Lost Poets* (2021–22), each name or verse a collector inscribes becomes an indelible block in a public archive—a form of distributed authorship impossible in earlier participatory works whose traces remained in wall labels or catalogs. Crucially, participation is also economically weighted: burning a Page to earn words entails an explicit cost, so creative decisions carry financial risk. This introduces game-theoretic depth absent from classic crowdsourcing art (e.g., MTurk drawings or open Wikis), aligning Pak's practice with emerging literatures on cryptoeconomic design rather than with social-practice documentation alone. Moreover, *Censored* (2022) demonstrates that protocol-based participation can transcend the art world entirely. AssangeDAO—a collective of over 10,000 members—pooled 16,593 ETH (approximately $52.8 million) to acquire the *Clock* NFT, with proceeds directed to Julian Assange's legal defense via the Wau Holland Foundation. When Assange was released in June 2024, the participation had demonstrably contributed to a real-world political outcome—a reach no gallery-bound participatory artwork has achieved.

5.2.4 Beyond Interactive Art. Interactive art from Myron Krueger's *Videoplace* to Rafael Lozano-Hemmer's public-space works invites real-time feedback loops, but those loops terminate once the exhibition ends. Protocol art designs interaction into on-chain fact. When a collector merges two *Merge* tokens or burns an NFT for $ASH, the blockchain records a state change that affects every future viewer and holder. Interaction ceases to be a momentary spectacle and becomes infrastructure—a permanent mutation in the artwork's ontology. Each transaction—a merge, a burn, a tokenized message in *Censored*—is an irreversible on-chain fact, not a fleeting gesture that vanishes when the gallery closes. Moreover, protocol interaction is asynchronous and scalable: millions of transactions are handled by the Ethereum network itself, so participation is bounded only by the scale of the chain rather than by gallery capacity or curatorial gatekeeping.

5.2.5 Beyond Performance Art. Performance art often foregrounds the performative encounter between artist and participant—think of Yoko Ono's *Cut Piece* (1964) [32], in which audience members were invited to cut away the artist's clothing, making collective action the medium. Protocol art extends this logic beyond the gallery and across the entire internet: anyone, anywhere, can permissionlessly participate in the work by signing a transaction, burning a token, or inscribing a message—no invitation, no curator, no physical co-presence required. Where Ono's performance was bounded by a single room and a single sitting, *Censored* (2022) enrolled nearly 30,000 participants across two days and multiple continents, each contributing a locked message that became part of an enduring on-chain chorus. The protocol replaces the artist's body as the performing agent: it executes its rules indefinitely, delegating durational endurance to automated smart-contract logic and DAO stewardship rather than to flesh and presence. Thus the locus of performance shifts from a singular body in time to a permissionless, planetary-scale system in perpetuity.

5.3 Limitations and Future Work

Our intensive case study of Pak's nine landmark protocol artworks demonstrates how smart-contract logic can serve as an artistic medium while providing foundational vocabulary for the emerging field. By focusing on the paradigmatic creator of protocol art, we have articulated seven characteristics that can now serve as analytical lenses for future comparative research.

This study does not claim that all protocol art exhibits the seven characteristics we identify; such a claim would require cross-artist sampling inappropriate to our exploratory aims. Instead, we offer a *generative* contribution: a vocabulary and analytical framework derived from close engagement with protocol art's most influential practitioner. These characteristics function as what Blumer termed *sensitizing concepts*—interpretive devices that orient attention without predetermining findings—that future researchers can apply, adapt, or reject when analyzing other artists [8]. The value of our contribution lies not in statistical generalization but in conceptual articulation: naming and describing phenomena that lacked prior theorization. Whether terra0, Sarah Friend, or Rhea Myers exhibit similar characteristics is an empirical question our framework now makes askable. Skeptics have questioned whether NFTs substantially modify art-world dynamics at all [37], making such

comparative work all the more pressing. We anticipate that some characteristics (e.g., system-centric composition, autonomous governance) will prove broadly applicable to protocol art as a genre, while others (e.g., economy-driven engagement at Pak's scale) may be specific to commercially-oriented practice. Comparative research is needed to distinguish genre-defining features from artist-specific idiosyncrasies.

At the same time, this focus exposes the field's present fragmentation: there is still no shared vocabulary, taxonomy, or methodological toolkit robust enough to account for the full diversity of protocol-driven practice. We therefore call for a concerted, interdisciplinary effort to systematize knowledge around protocol art. Concretely, future work should

- map a wider corpus of artists and projects to test and refine the analytical lenses introduced here;
- establish common descriptors for protocol mechanics (e.g., governance rules, token dynamics, temporal constraints) that are comparable across cases;
- develop metrics—both qualitative and on-chain quantitative—for assessing participation, emergent behavior, and sociocultural impact;
- integrate perspectives from art history, HCI, STS, economics, ethics [12], and legal studies to ground a theory of "protocolism" that distinguishes it from adjacent genres such as generative art and instruction-based conceptual art.

6 Conclusion

Our case study of Pak's nine landmark protocol artworks reveals seven distinct characteristics of protocol art, helping advance both its definition and our understanding of this emerging genre. Protocol art remains an emerging creative domain that lacks a comprehensive theoretical framework. While "protocolism" conceptualizes protocols as an artistic medium, the field needs more rigorous systematization of its concepts and aesthetics. Current discourse around blockchain-based art has emphasized market dynamics and hype over conceptual understanding [34]. This rapid evolution has created a significant gap between practice and theory—one that requires careful critical reflection and theoretical development to properly ground the field.

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A Pak's Protocol Artworks

This appendix contains collected information analyzing Pak's protocol art through eight analytical lenses summarized and derived from ChatGPT-o3 Deep Research: (1) Concept, (2) System-mechanism dynamics, (3) Participatory interaction, (4) Artist's control, (5) Collective emergent behavior, (6) Poetic meaning-making, (7) Key statistics, and (8) Annotation.

A.1 X (2020)

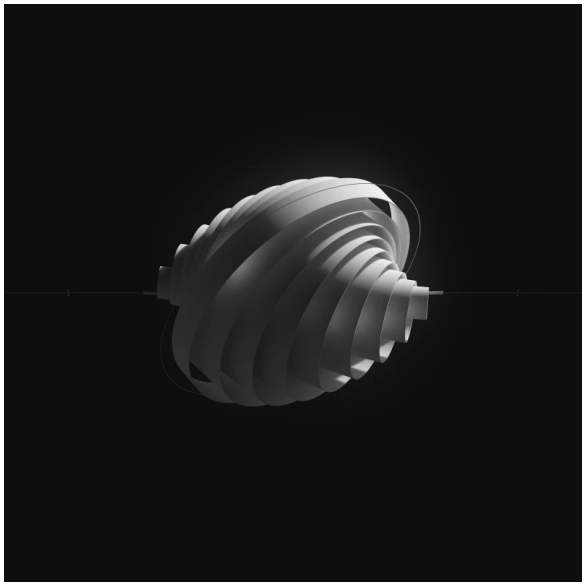


Figure 2: *The Wave*, edition of 3, from Pak's *X* collection (2020). Thirteen of the 15 pieces in *X* shared a time-based open-edition format where scarcity was determined by a 24-hour minting window rather than a fixed supply; the remaining two were one-of-one auctions.

Concept. *X* was Pak's pioneering experiment in defining digital scarcity through time rather than supply. Launched in August 2020 as an open-edition NFT sale on Nifty Gateway, it replaced fixed edition limits with a 24-hour minting window. This inversion of the usual rarity model made the concept of *X* about temporal urgency—the art's value derived from the moment of its creation rather than a predetermined quantity. In doing so, Pak introduced a novel protocol-native idea: that the conditions of a sale (time constraints and participation) can themselves be the conceptual core of the artwork, shifting focus from image scarcity to the shared time-bound experience.

System Mechanism. The *X* project consisted of 15 NFT pieces (13 open edition works and 2 one-of-one auctions) released simultaneously. Each open edition piece had no cap on mint count; instead, a 24-hour window was the sole limit. This scarcity mechanism *"based on time rather than volume"* was unprecedented at launch. Once the window closed, each piece's final edition size was fixed forever by the number of mints in that period. Technically, Pak's smart contract minted new tokens on demand during the sale, then refused further minting after the deadline, enforcing time-limited creation. The dynamics encouraged rapid uptake: as time dwindled, indecisive collectors had to commit or miss out. In parallel, two unique NFTs were auctioned, adding a traditional scarcity element. The interplay of these formats (open vs. fixed quantity) within *X* highlighted the NFT's programmability—scarcity became a flexible parameter of the artwork. Post-drop, the open edition pieces entered the secondary market with widely varying supply counts, testing how market dynamics would value an NFT explicitly designed without a fixed edition size.

Participatory Interaction. Collectors engaged with *X* by acquiring the NFTs during a strictly limited timeframe, effectively collaborating in a one-day event rather than competing for scarce editions. Anyone could mint as many as desired within the 24-hour window, turning the drop into a collective performance synchronized in time. This format, then-unusual, invited a broad pool of participants to be part of the work's creation—an approach that soon became a common practice in crypto art. The emphasis was on open participation: the art market's typical frenzy for limited pieces was replaced by an inclusive but fleeting opportunity, underscoring the role of community presence and timing in the piece.

Artist's Control. After *X* was launched, Pak's direct control was minimal—the rules were preset in the smart contract, and the outcome (how many tokens minted) was determined by the community within the allowed time. Pak's role was chiefly in conceptualizing and coding the parameters; once the clock started, the process was autonomous and irreversible, with Pak acting more as instigator than controller. This ceding of control to the protocol is central to the work's philosophy: the artist designed the playground but did not interfere with how many editions were ultimately created or who obtained them. The result is that *X* lives on as a completed event etched on-chain, with Pak's influence embedded in the mechanism but not exerted in real-time during or after the sale.

Collective Emergent Behavior. *X* attracted a broad swath of NFT collectors due to its open nature, with every buyer during that day becoming part of the work's narrative. The final mint counts effectively recorded the number of participants—a transparent metric of engagement—and in total, thousands of NFTs were minted, involving a large community. Rather than fostering a competitive race for a single token, *X* created a shared experience: collectors knew the availability was equal for all but also ticking away, which galvanized social media buzz and a sense of camaraderie among those "in the moment." This collective temporal convergence—everyone minting in the same 24-hour span—became a form of emergent community behavior, reinforcing Pak's notion that the artwork was as much about the crowd's response as the digital objects themselves.

Poetic Meaning-Making. *X* transforms the notion of an artwork into a time-bound performance, offering a poetic commentary on how value and meaning in digital art are shaped by temporal and social parameters. The piece demonstrates that an NFT's significance can lie not just in its image but in the circumstances of its creation—here, a collective moment that cannot be replicated. By foregrounding the protocol (the 24-hour clock) over the visual content, Pak underscored themes of ephemerality and community: the

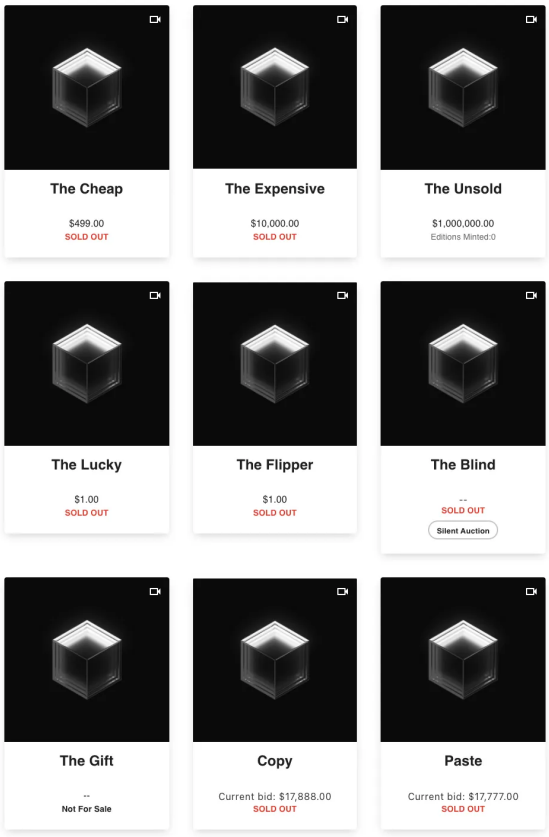


Figure 3: Marketplace listing for *The Title* by Pak (2021). All nine NFTs share an identical rotating cube visual; only the on-chain title, price, and distribution method distinguish each piece—foregrounding naming and context over visual content as determinants of value.

fact that *X* could only come into being through synchronized action imbues it with a narrative of shared presence. Ultimately, *X* invites reflection on an alternate mode of art valuation: one where scarcity is a function of time and collective presence rather than material limitation, thereby poetically aligning the artwork with the ethos of a decentralized, time-sensitive digital culture.

Key Statistics. Released 28 August 2020 on Nifty Gateway, the *X* collection ultimately comprised 15 artworks with a total of 63 editions minted (across 13 open works and 2 one-of-ones). Over 24 hours, collectors minted as few as 3 and at most 8 copies per open-edition piece, totaling only 63 pieces—far fewer than the theoretical infinity, underscoring the experiment's success. The highest known sale from *X* was the unique *The Void*, which was auctioned to a single collector (price undisclosed publicly), while aggregate primary sales for *X* exceeded six figures in USD terms (each open edition priced in the low hundreds of dollars). This series marked Pak's first major NFT drop, establishing the artist's reputation for novel mechanics in crypto art.

Annotation. *X* is the foundational case for **C1** (system-centric composition) and **C4** (temporal dynamism): the artwork has no fixed edition size—its supply is a function of collective behavior within a 24-hour window, making the protocol's time constraint, rather than any visual property, the locus of artistic meaning. What makes this particularly significant for digital art is the inversion of the scarcity paradigm: while artists can trivially copy digital files, market demand cannot be copied, and Pak exploits this asymmetry by substituting a temporal mechanism for the conventional predetermination of edition count. Scarcity in *X* is not declared by the artist but *discovered* through market-driven behavior—a limited window generates a limited edition without any authorial fiat over supply. This absence of predetermination is conceptually radical: it demonstrates that the scarcity of digital artwork need not be imposed from above but can emerge from the structure of participation itself. *X* thus initiates **C5** (economy-driven engagement) by turning the act of purchasing into the generative act itself, carrying a poetic meaning of market dynamism in which economically driven engagement literally constitutes the work. Notably, *X* shows minimal **C2** (autonomous governance) and no **C7** (composability): it is a self-contained event with no token mechanics that bridge to later works. As Pak's earliest NFT project, *X* establishes the core intuition—scarcity as a protocol parameter rather than an artist's decree—that all subsequent works elaborate.

Information.

- Launch Website: https://niftygateway.com/collections/pak
- Release Date: Aug 28, 2020
- OpenSea: https://opensea.io/collection/x-by-pak
- Contract Address: 0x99b546a19cc1ec8ec9a6ce781a237ddb642dda77 (ERC721)

A.2 The Title (2021)

Concept. *The Title* (January 2021) is a conceptual NFT series that interrogates the nature of value and ownership in crypto art. Pak created nine virtually identical digital objects—all a rotating translucent cube—but each NFT was given a different title and method of distribution [17]. By selling the same image at different prices and under labels like *The Cheap*, *The Expensive*, *The Unsold*, etc., Pak demonstrated that the perceived value of an NFT lies not in the visual content but in contextual factors such as scarcity, nomenclature, and narrative. The artwork's core concept is essentially a self-referential critique of the NFT medium: *The Title* asks what it is we truly buy when we purchase an NFT, positing that the token's title and associated story can override the image in defining its essence.

System Mechanism. Under the hood, *The Title* utilized a clever technical setup: all nine NFTs pointed to the exact same IPFS-hosted media file of the spinning cube. Despite this shared imagery, the smart contract distinguished each token by metadata—notably the title and edition info—which conferred each piece's unique identity and implied value. This meant that ownership of any one token was effectively ownership of the same underlying image, forcing a paradox: collectors held different tokens but "shared" the art content. The dynamics of this system laid bare the role of metadata and token provenance in NFT valuation; questions arose such as whether the holder of "The Expensive" had more claim to the art than the holder of "*The Cheap*," even though the visual asset was identical.

By structuring the NFTs in this way, Pak's smart contract became a philosophical device, highlighting how blockchain metadata and distribution rules can generate distinct meanings and hierarchies around an otherwise fungible digital image.

Participatory Interaction. Collectors engaged with *The Title* through a gamified multi-format sale. Each of the nine NFTs was obtained via a different mechanism—some were open editions (available to anyone for a limited time), others were limited editions at set prices, one was sold via blind auction, one via a standard auction, and one ("*The Gift*") was not sold at all but given away [17]. This design meant that the audience had to navigate various modes of acquisition, effectively turning the act of collecting into part of the artwork's performative narrative. By strategically involving buyers in auctions, giveaways, and timed drops, Pak cultivated a community-wide discourse and excitement around the project. The process of obtaining the pieces became a participatory spectacle of its own, reinforcing the idea that the artwork extends beyond the image to include the protocols and social interactions of its distribution.

Artist's Control. Pak's control over *The Title* after release was primarily conceptual and pre-programmed. Once the pieces were distributed through their various channels, Pak did not intervene in the tokens' existence or content—in fact, by anchoring all tokens to a single immutable IPFS image, Pak relinquished any ability to differentiate or alter the visual component for one token without affecting them all. The only lever of control exerted was at inception: defining the titles and scarcity of each edition, thereby scripting the value narrative in advance. After launch, the market of collectors took over; the artist's role shifted to observer of the unfolding debate and trade. This limited post-launch control aligns with the work's intention: it left collectors to ascribe meaning and value among themselves, illustrating Pak's point that the community's perceptions and the immutable smart contract rules (not the artist's hand) ultimately govern an NFT's fate.

Collective Emergent Behavior. The Title engaged a diverse group of participants, from high-end collectors willing to pay a premium in auctions to newcomers minting the affordable open edition. The total collector base spanned those nine sub-communities, all linked by the intrigue of the experiment. This project fostered a strong sense of community discussion; buyers compared their acquisitions (proudly identifying as the one who got "The Expensive" or the lucky recipient of "*The Gift*"), and observers debated the merits of each token on social media. Because each token's status (cheap vs. expensive, sold vs. unsold) was transparent on the blockchain, a collective narrative emerged in which the community itself assigned cultural significance to each piece beyond Pak's initial labels. In essence, the collectors became unwitting collaborators in Pak's social experiment, their behaviors—be it speculative flipping of "*The Cheap*" or holding "*The Unsold*" as a trophy—illustrating how a network of participants can create a rich tapestry of meaning around otherwise identical digital artifacts.

Poetic Meaning-Making. The poetic impact of *The Title* lies in its elegant exposure of art-world conventions transposed to the blockchain. By echoing Yves Klein's 1957 exhibition of identical blue paintings sold at different prices [4], Pak placed NFT culture in dialogue with historical avant-garde inquiries into what art really is. *The Title* makes viewers ponder why one iteration of a digital cube should carry more prestige or value than another. It reveals that the poetry of the piece comes from the questions it raises: What is ownership? What do we value in art—the image, the story, or the token that confers bragging rights? The work's broader significance is in demonstrating that blockchain art can critique itself; it's simultaneously a satire and a celebration of the cryptographic medium, showing how scarcity, community perception, and narrative alchemy collectively create meaning in digital art. In sum, *The Title* stands as a meta-artwork that is reflexive about its own value structure, engaging the art discourse on authenticity, authorship, and the economics of the intangible.

Key Statistics. Launched 6 January 2021 on Nifty Gateway, *The Title* comprised 9 works: *The Cheap* (192 editions at $499 each), *The Expensive* (8 editions at $10,000 each), *The Unsold* (1 edition, priced so high it remained unsold), *The Blind* (3 editions via silent auction), *The Flipper* (99 editions first-come at a low price), *The Lucky* (3 editions first-come, price $1 each—effectively a lottery of speed), *Copy* and *Paste* (each 1/1 auctions, paired conceptually), and *The Gift* (3 editions given free to early collectors). Total sales exceeded $200,000 across the series. Critically, all nine tokens reference one image file, illustrating Pak's point. Sotheby's later noted this collection as a breakthrough in conceptual NFT art, aligning Pak with avant-garde strategies of value interrogation.

Annotation. The Title is the purest expression of **C5** (economy-driven engagement) and **C6** (poetic message embedding) in the portfolio: by selling identical images at different prices under different names, Pak isolates price and metadata as the sole carriers of meaning, forcing participants to confront the question of whether value resides in the visual object or in the narrative apparatus that frames it. The satirical force of the piece lies in its provocation: since a smart contract requires a unique identifier for each entry, the work asks whether it is the *name* itself that holds primary value—whether the title, not the content, is what collectors truly acquire. This interrogation strikes at the heart of non-fungibility: even identical images, once assigned different names within the contract, become formally distinct, non-fungible things, revealing that the ontological boundary between fungible and non-fungible may hinge on something as thin as a string of metadata. The work thus exemplifies **C1** (system-centric composition) at its most distilled, since the "artwork" is the distribution structure and naming convention itself rather than the rotating cube that all nine tokens share. *The Title* is, in this sense, a work of "protocol art" in the strictest definition: the contract *is* the piece, and its poetic message emerges from the nature of the contract's requirements. However, *The Title* is an outlier for **C3** (distributed agency): collectors cannot alter the work or contribute content—they can only choose which token to acquire. This constraint is itself instructive: it reveals that communal authorship is not essential for protocol art to function as critique, but its absence limits the emergent social dynamics observed in later projects.

Information.

- Launch Website: https://niftygateway.com/collections/thetitle
- Release Date: Jan 6, 2021

- OpenSea: https://opensea.io/collection/the-title-by-pak
- Contract Address: 0x090c53bac270768759c8f4c93151bd1a808a280e (ERC721)

A.3 The Fungible

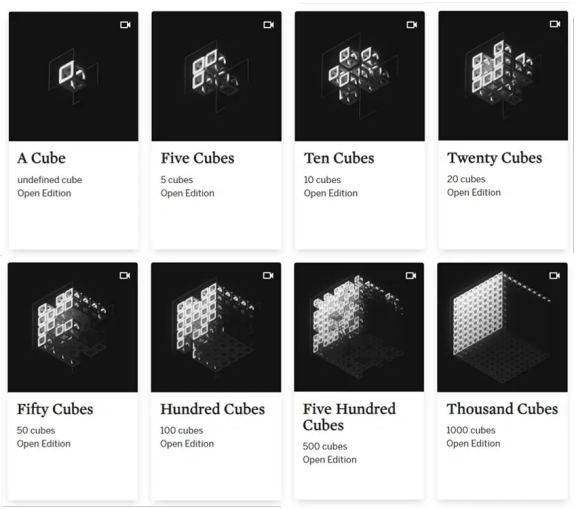


Figure 4: Open-edition tiers of *The Fungible* by Pak (2021). Collectors purchased cubes in varying quantities; the smart contract then minted unique NFTs whose visual composition reflected the number of cubes accumulated, turning fungible purchases into bespoke non-fungible artworks.

Concept. *The Fungible* (April 2021) was an ambitious collection that probed the definition of value in the context of digital art and fungibility. Created in partnership with Sotheby's, this project's very title is a play on the idea of fungible vs. non-fungible value: Pak offered an array of NFTs that collectively challenged the boundaries between unique art objects and interchangeable units. The concept centered on asking *"what does value mean, and from where does it derive authority?"* [45]—a question that the collection explored by introducing novel mechanics (like token merging and dynamic editions) which blurred the line between a singular artwork and a set of exchangeable pieces. In essence, *The Fungible* served as a critical examination of how scarcity and abundance intersect on the blockchain, turning the sale itself into an inquiry about why we value art: is it the content, the context of rarity, or the creative token logic behind it?

System Mechanism. *The Fungible* deployed innovative smart-contract mechanics that made collecting an interactive process. Core to the system were the Open Edition "Cubes," which were not traditional 1-of-n editions but a kind of modular token: buyers could purchase any number of identical cubes, and the contract would then deliver NFTs reflecting the quantities accumulated. For instance, if a collector purchased five cubes, they would receive an NFT depicting a cluster of five cubes; if they purchased fifty, they'd receive a single NFT showing fifty cubes—a graduated series that cleverly visualized ownership as a spectrum. This algorithmic distribution turned fungible purchases into bespoke non-fungible artworks. Additionally, Pak introduced dynamic one-of-one NFTs like *The Switch*, coded such that its owner could decide to "flip" the artwork's state once at a moment of their choosing (an irreversible transformation built into the contract). Another piece, *The Pixel*, consisted of a single gray pixel, emphasizing minimalism and the idea that even the smallest digital unit could hold enormous value in the right context. These mechanics—custom distribution, owner-triggered change, and extreme minimalism—showcased the versatility of smart contracts, engendering a set of artworks whose form and existence were defined by procedural rules and collector interaction, not just by static visuals.

Participatory Interaction. *The Fungible*'s drop was designed as a multi-day, multi-modal event that actively involved the audience in creating and discovering value. Over a three-day period, collectors could participate in Open Edition sales where they bought "fungible cubes" in whatever quantity they wished during the sale period [45], effectively letting each participant construct their own edition. Meanwhile, high-stakes auctions for one-of-a-kind pieces (*The Switch* and *The Pixel*) ran in parallel, drawing competitive bidding. Pak further engaged the community with puzzles and special rewards: for example, he gifted 30 unique NFTs to notable community "builders" and awarded four more NFTs (called "Equilibrium") to participants who met specific criteria like solving a puzzle or tweeting Pak's hashtag to the largest audience [3]. This layered approach meant that thousands of people joined at various levels—from casual buyers to dedicated players—making the sale itself feel like a collective happening. Every participant, whether buying a single cube or vying in an auction, became part of the narrative fabric that *The Fungible* wove around the notion of value.

Artist's Control. Once *The Fungible* launched, Pak largely let the programmed systems and collectors drive the outcomes. The rules for minting cubes and the parameters for pieces like *The Switch* were all predetermined, meaning that after initiating the sale, Pak did not manually influence how many cubes were sold or how the artworks evolved. In fact, *The Switch* exemplified a deliberate transfer of artistic agency: the moment of its transformation was controlled by the collector, not the artist [45]. Similarly, the open edition ran on its own schedule—Pak set the prices and time windows for each cube sale, but could not alter the open-edition once it was live. By structuring the project this way, Pak's role became one of orchestrator rather than micromanager. He created the conditions and constraints, then ceded control to the market and the code, a choice consistent with the work's exploration of decentralized value creation. After the sale, the artworks existed independently on the blockchain (e.g., *The Pixel* perpetually remaining just one pixel owned by its auction winner), requiring no further intervention from the artist.

Participants & Collective Emerging Behavior. *The Fungible* attracted an unprecedented scale of participation for an NFT art drop at the time. Over 3,000 individuals took part in the open edition cube sale alone, resulting in a total of 23,598 cubes sold across three short selling periods and 6,165 unique NFTs minted from the open edition process. The event's gamified structure (with leaderboards for top cube buyers, surprise rewards, and the allure of auctions) encouraged a spirited community response. Buyers strategized over

how many cubes to purchase to attain higher-tier cube NFTs, while others collaborated or competed for the special rewards. Sotheby's reported record-breaking engagement on Nifty Gateway during the sale, including the most bids ever placed on an NFT auction item up to that point. This collective excitement transcended typical art-world transactions; it felt more akin to a massive multiplayer event in which the audience's size and enthusiasm were integral to the work's impact. In the aftermath, collectors and observers alike debated whether the frenzy and competitive "game" of *The Fungible* were integral to its value, or if those incentives would fade, directly engaging with the very question the artwork posed about how value is sustained in digital art.

Poetic Meaning-Making. Beyond its clever mechanics and record-breaking sales, *The Fungible* resonated as a poetic statement on the fluid nature of value in the digital age. By literalizing the idea of fungibility—letting collectors accumulate and assemble value units (cubes)—Pak drew attention to the transactional element of art without forfeiting aesthetic intrigue. The collection as a whole becomes an allegory: the cubes symbolize the building blocks of value, and their conversion into unique artworks symbolizes the alchemy by which markets and perception turn the mundane into the precious. The open question *The Fungible* leaves us with is whether art's value is intrinsic or constructed: when a single pixel sells for $1.36 million and thousands of identical cubes become rare sculptures through a smart contract, one is compelled to acknowledge the role of consensus, context, and collective belief in creating worth. In the broader digital art discourse, *The Fungible* is seen as a work that married participatory art with commentary on economics, ultimately reminding us in a poignant way that even on the blockchain, value is a story we all collectively tell.

Key Statistics. The Fungible drop took place 12–14 April 2021 on Nifty Gateway, generating approximately $16.8 million in sales over three days. The open edition "Cubes" were sold in timed windows at $500, $1,000, and $1,500 price points on successive days, with a total of 23,598 cubes purchased. These merged into 6,165 NFTs, distributed to 3,080 unique buyers (reflecting many bought multiple cubes). Sotheby's auctioned *The Pixel* for $1.36 million and *The Switch* for $1.44 million, each becoming one of the earliest NFT artworks to surpass $1 million. The special one-of-one *The Cube* was awarded to the top cube buyer, and 100 editions of *Complexity* were awarded to the next 100 top buyers. In total, over 3,080 unique buyers participated in the primary sale. At the time, it set a record for the largest NFT sale by a single artist on a platform, until Pak's own *Merge* later that year.

Annotation. The Fungible is the portfolio's strongest early case for **C5** (economy-driven engagement): the Sotheby's partnership, tiered pricing, leaderboard competitions, and puzzle rewards made the market event indistinguishable from the artwork. It equally demonstrates **C1** (system-centric composition), as the algorithmic conversion of fungible cubes into unique NFTs—whereby participants could purchase interchangeable units and watch an algorithm transmute them into bespoke non-fungible artworks—embodies the shift from object to process. Crucially, the work plays with the very boundary between fungible and non-fungible: collectors could combine non-fungible elements back into fungible form, a kind of "coin play" that literalizes the conceptual slippage between currency and art. **C3** (distributed agency) is present but structured—participants co-determine the outcome through purchasing decisions, yet within tightly scripted rules, distinguishing this from the more open-ended authorship of Lost Poets or Censored. What elevates *The Fungible* beyond a single project, however, is its role as the foundational experiment in composability for Pak's subsequent practice. The market here provides an interaction space in which users can play, combine elements, and test composability, and the mechanics piloted in *The Fungible* directly laid the groundwork for the token-burning logic of burn.art, the multi-stage transformations of Lost Poets, and the self-merging dynamics of Merge. In this respect, *The Fungible* constitutes an early-stage laboratory for **C7** (interoperability and composability), leading users toward open-ended authorship and establishing the paradigm that Pak would elaborate across his entire oeuvre.

Information.

- Launch Website: https://www.niftygateway.com/collections/paksothebysauction/
- Release Date: Apr 12, 2021
- OpenSea: https://opensea.io/collection/the-fungible-by-pak
- Contract Address: 0xc7cc3e8c6b69dc272ccf64cbff4b7503cbf7c1c5 (ERC721)

A.4 burn.art / $ASH (2021)

Concept. burn.art (and its native token $ASH) is Pak's poetic framework for *"creation by destruction,"* an artwork-platform that turns the act of burning NFTs into an artistic medium in itself. Launched in 2021 after *The Fungible*, it proposed a cyclical ecosystem: collectors are invited to destroy their existing NFT artworks (irreversibly sending them to a burn address), and in return they receive a new fungible token called ASH—essentially the "ashes" of the burned art [3]. These ashes ($ASH) can then be spent on new art pieces by Pak, or even other creators, thereby continuing the cycle of creative destruction. The conceptual core is a commentary on value and permanence: by explicitly linking loss and creation, Pak challenges the notion of digital art as eternally replicable or static. Instead, *burn.art* frames destruction as a generative act, asking us to consider what we value more—the art we had, or the new possibilities unlocked by its sacrifice.

System Mechanism. The underlying mechanism of *burn.art* is an Ethereum smart contract that accepts NFTs and issues ERC-20 ASH tokens in return. Technically, when a user initiates a burn, the NFT is transferred to an inaccessible null address (removing it from circulation forever), while the contract credits the user with a certain amount of ASH according to a predefined schedule. The supply of ASH is thus dynamically generated by destruction: every token in circulation is proof that some piece of digital art was sacrificed. This introduces a self-balancing scarcity model—the more art is burned, the rarer the remaining artworks become, favoring their collectors by increasing relative scarcity. Pak designed $ASH's tokenomics such that all his future drops could interact with this system, for example by accepting only $ASH as payment for certain new works or giving exclusive access to ASH holders. This created an evolving feedback loop: the dynamics of burning and creating continually

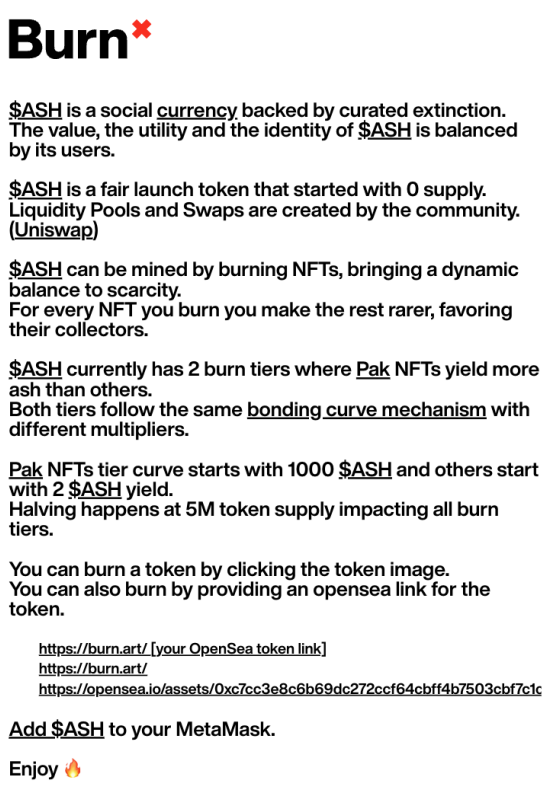


Figure 5: The burn.art landing page (2021), outlining the $ASH token economy. The system formalizes "creation through destruction": collectors permanently burn NFTs to receive $ASH tokens, establishing a cyclical protocol where artistic value is destroyed, transmuted, and regenerated.

affect each other, crafting a mini-economy where collectors' decisions to destroy or hold collectively shape the progression of the art ecosystem.

Participatory Interaction. Using *burn.art* is itself a performative interaction: collectors must actively choose to irreversibly destroy one of their NFTs in order to partake. Upon connecting their crypto wallet to the burn.art interface, a user can select an NFT they own and send it to the burn contract; the system then "mines" (mints) a corresponding amount of ASH tokens as a reward. The amount of ASH received depends on the category of the burned NFT—Pak implemented a whitelist with multipliers, meaning more significant or scarce works yield more $ASH. This process engages users on a psychological level: burning an artwork, especially a valuable one, is a moment of suspense and conviction, effectively making the user a co-creator of the conceptual piece. Communities sprung up around sharing burning experiences and strategies (e.g., which NFTs to burn for optimal $ASH yield), turning what could have been a solitary act into a communal ritual. By requiring collectors to "prove" their dedication (through destruction) to gain access to new creations, *burn.art* ensured that participation was not passive but deeply intentional and symbolic.

Artist's Control. While *burn.art* introduced a new level of community agency (the choice of what and when to burn lies with the users), Pak maintained strategic control over the ecosystem's parameters. He defined which NFTs are burnable for ASH and their relative yields via the whitelist—essentially curating the value of destruction. Furthermore, as the creator of the ASH token, Pak could influence its use by deciding which new artworks require ASH for purchase, thereby indirectly guiding demand for burning. That said, once the contracts were deployed, the day-to-day operation of the system is autonomous: any eligible NFT can be burned permissionlessly, and $ASH is dispensed according to code, not at Pak's discretion. In keeping with decentralization, the value of ASH and the decision of what to sacrifice for it were left to the open market and individual collectors. Pak's control was thus front-loaded—in the design and rules of the game—but he stood back as participants carried out the dramatic act of creation-through-destruction, letting the social experiment unfold organically.

Collective Emergent Behavior. burn.art quickly garnered a devoted following of Pak's collectors and intrigued onlookers, forming a sub-community fixated on the burn-to-mint ritual. Hundreds of NFTs were burned in the initial weeks, from common items to high-value artworks, as collectors sought to accumulate $ASH either for status or to use in Pak's future drops. This created a shared ethos among participants: a mix of fanaticism and camaraderie emerged, where those who burned valuable assets were celebrated (or playfully lamented) for their commitment to the art. Discussions on forums and social media centered on what NFTs people were willing to sacrifice; the "burn culture" introduced by Pak made some collectors view their holdings in a new light (knowing any Pak piece, if desired, could be converted to $ASH, a kind of artistic afterlife for stagnant assets). Over time, the collective action of these participants literally shaped Pak's art market: as more tokens were destroyed, the remaining ones grew rarer, and owning $ASH became a badge of participation in Pak's evolving narrative. This self-selected community, willing to destroy to create, exemplified a new kind of collector ethos unique to the protocol—one that values conceptual engagement over simply accumulating objects.

Poetic Meaning-Making. burn.art and $ASH elevate an almost mythic cycle of death and rebirth within the digital realm, making it one of Pak's most overtly metaphorical works. The project transforms the destructive act of blockchain burning into a meaningful ritual, suggesting that even in a space of infinite reproducibility, sacrifice can carry weight and give rise to new beauty. The poetry here lies in how absence is turned into presence: each $ASH token is a memorial of a destroyed artwork and simultaneously the seed of a new creation. In a world where digital files ostensibly last forever, Pak introduced impermanence and choice as artistic elements—echoing the destruction of physical art (recalling Gustav Metzger's "auto-destructive art" or Jean Tinguely's self-destroying sculptures) but with a constructive twist. The broader impact of *burn.art* is its commentary on value: it forces the community to question what gives an artwork value—its continued existence, or the legacy it leaves through transformation. By making his audience perform a collective dance of loss and renewal, Pak illustrated that in digital ecosystems, as in nature, endings can be beginnings. This piece

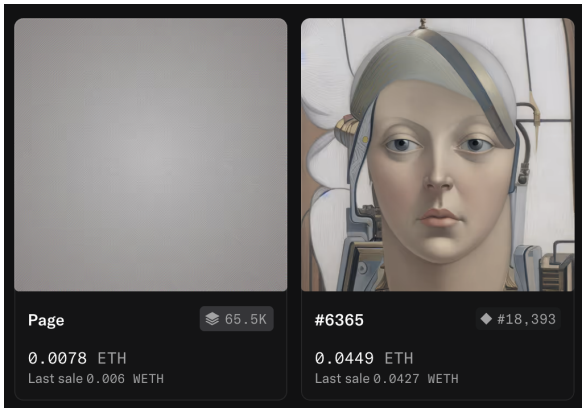


Figure 6: Lost Poets: before and after the reveal. Left: an unrevealed Page token, a blank placeholder. Right: a revealed Poet (number 6365), an AI-generated portrait unlocked by burning the Page—illustrating the irreversible state transition at the heart of the project's multi-act protocol.

thus bridges conceptual art and social experiment, leaving a lasting impression about the responsibilities and powers that protocols confer upon both artists and collectors.

Key Statistics. burn.art launched in May 2021. Within the first 48 hours, users burned over 1,000 NFTs to generate $ASH. By February 2022, more than 20,000 NFTs had been burned via the platform, including high-profile pieces by Pak and other artists, yielding over 4 million $ASH tokens. $ASH reached a peak market capitalization above $100 million during the 2021 NFT boom, reflecting the community's speculative interest. Pak's first $ASH-only NFT drop, "Chapter One—Carbon," sold out in minutes, consuming a substantial portion of the token supply. The initial reward rate was 1000 $ASH for Pak NFTs and 2 $ASH for others, with an automatic halving mechanism that reduces rewards at each supply milestone. As of 2025, over 30 million $ASH have been minted through successive burns, and the token is used by a handful of other crypto artists who accept $ASH for their work, extending Pak's poetic economy of art and $ASH.

Annotation. burn.art is the pivotal work for **C7** (interoperability and composability): it introduces $ASH as a cross-project fungible token that bridges The Fungible, Lost Poets, Merge, and future drops, transforming Pak's oeuvre from a series of discrete works into a unified economic ecosystem—the center of the Pak universe. It is also a powerful case for **C6** (poetic message embedding), as the ritual of destruction-as-creation literalizes themes of sacrifice, renewal, and the cyclical nature of value. **C2** (autonomous governance) is strong—the burn contract operates permissionlessly—yet Pak retains unusual ongoing influence through an ultimate DAO behind the contract that can tune burning rates for each series, granting dynamic ability to control floor prices across the entire collection. This mechanism functions as an economic adjustment machine: if the floor price of any Pak series drops below the potential $ASH yield from burning, buyers have a rational incentive to purchase and burn those NFTs into $ASH, thereby automatically establishing a guaranteed floor price. The structure operates, in effect, like a Federal Reserve for Pak's own art—a brilliantly engineered economic mechanism that guarantees basic value while preserving market freedom. This hybrid of autonomy and curatorial control complicates any simple narrative of decentralization in protocol art, making burn.art the only project where the artist actively steers post-launch demand through parametric governance rather than direct intervention. In its synthesis of permissionless burning, cross-project interoperability, and dynamic economic tuning, *burn.art* is arguably the most ingenious infrastructure-level artwork in the portfolio: an incredibly smart mechanism that turns the entire ecosystem into a self-regulating economy of creative destruction.

Information.

- Launch Website: https://burn.art/
- Release Date: May 16, 2021
- Contract Address: 0x64d91f12ece7362f91a6f8e7940cd55f05060b92 (ERC20)

A.5 Lost Poets

Concept. Lost Poets (September 2021) is a large-scale NFT art project that merges generative art, narrative puzzle, and strategic game into one poetic whole. At its core, the project consists of 65,536 unique AI-generated portrait NFTs ("Poets") originating from 1,024 rarer "Origin" Poets [2], all imbued with an aura of mystery and antiquity. The concept draws inspiration from Borges's *Library of Babel* and the idea of rediscovering lost creative souls: Pak envisioned these Poets as ancient voices "not found" until the community brings them to light. The project was unveiled as a multi-act saga—a kind of unfolding story where the NFTs would evolve over time—thereby exploring themes of memory (lost knowledge rediscovered), evolution (the NFTs reveal attributes in phases), and collective intelligence. *Lost Poets* is fundamentally about the interplay between algorithmic creation (the AI art and smart-contract logic) and human participation in meaning-making: it asks what happens when thousands of collectors jointly play a literary game with art, time, and chance.

System Mechanism. The *Lost Poets* smart contracts orchestrated an intricate multi-stage evolution of the NFTs. Initially, 65,536 Page tokens were minted (with Pak reserving 1,024 for the special Origin Poets). These ERC-1155 tokens had built-in utility: a holder could "burn" a Page token to transform it into a Poet token once Act II commenced. The transformation was irreversible, effectively migrating the NFT from one state (Page) to another (Poet) and revealing the AI-generated portrait and some initial attributes. Crucially, the contract did not reveal all attributes of a Poet at once; instead, additional traits (like words the Poet could "speak") unlocked gradually over Act II and Act III, either automatically or through user actions. Feeding a Page to a Poet (another burn action) was a method to update the Poet's metadata—the contract would record the new name given by the user and randomly assign a set of words to that Poet, altering its uniqueness. All these state changes were governed by on-chain logic, ensuring that no two Poets ended up the same despite coming from identical Pages. The system also tracked leaderboards and triggers for awarding the Origin Poets to top collectors at the end of Act I. Finally, a time-lock dynamic

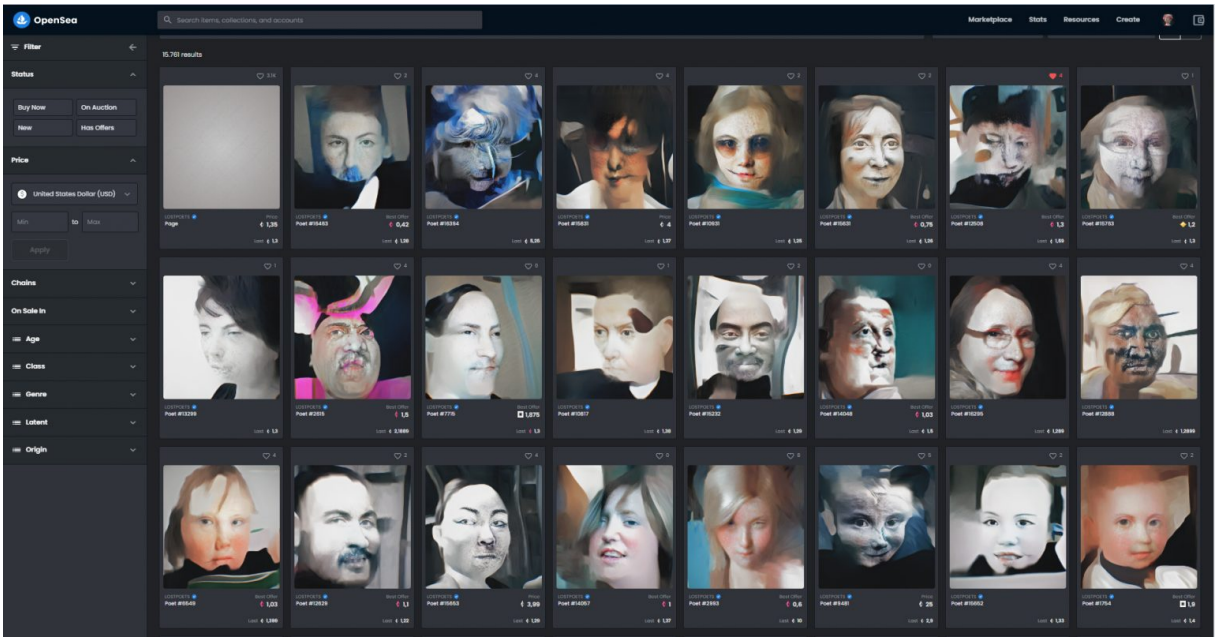


Figure 7: Gallery view of revealed Lost Poets on the secondary market. Each portrait was procedurally generated with unique visual traits; collectors further individualized their Poets by naming them and "feeding" additional Page tokens to unlock poetic word combinations, layering human authorship onto algorithmic creation.

was present: at the conclusion of the one-year project timeline, the contract "locked in" the final state of all Poets (Act IV, aptly titled "The Twist") and dispensed promised $ASH rewards to participants, marking the end of the journey. This layered smart contract design allowed *Lost Poets* to behave almost like an autonomous game engine running on Ethereum, driving the content and rarity of the NFTs in response to player inputs and time.

Participatory Interaction. Engagement with *Lost Poets* was deeply interactive and unfolded in distinct phases (Acts I–IV). It began with the distribution of "Pages"—blank NFTs that served as tickets to the game [31]. Early on, Pak rewarded loyal fans by airdropping Pages to wallets holding at least 25 $ASH tokens and opened a public sale where others could purchase Pages (priced at 0.32 ETH each). Once armed with Pages, participants faced choices in Act II ("The Reveal"): they could burn a Page token to summon its Poet (revealing a unique AI-crafted portrait), or they could even burn Pages for more $ASH instead, adding a twist of sacrifice to the game. In Act III ("The Explorer"), collectors could feed extra Pages to their Poets, each feed allowing them to rename the Poet and gifting the character new words (2–4 random words per Page) which enriched its traits and lore. Throughout these interactions, Pak maintained a live leaderboard; the top 100 collectors who amassed the most Pages received additional rare Origin Poets as rewards, incentivizing strategic play and competition. The project was designed to span 365 days, during which participants continuously engaged—naming their Poets, deciphering clues, trading Pages and Poets, and anticipating "The Twist" of Act IV. This sustained, game-like interaction meant that collecting *Lost Poets* was not a one-off transaction but a prolonged creative exercise that bound the community together.

Artist's Control. Pak's role in *Lost Poets* was akin to a dungeon master setting the rules of a game, then letting the players roam. Pak exercised significant control in the design phase: determining the number of tokens, the pacing of the acts, the mechanics for conversion and feeding, and even withholding the 1,024 Origin Poets to distribute as rewards or for future surprises. However, once the project commenced, the progression was largely automated and community-driven. Pak did not alter the contract rules mid-course; the code itself dictated when new attributes would appear and how each action translated into an outcome. The element of the unknown ("The Twist" of Act IV) was built-in—Pak had likely pre-planned an ending but kept it secret, triggering it through the programmed schedule or an on-chain call at the appropriate time. Throughout the year-long evolution, Pak's direct intervention was minimal, aside from providing occasional hints or narrative flavor via social media to enrich the lore. In essence, after launching *Lost Poets*, Pak relinquished control to the protocol and the participants, allowing the artwork to self-evolve within the boundaries Pak had coded. This balance—tight authorial control over structure, but freedom for users within it—underscores Pak's commitment to exploring protocol as an art form.

Collective Emergent Behavior. Lost Poets attracted a massive and engaged community, as evidenced by the entire supply of 65,536 Pages selling out in just 2 hours (raising about $70 million) and thousands of collectors joining the fray. The project's gamified nature led to rich emergent behaviors: collectors formed online groups to decode hidden clues in Poet attributes and to strategize the best use of Pages. A vibrant secondary market developed where

Pages and Poets were traded, with some speculators hoarding Pages early in hopes of obtaining more Origins or leveraging them in later acts. The competition for the top 100 collector spots was intense, leading certain individuals to accumulate enormous quantities of Pages (and become known figures in the community for it). Meanwhile, other participants took a more curatorial approach, carefully naming their Poets and sharing the whimsical or profound word combinations their Poets "spoke" after feeding—effectively collaboratively writing a decentralized poem through their NFTs. Each phase change (Act II's reveal, Act III's feeding, etc.) was accompanied by collective excitement on forums and Discord, as people shared discoveries and theories about what Act IV, "The Twist," might entail. By the end of the 365 days, *Lost Poets* had fostered not just a market but a participatory culture—blending competition, storytelling, and collaboration—arguably one of the most sustained communal engagements for an NFT project of its era.

Poetic Meaning-Making. The poetry of *Lost Poets* emerges through its synthesis of technology and storytelling. On one level, it is a meditation on authorship: each collector who names their Poet and contributes words becomes a co-author, blurring the line between artist and audience in a manner reminiscent of exquisite corpse or collaborative poetry. The project also poignantly plays with the idea of "lost" voices found—the algorithm conjured tens of thousands of unique faces and fragments of text, like ghosts of poets past, and gave the community the power to nourish these ghosts with new words. Over the course of the acts, participants experienced themes of discovery, transformation, and ephemerality (as unused Pages dwindled and choices had to be made). In the final Epilogue, when all Poets reached their ultimate form and the last secrets were unveiled, the community could look back on a journey that it had collectively authored. Pak managed to reveal that NFTs need not be static collectibles; they can be alive with narrative potential and participant-driven change. *Lost Poets* stands as a testament to the idea that protocol-based art can achieve a form of literary and artistic richness—it turned a blockchain ledger into the stage for a year-long participatory saga about remembering and reinventing creative voices. The broader impact is an expanded notion of what digital art can be: not just an image or an object, but a living story that engages its audience in poetic meaning-making.

Key Statistics. Lost Poets launched with 65,536 Page NFTs at 0.32 ETH each, selling out and raising roughly $70 million in its initial sale. 1,024 Origin Poets were distributed (277 to top 100 collectors, 730 via daily random drops, 17 reserved). Phase II saw thousands of Pages burned: within the first week, over 50,000 Pages were converted into Poet NFTs, leaving near 15,000 Pages for the final phase. Each Poet NFT is programmatically one of 1,024 "families" and has 256 trait parameters, making each uniquely identifiable. As of the end of Phase III, about 15,000 Poets received names and poems (meaning that many Pages were sacrificed to finalize them), while a number of Poets remained "silent" because their owners chose not to burn pages. The most popular names taken include historical luminaries ("Shakespeare" was named within minutes of launch). Secondary market activity was robust: Origin Poets traded at a premium (some over 5 ETH each) due to their limited supply and role as progenitors. By project's end, the community had collectively written tens of thousands of individual one-line poems, effectively creating one of the largest collaborative literary works in NFT form.

Annotation. Lost Poets is the richest case for **C3** (distributed agency) and **C4** (temporal dynamism): its multi-act structure unfolds over a full year in a genuinely performative and crowdsourced process, and collectors become genuine co-authors by naming their Poets and choosing whether to transform, hold, or burn their tokens. The temporal dynamic is essential: each phase—from the initial Page distribution through the Reveal, the Explorer phase, and the final Twist—constitutes a distinct participatory epoch, and the work's meaning accrues through the cumulative decisions of thousands of participants across these stages. It also deeply exemplifies **C6** (poetic message embedding), with the Borges-inspired narrative framing the naming ritual as a meditation on language and memory. **C7** (composability) is significant: the project bridges into the $ASH ecosystem, utilizing the burn mechanism introduced in burn.art—participants can burn Poets for $ASH, and $ASH holders received airdropped Pages, creating a feedback loop between projects. What makes *Lost Poets* distinctive is the depth of its branching decision space—at each stage, every participant faces a choice to transfer, hold, or burn, and each holder's path through the Acts yields a different outcome, producing an emergent diversity that exceeds what any single-mechanism work (like X or Merge) can generate. The project demonstrates that everyone can participate in the unfolding of protocol art, and that the temporally extended, multi-stage structure is essential for cultivating the kind of sustained collective authorship that transforms a smart contract into a living literary work.

Information.

- Launch Website: https://lostpoets.xyz/
- Release Date: Sep, 2021
- OpenSea: https://opensea.io/collection/lostpoets
- Contract Address:
  0xa7206d878c5c3871826dfdb42191c49b1d11f466 (ERC1155 for Page)
  0x4b3406a41399c7fd2ba65cbc93697ad9e7ea61e5 (ERC721)

A.6 Hate / Invisible Mechanisms (2021)

Concept. Invisible Mechanism are intertwined artworks that together form a provocative commentary on control, ownership, and the relationship between creator and audience (even the antagonistic part of the audience). In late 2021, Pak executed *Hate* as a conceptual performance: Pak offered special NFTs titled "Hate" to thirty of Pak's harshest critics on social media—effectively gifting tokens to those who had publicly disparaged Pak [51]. The twist was that these *Hate* NFTs were programmed to be immutable and non-transferable by the recipients, symbolizing the idea that their negativity had earned them a token they could not get rid of. This gesture served as both a prank and a statement, turning the act of hating Pak into an involuntary participation in Pak's art. Underpinning *Hate* was Pak's new smart contract prototype called *Move*: an "invisible mechanism" that grants the creator the power to transfer any token from any wallet within that contract to another address at will, irrespective of holder consent. *Move* embodies the mantra

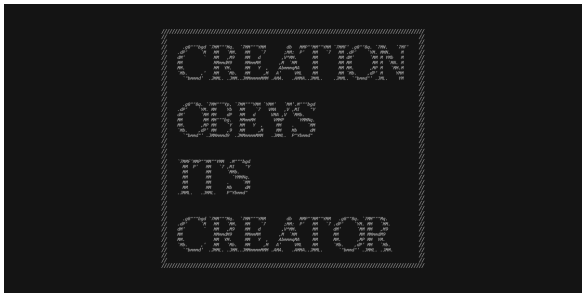


Figure 8: "CREATION OBEYS ITS CREATOR"—a statement embedded as ASCII art in the source code of the *Hate* NFT smart contract, part of Pak's *Invisible Mechanisms* (2021). The phrase encapsulates the *Move* protocol's radical inversion of NFT ownership: the creator retains administrative power to lock, transfer, or reclaim any token at will.

"CREATION OBEYS ITS CREATOR", flipping the usual decentralization narrative to assert total artistic control over distribution. Together, *Hate* (the scenario) and *Move* (the technology) form a conceptual piece that asks pointed questions: What if an artist could reclaim authority over an artwork after it's been distributed? Can an artwork be a form of dialogue—or retaliation—between artist and critic? By engaging directly with haters and by unveiling a contract that subverts NFT norms, Pak's concept challenged the community to reflect on power dynamics and the presumed inviolability of ownership in the crypto space.

System Mechanism. The *Hate* NFTs were engineered using the *Move* contract architecture, which fundamentally alters standard ERC-721 behavior [50]. Normally, once an NFT is in a wallet, only the owner can transfer it; Pak's custom contract introduced admin functions that allowed Pak (as the contract owner) to lock tokens and later move them at will. Upon minting the 30 *Hate* tokens, they were immediately "locked" to their respective recipient addresses—hence any transfer or sale initiated by those holders would automatically fail, as the contract overrode such actions. The NFTs had identical metadata (depicted simply by a heart symbol), emphasizing that their differentiating feature was the wallet they resided in, not visual content. After letting the scenario play out for about 24 hours, Pak utilized *Move* to demonstrate its power: Pak, as admin, transferred all *Hate* tokens out of the haters' wallets back into Pak's own, even updating their metadata before doing so. This action conclusively illustrated the dynamic—the artist could literally reclaim the tokens at will, something impossible under standard token contracts. The *Move* contract thus created a dynamic where token ownership was provisional, entirely subject to the creator's whims. Such a mechanism is invisible until exercised, earning its name, and it turned the typical trust model of NFTs on its head: here, the code enforced a hierarchy where the art always ultimately "belonged" to its maker.

Participatory Interaction. Hate inverted typical participation—it was the artist who "participated" in the lives of certain audience members by depositing NFTs into their wallets uninvited. Pak solicited volunteers by asking Pak's followers to prove they had posted genuine hate toward Pak (via old tweets). The "winners" of this dubious honor were then airdropped the *Hate* NFTs; about 30 individuals received one. Their engagement was largely one of surprise and frustration: many attempted to trade or remove the tokens, only to discover every transfer attempt was automatically rejected by the contract. In essence, their interaction was to experience powerlessness—an unusual, perhaps uncomfortable form of audience participation where the usual agency of a collector was stripped away. As for *Move*, the wider community's participation came through observation and discussion rather than direct use (since *Move* is a contract design, not a direct-to-consumer app). Pak publicly shared the *Move* contract and its implications for all to inspect, inviting creators and collectors to contemplate this new paradigm. In doing so, the community collectively engaged in a discourse about consent and control in NFTs. In summary, *Hate/Move* turned the tables on engagement: instead of people actively opting into the art, the art opted into their lives, thereby making the audience's reactions and discussions (especially the haters' public bemusement) an integral part of the piece.

Artist's Control. By its very nature, *Hate/Move* was an exercise in maximizing artist control. Pak retained absolute authority over the *Hate* tokens at all times—Pak was the only one who could mint them, the only one who could move or burn them, and even the only one who could change their content. This project was a deliberate outlier compared to Pak's other works: instead of surrendering control to autonomous rules or the community, Pak crafted a scenario where Pak's hand remained firmly on the lever from start to finish. In fact, the project can be seen as a manifesto of control: *Move* was Pak asserting that as an artist-programmer, Pak could imbue a token with a piece of Pak's will, overriding the default freedoms typically given to collectors. After the initial performative phase, Pak ended the experiment on Pak's own terms by retrieving the tokens and effectively erasing them from the participants' wallets. In doing so, Pak underlined the central statement: these creations were never truly "theirs"—they were on loan at the creator's mercy. Such extreme control is generally anathema to the decentralization ethos, which is precisely why *Hate/Move* is so incisive; it used exaggerated artist control as an artistic device itself.

Collective Emergent Behavior. The immediate participants—the recipients of *Hate*—reacted with a mix of confusion, amusement, and annoyance. Some joked about selling their entire wallet (since they couldn't sell the token itself), highlighting the absurd lengths one would need to go to bypass the restriction. This small group of 30 became inadvertent performers in Pak's drama, their attempts and public commentary forming a crucial part of the narrative that others followed. Meanwhile, the broader NFT community watched the spectacle with fascination. On social media and blogs, a flurry of debate ensued about the ethics and implications of *Move*: some collectors expressed relief that such a mechanism was not widespread, while some creators were intrigued by the power it demonstrated. The collective behavior here was largely discursive—*Hate/Move* spurred conversations about the nature of ownership and the extent of smart contract programmability. People questioned how this contrasts with the spirit of self-sovereignty that NFTs usually promise, and whether it was "fair" or simply a clever conceptual stunt. In the end, once Pak reclaimed the *Hate* NFTs, the haters were free of their burdens, perhaps a bit wiser to the power of code

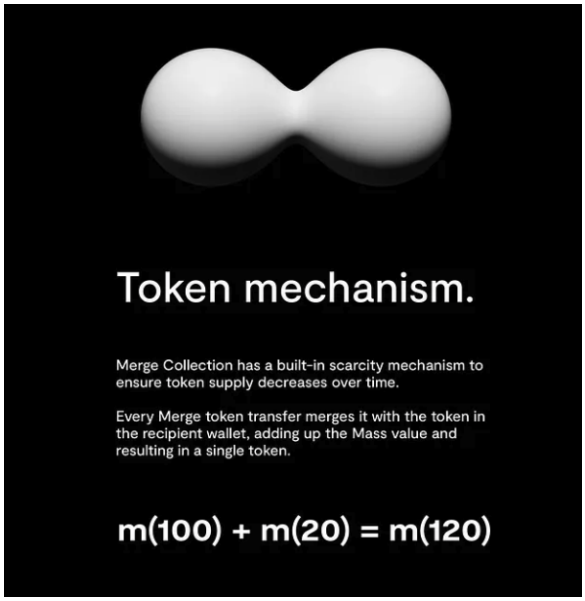


Figure 9: The token mechanism explained on the *Merge* (2021) launch website. When two tokens enter the same wallet, the smart contract automatically combines them into one with summed mass—a built-in deflationary protocol that ensures the total supply can only decrease over time.

in digital art. The community that observed gained a nuanced understanding: emerging from it was a collective acknowledgement that decentralization in art is not absolute, and that the artist's intent coded into a contract can drastically shape user experience. This dialogue and reflection were exactly the emergent cultural outcomes Pak likely sought, elevating the work from a mere prank to a significant case study in the NFT space.

Poetic Meaning-Making. In retrospect, *Hate/Move* reads like a sharp, if mischievous, parable within the NFT art narrative. It poetically frames the tension between artist and audience: the *Hate* tokens were as much a mirror to the recipients (reflecting their hostility back as an unusable "gift") as they were a canvas for Pak's statement about artistic sovereignty. There's dark humor and irony in the idea that hatred towards an artist could be alchemized into an artwork that essentially traps that hate—a modern digital twist on holding up a mirror to one's critics. The *Move* mechanism adds an extra layer of meaning: it challenged the community to realize that the liberties they take for granted in decentralized art can be tweaked or overturned by a clever creator. This provocation was unsettling to some and thrilling to others, serving as what one might call a necessary thought experiment in a hype-driven field. By co-opting Pak's detractors into unwilling collaborators, Pak turned negativity into a generative component of Pak's practice, raising questions about consent, power, and the very definition of ownership. In the broader context of digital art discourse, *Hate/Move* is significant for revealing that the blockchain is not inherently liberating—its effect depends on how it's used. Pak's broader impact here is to remind both creators and collectors that the medium's rules can themselves be the artwork. *Hate/Move* ultimately stands as a conceptual punchline with a serious core: an artwork about authority, delivered in the medium of authority itself.

Key Statistics. In November 2021, Pak airdropped 30 one-of-a-kind *Hate* NFTs (depicted as a simple heart symbol) to selected critics. Each had an embedded "move" mechanism allowing Pak to transfer them. The contract (address `0xMove...`) was written by Manifold Studio and made public on Etherscan. During the first week, at least 2 instances of Pak using the move function were observed, and 0 transfers by holders (since none could occur). The stunt quickly spread awareness; tweets about "Pak's Hate" garnered thousands of impressions, and articles in crypto media (e.g., CryptoTimes and others) explained the phenomenon. The term "Invisible Mechanism" was coined by Pak in a tweet announcing the project's true purpose. Ultimately, no monetary exchange took place for these NFTs on the market (until perhaps after Pak later unlocked them, if Pak did). Instead, their value was purely conceptual. Pak's "Move" contract was later referenced in discussions on NFT standards, making these 30 tokens and their story a small but significant footnote in NFT history about creative smart contract design.

Annotation. Invisible Mechanisms is an outlier that inverts nearly every pattern in the portfolio. Where other works distribute control (**C2**), this one concentrates it absolutely: the `move()` function grants the artist unilateral power to seize or relocate any token. Where other works invite willing participation (**C3**), here the recipients were enlisted without full knowledge of the token's constraints. The work's true innovation, however, lies in its creation of a non-transferable asset—a token that, once deposited in a wallet, cannot be moved by its holder. This is a radical contribution to **C1** (system-centric composition): the contract's permissions structure *is* the artistic statement, and the meaning of the work resides entirely in what the protocol forbids rather than what it enables. The non-transferability mechanism directly anticipates the "soulbound token" concept later formalized by Weyl, Ohlhaver, and Buterin [54], making *Hate* a historically significant precedent in which an artistic experiment prefigured a major theoretical development in blockchain design. The work's primary contribution is to **C6** (poetic message embedding): the non-transferable "Hate" token literalizes the idea that negative attention, once given, cannot be taken back—a pointed commentary on power asymmetry encoded directly in the smart contract. Furthermore, the mechanism pioneered here did not remain isolated: the non-transferability logic later inspired the soulbound design deployed in *Censored*, where message tokens were locked until Assange's release, demonstrating that even Pak's most provocative experiments serve as compositional building blocks for subsequent works.

Information.

- Launch Website: Pak's Twitter
- Release Date: Nov, 2021
- OpenSea: https://opensea.io/collection/coic
- Contract Address: 0x938e95271311641dc88fedaa6d7b9afdc875daa9 (ERC721)

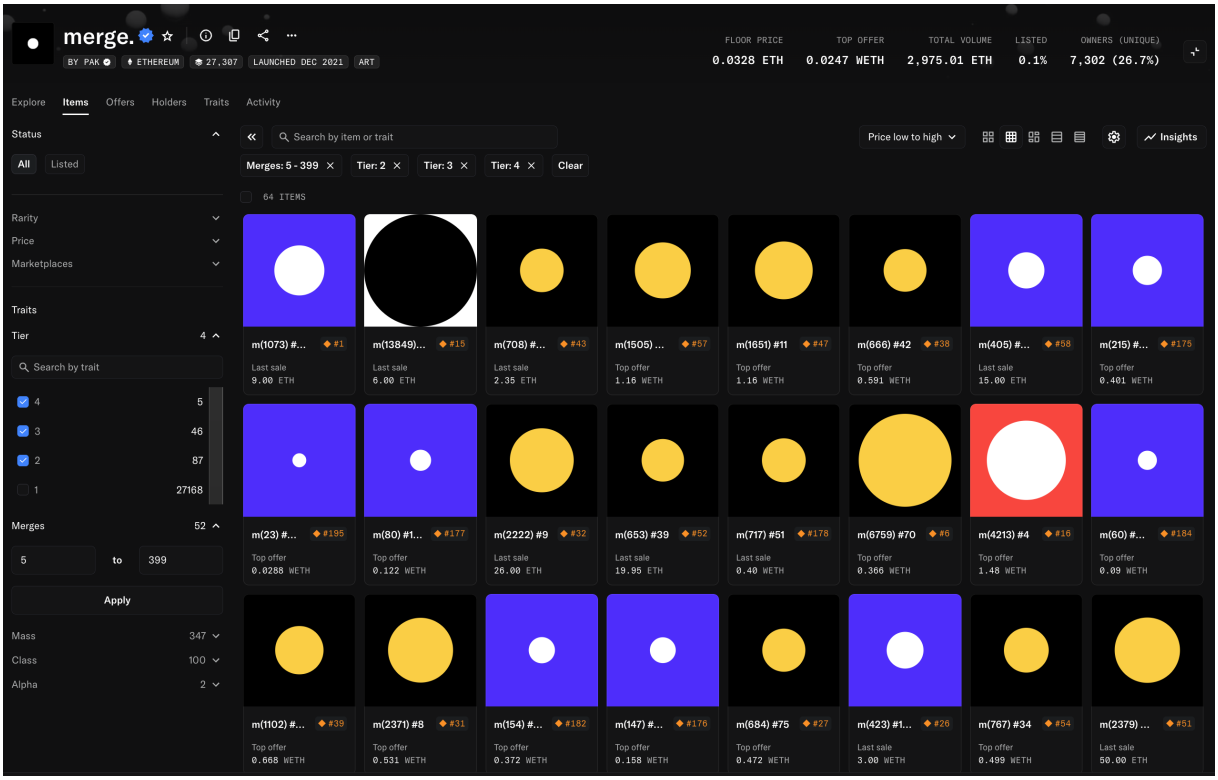


Figure 10: *Merge* on OpenSea. Each NFT is visualized as a circle whose size corresponds to its accumulated mass. Color tiers (white, yellow, red, blue) indicate mass thresholds, making the relative "weight" of each collector's holdings immediately legible across the marketplace.

A.7 Merge

Concept. *Merge* (December 2021) is a landmark NFT work wherein Pak explored themes of unity, rarity, and collective participation by creating an artwork that exists in fragments yet has the potential to become a single whole. Billed as the first artwork that collectors could collectively assemble, *Merge* was sold not as discrete editions but as "mass units"—small identical tokens of mass that buyers could acquire in any amount during a 48-hour sale. Each buyer's mass units automatically fused into one NFT (a single mass) in their wallet, whose size (visualized by a growing circular form) was proportional to the amount of mass purchased. The concept plays on the idea of merging: if two *Merge* NFTs ever end up in the same wallet, they combine into one larger mass, reducing the total number of tokens in circulation. In effect, Pak conceived *Merge* as a dynamic, self-collapsing collection—one that challenged the traditional notion of an edition size by making the supply theoretically shrinkable over time. Thematically, *Merge* invokes a sense of digital unity: all collectors hold a piece of a conceptually singular artwork, and if one entity were to gather every piece, the title's promise would be realized as a single merged entity. Through this, Pak commented on the interplay between collaboration and competition, inviting the question of whether collectors would consolidate or guard their individual pieces, and what ultimate form the artwork might take.

System Mechanism. The *Merge* contract innovated on the token model by introducing an additive property to NFTs. Technically, each mass unit was an ERC-1155 token minted during the sale; at the close of the sale, the contract "compressed" a buyer's multiple units into a single ERC-721 NFT that recorded the total mass count as an attribute. The NFT's visual appearance (a circle of a certain size and perhaps color) was programmatically determined by the mass count, making the artwork generative and data-driven. The merging logic was enforced at the contract level: it utilized a transfer hook that, upon detecting a *Merge* token arriving in a wallet that already held one, would cancel the separate existence of the incoming token and increment the mass of the token already in that wallet. This mechanism guaranteed that no wallet could ever hold more than one *Merge* NFT—a radical departure from standard NFTs. Over time, if collectors consolidated holdings or accidentally merged by buying with a pre-existing mass in their wallet, the total token count of the project would decrease from the initial 28,983 supply. Unlike most art, where the edition size is fixed, *Merge* had a fluid supply that could contract, theoretically even to 1. This dynamic introduced emergent phenomena: for example, the rarity of certain visual variants depended on how people managed their tokens, not solely on predetermined traits. By embedding these rules, Pak effectively encoded a set of interactions and potential outcomes (even conflict) into the artwork's DNA, making *Merge* as much a social experiment as a digital sculpture.

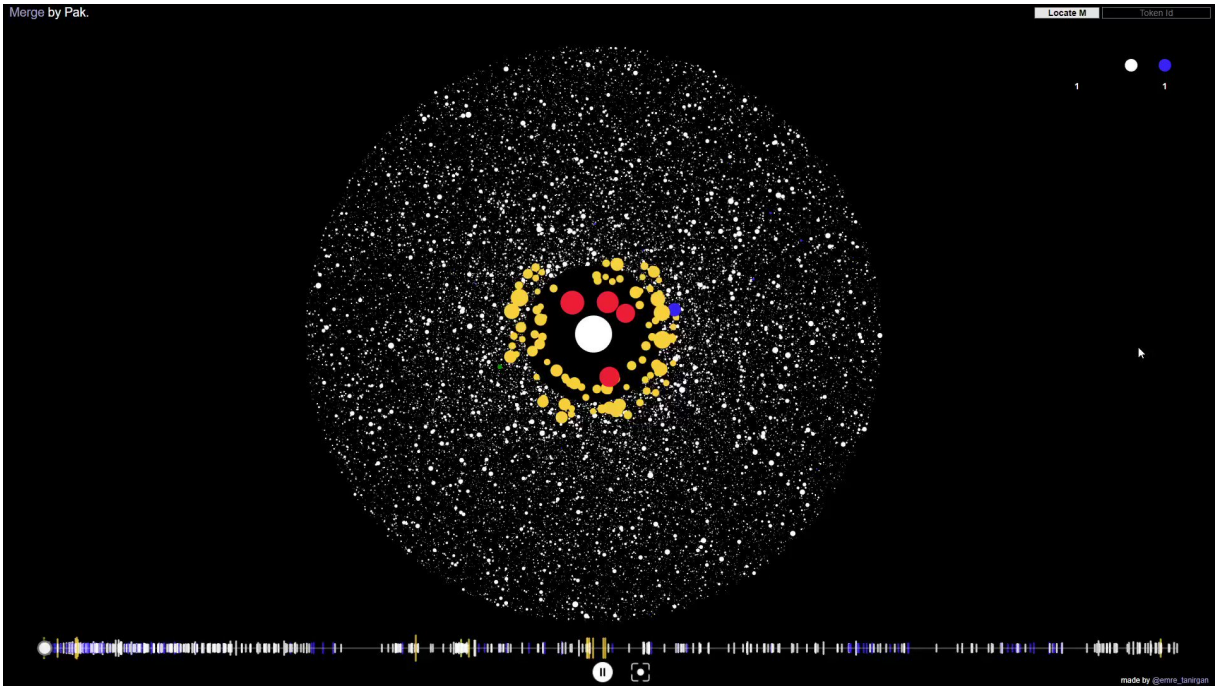


Figure 11: Third-party interactive visualization of all *Merge* tokens at https://mass.show/. Each dot represents one token, sized proportionally to its mass. The galaxy-like distribution reveals the power-law concentration of mass among a few dominant holders surrounded by thousands of smaller participants.

Participatory Interaction. Participation in *Merge* was straightforward yet unprecedented in scale: 28,983 collectors took part in the open sale, collectively purchasing 312,686 mass units over the two-day period. Instead of competing for limited editions, buyers were cooperating in a sense—everyone was guaranteed to receive their own NFT mass, and many aimed to accumulate as much mass as they could. The interactive twist emerged after the sale: whenever a *Merge* NFT was transferred on the secondary market, the contract would check the recipient's wallet. If the recipient already had a *Merge* NFT, the incoming mass would merge with the existing one, destroying one token and increasing the other's mass. This meant that collectors had to strategize; some chose to split their holdings across multiple wallets to keep separate smaller masses (especially if those had unique visual traits like a different color), while others intentionally merged to build a singular, more "massive" mass. There was even a gamified angle of aggression and defense: theoretically, someone could send a large mass to another collector's address (without permission) to forcibly merge and absorb a smaller mass, as a way to sabotage its rarity or uniqueness. Such scenarios made holding a *Merge* NFT a participatory experience beyond the initial purchase: the community was actively discussing merger tactics, bragging about the size of their mass, and contemplating alliances or friendly competitions. In essence, *Merge* turned collecting into a collective game that extended into every transaction post-drop.

Artist's Control. After *Merge* was launched, Pak's role was largely hands-off; the rules in the smart contract dictated the fate of the tokens. Pak did not exert control over who could buy or how much (beyond setting the sale's time frame and pricing increments), nor could Pak intervene in the merging process once tokens were in circulation—that process was entirely automatic and irrevocable. However, Pak's control was asserted in the careful design: Pak set the initial conditions that governed everything, from the pricing mechanism (which increased the price per mass unit in stages as certain sales milestones were hit) to the visual algorithm that represented mass. By relinquishing active control and entrusting the artwork to self-execution, Pak reinforced *Merge*'s stance as a decentralized piece governed by protocol. In fact, the only way Pak influenced the outcome was indirectly, through Pak's initial decision not to cap the edition: this allowed the community's demand to define the scale of the piece (and ultimately break the record for the largest-ever art sale by a living artist). In the life of *Merge* post-sale, Pak stepped back completely—any further evolution (like tokens merging into fewer tokens) was purely at the discretion of the holders and the mechanics Pak had put in place. This minimal ongoing control is consistent with Pak's tendency to let Pak's protocol-based works run their course autonomously, in stark contrast to the interventionist stance of *Hate/Move*.

Collective Emergent Behavior. The launch of *Merge* saw an enormous turnout, and this critical mass of participants created a unique collector community bonded by the experiment. Immediately, *Merge* holders began comparing the sizes of their masses, fostering playful rivalries between "whales" (those with very large masses) and everyday collectors. There was a leaderboard mentality; some individuals who acquired huge quantities of mass became minor celebrities in the community, their holdings seen as a bold statement of support

for Pak's vision. On secondary markets, novel behaviors emerged: because any purchase that combined two masses was irreversible, some collectors were hesitant to buy an additional *Merge* token unless it was larger than the one they already possessed, to avoid 'losing' their smaller piece in a merge. This led to an unusual trading strategy where sometimes whole wallets (with a *Merge* NFT inside) were sold peer-to-peer, just to preserve the token's separate identity. The theoretical endgame of one entity eventually merging all masses into "The One" became a topic of both amusement and intrigue, serving as a metaphor for consolidation of power or unity of art. Meanwhile, the sheer fact that *Merge* had broken the world record for an art sale—not by one person's expenditure but by the collective effort of nearly 29,000 buyers—instilled a sense of communal pride. This remains a profound aspect of the piece's narrative: it proved that a decentralized network of collectors could, together, make art history. Over time, as some merges did occur and the token count slowly diminished, the community continued to monitor and discuss these developments, treating the artwork as an ongoing story they were all part of. *Merge* thus nurtured both camaraderie and competition among its participants, encapsulating a microcosm of the crypto community's spirit.

Poetic Meaning-Making. On a conceptual level, *Merge* operates as a poetic exploration of unity and the power of the many. It turned the act of collecting into a narrative of convergence: each individual NFT was not just an endpoint but a piece of a larger potential composition. There is an inherent poetic image in thousands of separate collectors holding what could be fragments of one singular artwork—it's as if a digital star was shattered and distributed, with the ever-present possibility of reassembly. This resonates with ideas of community in the crypto space: *Merge* implicitly asks whether the true value of an artwork might reside in shared ownership and collective action rather than exclusivity. The artwork's very existence and record-breaking price were a testament to collaboration (a crowd of buyers rather than a single bidder), making it a celebration of a decentralized patronage model. Additionally, the merging mechanic itself can be seen as a commentary on accumulation and synthesis: smaller masses being absorbed by bigger ones evokes phenomena in economics and nature alike, delivered here as a voluntary game. By provoking participants to consider merging or resisting merges, Pak surfaced questions about competition versus cooperation and about whether art is better experienced as a multitude or as a unity. Ultimately, *Merge*'s broader impact lies in its demonstration that scarcity and unity can be artistically intertwined: it delivered a visual and participatory poem about how the many can become one. In doing so, it expanded the discourse of digital art to include not just the creation of images, but the creation of new social contracts and economic structures as vehicles for meaning.

Key Statistics. Merge was sold on 2–4 December 2021 and drew 28,983 buyers who purchased 312,686 total mass units. The sale grossed $91.8 million, making it (at that time) the highest total for any NFT artwork and thrusting Pak above Jeff Koons as the priciest living artist by primary market sales. The average collector bought about 10.8 mass units. Initially, 28,983 Merge tokens existed (one per buyer). Through secondary-market activity and merging, the supply has been decreasing: one year post-sale, the number of distinct Merge tokens had dropped to around 27,000 as consolidations happened. The largest token (*Alpha*) amassed 933,878.2 mass (some collectors found ways to add mass beyond the sale via special mechanics or bonuses), and the next few largest were orders of magnitude smaller, highlighting a steep consolidation curve. The smart contract ensured that a Merge token's mass count and visual size update in real-time with each merge; Nifty Gateway's interface had to be adapted to handle these dynamic NFTs. By January 2022, *Merge* tokens had done over $100 million in secondary trading volume as collectors continued to jockey for position. Importantly, no single entity has (yet) merged all tokens—tens of thousands of decentralized pieces remain, meaning *Merge* lives on as a plural artwork owned by many, with the theoretical possibility that it could one day coalesce further [52].

Annotation. Merge is the most ambitious and conceptually far-reaching work in the portfolio, serving as the definitive case for **C1** (system-centric composition) and **C2** (autonomous governance): once deployed, its self-merging deflationary logic operates without any artist intervention, and the artwork's visual form (the size and color of each mass token) is entirely determined by on-chain state. After the initial open-edition sale, everything becomes an automatically self-governed universe in which the protocol alone dictates outcomes. **C3** (distributed agency) reaches its largest scale here—28,983 buyers collectively sculpt the work's final distribution—while **C5** (economy-driven engagement) manifests not only in the frenzied mass-hoarding competition but in the emergence of the Internship DAO, a collectively organized effort to acquire the Alpha token that arose entirely from participant initiative rather than artist design. This emergent behavior is paradigmatic: user activity creates its own attentional dynamics, as though the work generates a distinct game that no one scripted. Every person, at every moment, faces the choice to sell or to acquire others' tokens, and this perpetual decision space—playable at any time, but always with genuine economic incentive—transforms *Merge* into something closer to a persistent world than a static artwork. Merge is notable for the *irreversibility* of its dynamics: tokens can only grow through merging, never split, creating a one-directional "extinction game" that distinguishes it from the reversible or cyclical mechanics of burn.art and Lost Poets. This irreversibility gives Merge a distinctive temporal character (**C4**): the work can only become more concentrated over time, never return to its original state, ensuring that its aesthetic and economic trajectory is entropic and unrepeatable.

Information.

- Launch Website: https://www.niftygateway.com/collections/pakmerge/
- Release Date: Dec 2, 2021
- OpenSea: https://opensea.io/collection/m
- Contract Address: 0xc3f8a0f5841abff777d3eefa5047e8d413a1c9ab (ERC721)

A.8 Censored

Concept. Censored (February 2022) is a two-part collaborative artwork by Pak and WikiLeaks founder Julian Assange that confronts issues of censorship, free speech, and the power of the collective. Conceived while Assange was imprisoned, the project's central



Figure 12: "Censored is a Collection by Pak and Assange and You." *Censored* (2022). Top: a soul-bound message NFT in its censored state, with text obscured by a redaction bar—untransferable while Assange remains imprisoned. Bottom: the same NFT in its uncensored state after Assange's release, revealing the full message and becoming freely transferable.

question is how information and truth can be either suppressed or liberated in the digital age. The first part, *Clock*, is a one-of-a-kind dynamic NFT that simply displays a count of the number of days Assange has been in custody—an ever-increasing tally that starkly visualizes the passage of time lost to censorship and incarceration [13]. The second part was a dynamic open edition often referred to as *Censored* (later "Uncensored"), which invited anyone to anonymously submit a text message. Each submission was minted as an NFT where the message initially appeared as blacked-out blocks (as if redacted), but later these NFTs were revealed to show the full message—creating a permanent, public ledger of uncensored speech on the blockchain. Together, these components embody a powerful concept: *Censored* is both a protest and a platform, highlighting the plight of Assange specifically and the principle of uncensored expression universally. By design, the project blurred the line between artist and participant, making "you"—the public—a co-creator of the open edition piece, echoing the idea that free expression is a collective, democratic effort.

System Mechanism. The technical structure of *Censored* mirrored its conceptual duality. *Clock* was implemented as a dynamic NFT: its content updates once per day to increment the count of Assange's imprisonment. This likely involves either an on-chain calculation of days since a start date or an off-chain oracle pushing daily updates—either way, the piece is programmatically tied to the real-world passage of time and will continue to tick until Assange's status changes. The open edition was dynamic in a different sense: when each *Censored* NFT was first minted, the text submitted by the user was stored (on-chain or via metadata) but visually represented in a redacted style (for example, as black bars or scrambled characters). Then, upon Assange's release on 24 June 2024, a contract function executed to "uncensor" all these tokens, updating the metadata so that the true text became visible. Each open-edition NFT is thus unique in message but identical in having undergone the same transformation from obscured to revealed. The fundraising mechanism was straightforward: the sale smart contract directed the incoming Ether to designated wallets associated with Assange's defense fund and other aligned charities (indeed, a portion of the 671 ETH raised from the open edition was later donated to support journalistic freedom and even humanitarian aid). The dynamics here combined artistic intent with real-world impact: the more people voiced themselves (minted NFTs) and the higher the DAO bid for *Clock*, the more tangible support was generated for the cause. In a sense, the blockchain functions as both canvas and conduit in *Censored*, ensuring that the art's message (the imperative of free expression) is inseparable from the action it precipitates (material aid for a free press).

Participatory Interaction. The participatory element of *Censored* was striking. For *Clock*, participation took the form of collective fundraising: an Assange-supporter DAO (decentralized autonomous organization) pooled resources from over 10,000 people to bid on and ultimately win the piece for 16,593 ETH (about $52.8 million), making each contributor a part-owner of the artwork and massively amplifying its political message. For the open edition, Pak opened a web portal on February 7, 2022, where anyone could type a short message and mint it as an NFT. There were minimal barriers—aside from blockchain transaction fees—which allowed thousands of ordinary people worldwide to inscribe their uncensored thoughts onto the blockchain. During the mint period, participants wrote messages ranging from political statements ("FREE ASSANGE NOW") to personal reflections, fully aware that they would initially be recorded in a censored (illegible) state. After the mint closed, Pak triggered a global reveal: all the NFTs' images were updated to show the actual text of the messages, symbolizing voices breaking through suppression. In this way, the audience's role wasn't just to observe but to speak and be memorialized as part of the art. Additionally, by buying these open-edition NFTs (each priced modestly), participants contributed to a fundraiser—all proceeds were directed to Assange's legal defense and pro-freedom organizations—blending activism with artistic engagement. In essence, *Censored* turned its audience into an active assembly of

publishers and protesters, demonstrating the principle that in a decentralized network, everyone can raise their voice and collectively bolster a cause.

Artist's Control. In *Censored*, Pak acted not only as an artist but also as a facilitator of collective expression and activism. Pak and Assange's team set the stage—defining the parameters of the open edition (time frame, interface for input, price) and crafting the *Clock* NFT—but then handed the mike to the public. For the open edition, Pak exercised restraint in content moderation: applying no filters in alignment with the project's absolutist free speech stance, Pak allowed minters to submit any text, which was a radical trust in the community. However, Pak retained control over the overall execution: Pak decided when the reveal would happen and ensured it occurred uniformly for everyone, and Pak controlled the smart contract that forwarded funds to the intended beneficiaries. With *Clock*, once it was launched, the control shifted to the AssangeDAO (as the new owners) in terms of display and eventual fate of the piece, although the daily increment feature was baked into the token itself. In essence, Pak's control was about creating a secure and open channel for expression and then stepping back at the right moments. The success of *Censored* depended on this light-touch approach; too much control (e.g., censoring the messages or manipulating the outcomes) would have undermined the trust and authenticity the piece needed to resonate. By structuring it as Pak did, Pak underscored Pak's role as an enabler—Pak controlled the framework but not the voices within, embodying the artwork's ethos in the very way it was managed.

Collective Emergent Behavior. The *Censored* project galvanized a uniquely blended community of art enthusiasts, cypherpunks, transparency advocates, and supporters of Assange. The formation of AssangeDAO itself was a landmark event: thousands of strangers coordinated in a matter of days on chat platforms, raised tens of millions in cryptocurrency, and collectively won the *Clock* auction, an unprecedented feat of decentralized crowd-funding. This feat gave participants a profound sense of accomplishment—each member of the DAO owns a fractional piece of *Clock* via tokens, making *Clock* a collectively owned symbol of protest. In parallel, the open edition saw 29,766 NFTs minted across its 48-hour run, reflecting broad participation from the crypto community and beyond. Upon the reveal, a new collective experience began: people scoured the now-uncensored messages, sharing poignant or powerful quotes they found among the NFTs. The collection became a digital chorus of statements about freedom, justice, and personal sentiments, and owning one meant being part of that chorus. A notable emergent behavior was the way traditional lines blurred: activists became art collectors by minting NFTs, and NFT collectors became activists by joining the political messaging. The *Censored* Discord and other forums buzzed with discussion not just about the art's value, but about the cause it supported and the stories behind individual messages. This convergence of normally separate communities (art, crypto, activism) was itself a product of the project. In the aftermath, the collective energy didn't dissipate immediately: the DAO refocused on continued advocacy for Assange, and many open-edition holders continued to promote the messages they had minted, effectively using their NFTs as badges of alignment with the free speech movement. *Censored* thus forged an alliance of convenience into a lasting community centered on principle and expression.

Poetic Meaning-Making. *Censored* stands out as a poignant union of art and activism, transforming the cold mechanics of blockchain into an emotional and political narrative. The poetic substance of the work arises from its contrasts: a single, ever-ticking clock counting the days of one man's silencing, and a sea of uncensorable messages giving voice to thousands. The *Clock* NFT is minimalistic yet profound—each passing day it displays is a testimony to injustice, a visual poem of waiting and resilience. The open edition, once uncensored, became an anthology of global voices; its poetry is both literal (many entries were written with genuine passion or wit) and metaphorical, in that it turned censorship on its head—what was once hidden is now immortalized in public view. There is a strong sentiment that *Censored* wasn't just documenting a moment in crypto art, but a moment in history: it bridged the gap between the decentralized art world and real-world social issues, demonstrating that the blockchain community could rally around something deeply human. The broader impact of *Censored* lies in its demonstration of how digital art can be immediately socially relevant. It set a precedent for using NFTs as a medium of protest and fundraising, expanding the notion of what kind of statements can be made—and preserved—through art. In summary, *Censored* made poetic meaning through direct action: it is art as a verb, an event in which aesthetic expression, technological infrastructure, and moral conviction converged to powerful effect.

Key Statistics. The *Clock* NFT sold on 9 February 2022 for 16,593 ETH (approximately $52.8 million), bought by AssangeDAO, a collective of 10,000+ members pooling funds. This made it one of the most expensive NFTs ever and provided a huge donation to Assange's legal defense. The open edition *X/X* minted 29,766 NFTs over its 48-hour run, raising 671 ETH in voluntary contributions (about $2.1 million) for pro-freedom organizations chosen by Pak and Assange. Each of these message NFTs was initially non-transferable; following Assange's release on 24 June 2024, the tokens were unlocked and the censored messages revealed. Over 17,000 unique Ethereum addresses participated in the mint (many contributed multiple messages via additional wallets). The largest donation from a single minter was 50 ETH (showing some used the mint as a way to donate significantly). Post-drop, AssangeDAO has kept *Clock* on display via a fractionalized ownership governance token (representing membership shares in the DAO). *Censored* stands as a record-breaking instance of political fundraising through digital art, and a case where an NFT project directly engaged international press and communities far beyond the traditional art world.

Annotation. *Censored* is the most politically charged and arguably the most poetically powerful work in the portfolio, serving as the strongest case for **C6** (poetic message embedding): the entire interaction ritual—submitting a message that is initially blacked out, then revealed only upon Assange's release—enacts the experience of censorship and liberation in a way that purely visual art cannot. The political claim embedded in the work is inseparable from the collective behavior it demands: nearly 30,000 participants became co-authors of a collective "censored chorus," each contributing a personal message that functioned simultaneously as

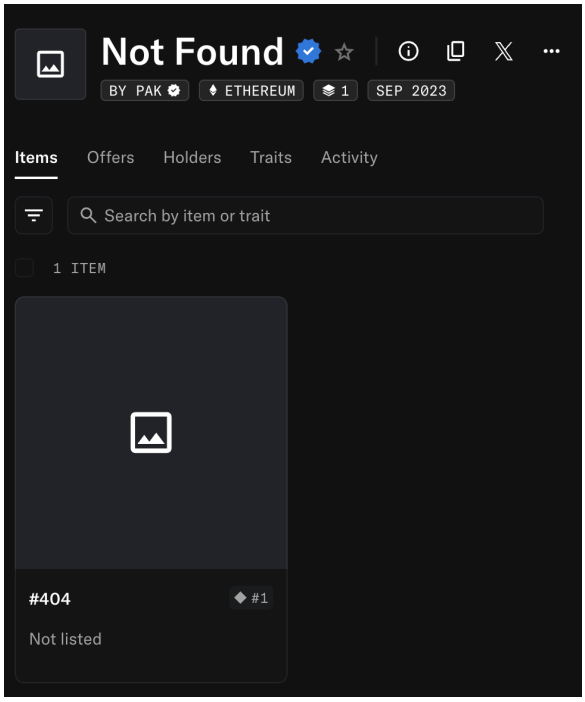


Figure 13: *Not Found* #404 on OpenSea (2023). The token was minted with no metadata by design—no image, no name, no description—so that any platform querying it receives only a 404 error. The resulting broken-image placeholder becomes the artwork itself: a deliberate void memorializing the absent.

artistic expression and political advocacy for Assange's release (**C3**, distributed agency). The poetic message was literally embedded into the NFT, and the entire arc—from locked, non-transferable tokens bearing blacked-out text to their eventual unlocking and revelation upon Assange's release on 24 June 2024—constitutes a profoundly poetic process with genuine geopolitical meaning. The non-transferability mechanism, inherited from the soul-bound logic pioneered in *Hate / Invisible Mechanisms*, here acquires a new resonance: the tokens were imprisoned alongside Assange, and their liberation mirrored his. **C2** (autonomous governance) takes an unusual form: AssangeDAO's collective ownership of Clock, and the reveal mechanism's binding to an external real-world event, make the artwork's governance partly extra-protocol—dependent on geopolitical outcomes beyond any participant's control. This external dependency is unique in the portfolio and raises the question of whether protocol art's autonomy can meaningfully extend to conditions outside the blockchain. The whole process—collective advocacy encoded in code, censorship enacted and then reversed, tokens locked and then freed—is deeply powerful, demonstrating that protocol art can achieve a form of political poetry in which the medium's constraints and affordances carry moral weight.

Information.

- Launch Website: https://censored.xyz/
- Release Date: Feb 7, 2022
- OpenSea: https://opensea.io/collection/censored-pak-assange
- Contract Address: 0xda22422592ee3623c8d3c40fe0059cdecf30ca79 (Soul-bound ERC721)

A.9 Not Found / #404 (2023)

Concept. Not Found #404 is a 1-of-1 NFT forged "in memory of the absent" that Pak created in August 2023 as a poignant tribute to the late crypto artist Alotta Money. The concept revolves around absence as presence. It leverages the web's familiar "404 Not Found" error—the message one sees when a webpage is missing—as an artistic statement. Pak minted *404* with no metadata: no image, no name (beyond the token ID), no description. In Pak's words, "#404 is a token forged in memory of the absent… Void of metadata by design to amplify the presence of absence." The NFT exists as a sort of intentional glitch or blank, symbolizing the void left by Alotta Money's passing. Socially, it speaks to how loss is felt in the digital age—even on a blockchain, an empty space can carry profound meaning as a memorial.

System Mechanism. Technically, *404* is engineered to be an NFT that always produces a 404 error for its metadata endpoint. Typically, an NFT's metadata link provides JSON data including the name, description, and image URI. Pak deliberately set up *404* so that when any application (like OpenSea or Etherscan) queries the token's metadata, the server responds with a "Not Found" status. This means the token has no visible content—no name, no image—just its token ID (#404 on that contract). However, embedded within the smart contract is a tiny message: instead of the usual metadata, Pak hard-coded a plain string that says "In memory of the absent" as the response. That phrase is the only "content" of the NFT, acting like a eulogy delivered in code. The dynamic effect is that on any NFT marketplace, *404* appears as an empty or broken entry (which is itself conspicuous). Over time, assuming the piece stays as is, it will forever display as a missing asset, effectively eternalizing the idea of absence. This is a case where the lack of data is the feature, not a bug—a radical use of the NFT format to signify zero.

Participatory Interaction. 404 was part of a charity auction (the Alotta Money Memorial on MakersPlace), so the direct participation was in the bidding process. Collectors vied not for a flashy image but for the honor of owning this conceptual piece. The winning participant, prominent collector WhaleShark, essentially paid a large sum for an NFT that "looks" like a broken link. In a broader sense, the audience participation comes in the form of interpretation: everyone who views the token on marketplaces just sees an error or blank, and must mentally fill in what it represents. Interestingly, because the contract ensures the metadata always returns a 404 error, any platform displaying it will show a broken image icon or "Not Found" text, inviting each viewer to participate by remembering or inquiring about Alotta Money and the context. Thus, while not interactive in a traditional way, it engages the audience's awareness and curiosity. The community also participated in spreading the story—tweets and articles explained what *404* meant, effectively crowdsourcing the task of giving this "silent" NFT a voice.

Artist's Control. Pak had meticulous control over *404*'s presentation. By deciding to include no metadata and making the token

unchangeable (immutable after mint), Pak ensures that neither Pak nor the owner can ever add an image or title later. This permanence is part of the tribute's integrity. The artist also controlled the context: *404* was introduced with a tweet explaining its purpose and dedication, guiding the initial audience understanding. After the auction, however, Pak's control yielded to the token's behavior in the wild—any confusion or discussion arising from people seeing a blank NFT became part of the piece's life. It's worth noting that creating an NFT that defies normal display could have negative repercussions (some might think it's an error), but Pak accepted that risk to preserve the concept. In terms of curation, Pak placed *404* in a charity event so that its sale (48 ETH) benefited a cause (Alotta's cancer fund or a related charity), aligning control of proceeds with the homage. Ultimately, Pak's control was about ensuring emptiness—an ironic but powerful form of control where doing "nothing" was a deliberate artistic act.

Collective Emergent Behavior. Once *404* was out in the world, the NFT community responded collectively by imbuing it with significance. Discussion threads emerged about *"the NFT with no data"* and what it meant; in this way, the community co-authored the narrative by sharing the backstory. Some artists were inspired by this approach and contemplated similar "negative space" works. As for the owner, WhaleShark displayed *404* in virtual galleries and on social media, where the emptiness became thought-provoking. Rather than diminishing interest, the lack of an image actually drew people in—a reverse of the usual NFT hype cycle. A subtle emergent behavior is that marketplaces had to handle a token with no metadata gracefully; some updated their interface to show "Unnamed" or simply the token ID. This sparked minor technical conversations in developer circles about how to index such an NFT, thereby *404* gently pushed the boundaries of NFT platform expectations. The most heartening emergent behavior was the collective act of remembrance: the NFT community, normally fixated on visuals and rarity, paused to remember an artist through a non-visual artifact. In that sense, *404* succeeded in creating a communal moment of silence, as it were, in the bustling NFT space.

Poetic Meaning-Making. *404* is pure poetry in digital form. Its poetry lies in what is absent: it forces the viewer to confront a void and find meaning in it. Much like John Cage's silent composition "4'33"" or Rauschenberg's erased drawing, Pak's *404* finds art in nothingness, which in this context becomes a profound statement about loss. The use of the "Not Found" web error as the medium ties our sense of missing information to the emotion of missing a person. It's a requiem encoded as a glitch. The token number 404 itself is meaningful—in web lore, 404 symbolizes a dead link, something that was once there but no longer accessible, mirroring Alotta Money's departure. Moreover, *404* leverages the permanence of blockchain to eternalize an impermanent idea (absence). Its message *"In memory of the absent"* resonates universally—it's not just about one individual, but about all those we've lost (it invites anyone to project their own feelings of loss onto it). As a social/artistic message, it reminds the tech-forward NFT community of human mortality and the gap that death leaves in our networks. In its quiet way, *404* perhaps also comments on the oversaturated NFT market—amid thousands of gaudy images, the most meaningful piece can be an empty one. The poetry of *404* lies in its silence and subtlety, making the presence of an absence palpably felt.

Key Statistics. *404* was minted on 31 August 2023 and auctioned the next day at the "Alotta Money Tribute" event on MakersPlace. It sold for 48 ETH (roughly $78,000 at the time) to collector WhaleShark, with sale proceeds going to charity. The token resides on a custom contract; it is token ID 404 and notably the only token in that contract (no other token IDs exist, making 404 both the ID and the collection name). Its on-chain metadata call returns a 404 error code by design, and the token carries a brief on-chain text "In memory of the absent." The piece garnered considerable media attention for an NFT—features in art publications highlighted it as the first NFT that intentionally "does nothing" visually yet carries deep meaning. As of 2025, WhaleShark has not listed *404* for resale (and likely never will), aligning with its status as a memorial piece. *404* stands as one of Pak's later protocol artworks, and while it's a single edition, its impact was amplified by the hundreds of artists and collectors who witnessed and shared in the commemorative moment it represents.

Annotation. *Not Found* is the portfolio's limiting case: a work that strips protocol art to its conceptual minimum. **C1** (system-centric composition) is expressed through pure negation—the artwork's meaning resides entirely in the contract's deliberate refusal to return metadata, making the absence of content the content itself. **C6** (poetic message embedding) is correspondingly intense: the token ID 404 and the lone on-chain string "In memory of the absent" compress an entire elegy into the structure of a failed HTTP request. Unlike every other work in the portfolio, *Not Found* involves no **C3** (distributed agency), no **C5** (economy-driven engagement beyond the charity auction), and no **C7** (composability). Its isolation is the point: it demonstrates that protocol art need not rely on mass participation or elaborate tokenomics to achieve poetic force—a single, precisely engineered absence can suffice.

Information.

- Launch Website: Pak's Twitter Account
- Release Date: Aug, 2023
- OpenSea: https://opensea.io/collection/in-memory-of-the-absent
- Contract Address: 0x3a91740d25587a0cd5baa27755876231559a3e60 (ERC721)

Mycortex: Exploring Non-Human Symbolic Communication through Art and Bioelectric Signals

Mycortex: Non-Human Symbolic Communication

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Figure 1: Mycortex installation visual presentation (Photo by author, 2024)

Abstract

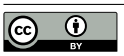
Mycortex is an interactive art installation that juxtaposes fungal electrical signals with human brainwaves in a dynamic space, transforming them into non-narrative language and symbols. The project perceives language as a dynamic organism, reducing the life phenomena of humans and fungi to electrical signals and converting the waveforms of these signals into non-narrative acoustic language and organic symbol representations. It aims to construct a "third space" for interspecies language translation between humans and non-humans from a non-anthropocentric perspective. Within this confined space, the electrical signals emitted by humans and mushrooms intertwine and influence each other, generating a new dynamic symbolic system. The installation does not claim a literal interspecies dialogue but instead evokes an open, non-anthropocentric field of resonance in which signals, rhythms, and symbols emerge in mutual influence.

CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**;

Keywords

Interactive Art Installation, Non-Narrative Symbols, Interspecies Communication, Posthumanism



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1 Conceptual Framework

Human activity and technological expansion have dissolved the boundary between humans and nature, forming an interdependent ecological whole. Within this, non-human entities possess agency and complex perceptual and symbolic systems [1]. Fungi, for example, create extensive underground mycorrhizal networks that transmit materials and signals between plant roots [2], enabling interspecies communication and contributing to human–nature entanglements [3].

These networks form a complex linguistic system between fungi, ecosystems, and humans, one that exceeds the limits of single-species symbols and resists anthropocentric translation. This raises a central question:

How can we build a communicative framework that transcends human - cantered language and acknowledges non-human agency?

Mycortex explores this question by merging theoretical reflection with installation art. The project constructs a "Third Space" [4], beyond normative logic, where human and fungal signals, brainwaves and bioelectricity, are visualized and signified as abstract, non-narrative symbols. Drawing on posthumanism theory [1] [2] and interactive media, Mycortex seeks to dissolve conventional perceptual boundaries and create a shared symbolic space.

Rather than translating non-human signals into human meaning, the work foregrounds their alterity, using art's speculative potential to bridge perceptual and spiritual gaps. The goal is to generate pre-linguistic, a priori forms of interspecies engagement, enabling humans to encounter fungi through new, non-anthropocentric dimensions.

Theoretical Background

1.1 Beyond Human Semiotics: Cross-Species Symbolic Systems

To understand how the signals between humans and fungi might constitute a form of "language," we must return to a more fundamental question: What is a symbol, and who is entitled to use it?

This question lies beyond the scope of traditional, human-centered linguistics and points toward a semiotic perspective that extends beyond the human. Eduardo Kohn, drawing on posthumanism and semiotics, proposed the idea of "anthropology beyond" [1], extending Peirce's semiotic theory to non-human life form. He challenges anthropocentrism by arguing that all living beings, not just humans, use symbols to engage with their environments. This symbolic exchange is essential for species' survival and evolution, offering a broader, non-human view of meaning and language.

Kohn's cross-species semiotics primarily focuses on the symbolic interactions between animals and humans, while overlooking the perceptual capabilities and symbol generation of plants [1]. However, plants can also respond to external stimuli through electrical signals. For instance, research shows that when plant leaves are damaged, they quickly transmit electrical signals, triggering defense mechanisms [2] [7]. Different stimuli generate distinct signals, such as how the Venus flytrap uses action potentials to determine when to close its trap [8].

Communication between plants occurs through underground mycorrhizal networks, which transmit complex information and affect the growth and defense mechanisms of surrounding plants. Studies have found that voltage fluctuations within mycelial networks regulate plant behavior, and around 90% of terrestrial plants rely on mycorrhizal systems for interspecies communication [2] [8] [9] [10].

These findings extend the scope of semiotic inquiry beyond the human, suggesting that the roots of language may already lie within the reciprocal perceptions of life and ecology. In this sense, cross-species symbolic communication not only runs parallel to human linguistic systems but also offers new reference points for understanding the evolution and structure of language.

1.2 Symbolic and Linguistic Systems

From an evolutionary perspective, the linguistic systems of mycorrhizae and humans share key parallels, both relying on environmental perception to transmit signals that aid species survival [6]. Whether through plant networks or human neural systems, biological behaviors are shaped by signals and symbols as adaptive responses to external conditions.

Linguistic signals influence cognition and behavior through dynamic interactions across cultural, biological, and cognitive systems [6] [5]. Their meanings are context-dependent, emerging through sender–receiver relationships [11]. Thus, language and signals form dynamic ecological linkages between humans and fungi. However, fundamental perceptual and symbolic differences prevent direct translation, creating an abstract gap where meanings remain elusive [12].

Art, as a spiritual and symbolic medium, can help bridge this gap. Drawing on Homi K. Bhabha's concept of the Third Space [4], this project constructs an interstitial field where human and fungal symbolic systems converge. *Mycortex* translates bio-signals into real-time audiovisual symbols, forming a nonlinear system that transcends rational and linguistic constraints to explore new perceptual dimensions.

The project extends symbolic representation beyond human–animal models [1], incorporating plants often overlooked, into this communicative framework. Despite differing impacts on the environment, plants and humans share fundamental electrochemical signaling mechanisms. Through mycorrhizal networks [2], plants reshape not only ecosystems but human perception of them.
Since true interspecies communication can never entirely transcend symbolic boundaries [6], *Mycortex* employs the *Third Space* to articulate a shared symbolic system. Grounded in the ambiguity of artistic abstraction, the work reconfigures perception into an open, pre-linguistic field of communication between human and fungal life.

Figure 2 visualizes the conceptual and technical framework through which Mycortex translates human and fungal signals into a shared perceptual field. To implement the system, physiological and electrophysiological data were simultaneously acquired from human and fungal sources using a multi-sensor configuration. EEG signals were non-invasively recorded using Muse 2 headsets, offering high temporal resolution and streamed via OSC to TouchDesigner for real-time processing [13] [14] [15].

Participants wore the device in natural environments. Simultaneously, portable EMG patches were attached to mushroom surfaces to capture fungal electrophysiological activity with minimal interference. These signals were pre-processed for clarity [15]. A pH sensor was also integrated to detect subtle chemical variations in the fungal microenvironment, reflecting metabolic and communicative dynamics. pH data were sampled using Arduino ADC and transmitted to TouchDesigner.

The combined EEG, EMG, and pH signals were processed in a real-time pipeline. EEG frequency bands, fungal EMG oscillations, and pH fluctuations were mapped to sound synthesis and symbolic visual generation. These multimodal biosignals were projected as evolving acoustic textures and non-narrative visual symbols onto a sheer curtain, creating an immersive space of shared perception between humans and fungi.

EEG signals were captured via Mind Monitor and streamed through OSC at 256 Hz. Key frequency bands (Alpha, Beta, Theta, Delta) were extracted and mapped to audio pitch and symbol frequency. Fungal EMG and pH signals were sampled at ~60 Hz using Arduino. During ~5-minute sessions, all biosignals were normalized and fed into a real-time audiovisual system in TouchDesigner, enabling a generative feedback loop between human brain activity and fungal metabolism.



Figure 2: Conceptual and System Architecture of Interspecies Signal Translation in Mycortex

Participants interacted via gentle touch or presence, influencing signal flow and dynamically shaping a shared symbolic environment.

2 Documentation

Visual documentation of the installation is available at VimeoLink.

3 Discussion & Conclusion

Mycortex explores interspecies communication through the ambiguous yet measurable biosignals of fungi and humans. While fungal electrophysiological and chemical signals may not represent structured dialogue in a human sense, the project embraces this indeterminacy as a posthumanist gesture, resisting anthropocentric expectations of ordered meaning and instead highlighting reciprocal, co-emergent influence between species. The audiovisual outputs, though inevitably shaped by human aesthetics and technology, function as a speculative symbolic milieu, a "third space" where traditional semiotic hierarchies dissolve. Situated within Kohn's cross-species semiotics and Bhabha's theory of the third space, *Mycortex* juxtaposes EEG-based human brainwaves with fungal EMG and pH signals in real time, constructing a dynamic system of signal translation. This continuous feedback loop produces evolving, non-narrative visual and acoustic symbols, dissolving interspecies language barriers and fostering a shared perceptual environment. By reframing language as a living, co-authored phenomenon, *Mycortex* offers a new paradigm for cross-species attunement and symbolic co-creation.

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From Motion to Meaning

Educational and Design Perspectives on Embodied Locomotion in Virtual Reality

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Abstract

This paper examines embodied locomotion in virtual reality (VR) through student-designed projects in an educational course focused on interactive virtual environments. The students developed VR experiences inspired by real-world scenarios, incorporating physical movements for navigation, such as kayaking, biking, and climbing. Using Unreal Engine 5 and Oculus Meta Quest 2, these projects aimed to foster empathy and immersion by aligning physical actions with virtual interactions. The study highlights both the potential and challenges of embodied locomotion in VR. Althoughugh students demonstrated creativity and innovation, they faced significant technical and design barriers, including hardware limitations, interaction inconsistencies, and performance optimization issues. Feedback from participants and student reflections provided valuable insights into these challenges. Based on these findings, the paper proposes strategies to simplify interaction mechanisms, optimize development for target hardware, and incorporate iterative user testing. The study underscores the value of educational frameworks that equip novice developers to create seamless, engaging, and empathy-driven VR experiences.

CCS Concepts

• **Applied computing** → **Interactive learning environments**; **Media arts**; • **Human-centered computing**;

Keywords

Virtual Reality, Embodiment, Locomotion, Education

ACM Reference Format:

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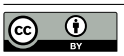
1 Introduction

Virtual reality (VR) has emerged as a transformative medium for immersive experiences, enabling users to explore digital environments with an unparalleled sense of presence and interactivity. Among the essential components of VR, embodied locomotion—movement techniques that integrate a user's physical motion with their virtual navigation—stands out as a critical factor influencing user engagement, immersion, and overall satisfaction. Embodied locomotion in VR entails the seamless alignment of physical and virtual movements, bridging the gap between the user's real-world actions and their avatar's behavior in the digital space. This concept draws extensively on theories of embodied cognition, which emphasize that cognitive processes are deeply rooted in the body's interactions with its surroundings. By incorporating physicality into VR interactions, embodied locomotion has the potential to enhance spatial understanding, agency, and the emotional impact of virtual experiences. Despite its transformative potential, embodied locomotion in VR presents significant challenges, ranging from motion sickness and physical strain to technical and hardware limitations.

Replicating real-world physical experiences—such as walking, biking, or swimming—in virtual environments requires overcoming both software and hardware constraints, such as tracking fidelity, latency, and frame rate. These factors significantly affect the user's sense of embodiment and can lead to disorientation or alienation when technological limitations disrupt the seamless experience. Beyond its technical applications, VR serves as a powerful medium for fostering empathy by enabling users to "step into someone else's shoes." Embodied locomotion plays a pivotal role in this context, allowing users to form deeper connections to social issues and challenges by directly engaging their physical bodies and emotions in the process.

This paper examines the current landscape of embodied locomotion in VR, addressing both technical and human-centered challenges associated with its implementation. Specifically, it explores how locomotion design impacts immersion, user experience, and the ability to create compelling narratives. The discussion extends to a series of student-developed projects that leverage embodied locomotion to support empathy-driven applications, such as navigating as a small creature, kayaking, and biking. These projects demonstrate both the potential of VR to deliver engaging embodied experiences and the limitations imposed by technical constraints. Through an analysis of these design approaches, we investigate how issues such as hardware fidelity, interaction design, and movement mechanics influence the quality of VR experiences. This paper also highlights how educational programs can better prepare students for VR development by addressing these technical and design challenges, empowering them to push the boundaries of what embodied locomotion in VR can achieve. By advancing the understanding of embodied locomotion, this paper aims to inspire future innovations

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in VR design that prioritize user immersion, empathy-building, and technical excellence.

2 Background and Prior Works

Since the inception of virtual reality (VR) development and research, a primary goal has been to immerse users in simulated environments that respond dynamically and realistically to their movements and interactions [4]. While advancements in technology have made VR more accessible and widely available, the challenges of designing and developing compelling virtual experiences remain substantial. Embodied locomotion, a critical aspect of VR, has been a longstanding area of research, with a focus on understanding how movement techniques affect a user's sense of presence, immersion, and physical comfort within virtual environments. Early studies explored the relationship between user motion and virtual navigation, highlighting the importance of seamless integration between physical and virtual actions for enhancing the overall VR experience.

2.1 Sense of Embodiment

Kilteni et al. (2012) define the sense of embodiment as comprising three interrelated components: the sense of self-location, the sense of agency, and the sense of body ownership[2]. These elements collectively enable users to feel immersed in a virtual body and environment. The synchronization of multisensory feedback—visual, auditory, and tactile—is critical for enhancing embodiment, as it reinforces the user's perception of presence and immersion within the virtual world. For example, congruent visual and haptic feedback strengthens the user's sense of physical presence in the digital environment, making interactions more natural and engaging.

2.2 Locomotion in VR

Research on VR locomotion reveals a complex interplay of tradeoffs between different navigation methods. Boletsis and Cedergren (2019) provide a comparative analysis of widely used techniques such as teleportation, joystick-based locomotion, and hybrid systems. Their findings indicate that teleportation reduces cybersickness effectively but can detract from spatial awareness and presence. Conversely, continuous joystick locomotion supports spatial continuity and immersion but is more likely to cause motion sickness. Riecke and Zielasko (2020) emphasize the benefits of embodied locomotion interfaces, which rely on intuitive, body-driven movements to foster a stronger sense of presence while reducing cognitive load. These interfaces leverage users' natural affordances, such as walking or reaching, to align physical actions with virtual navigation. Together, these studies highlight the need to balance user comfort, immersion, and spatial orientation when designing VR locomotion systems [1] [5].

2.3 Embodied Interaction

Embodied interaction integrates physical movement and perception with digital experiences, making interactions more engaging, memorable, and effective [7]. This approach is particularly significant in immersive environments, where users' physical actions directly influence their interactions with digital content. Lee-Cultura and Giannakos (2020) explore the role of embodied interaction in developing spatial skills, a critical component of effective cognitive task management [3]. In educational contexts, embodied interaction enhances engagement and retention by providing kinesthetic and multisensory learning opportunities. This is especially impactful when addressing complex

3 Design Task in Class

The exploration of embodied locomotion was integrated into the Interactive Virtual Environment course at Texas A&M University. As part of the curriculum, students were tasked with a design challenge: to create a VR experience that incorporates an embodied form of locomotion. The goal was to emphasize the use of physical movements as a primary means of navigation in a virtual world, with a focus on replicating real-world locomotion to enhance immersion and foster empathy by putting participants "in someone else's shoes." Students were encouraged to select physical locomotion methods that aligned with their interests and the narrative context of their projects. Working in teams, they developed their projects using Unreal Engine 5 for the Oculus Meta Quest 2, employing the system's tracked controllers to design innovative and diverse locomotion systems. These projects aimed to push the boundaries of VR interaction, demonstrating the potential of embodied locomotion to create unique and impactful immersive experiences. The project was completed in teams, with each team comprising members from diverse backgrounds, including visualization, graphic design, computer science, and engineering. Team roles included a project manager to oversee coordination and timelines, and a 3D asset artist responsible for developing the project's visual components. This multidisciplinary approach allowed each team to draw on a variety of skills and perspectives, fostering innovation and collaboration.

3.1 Design Process

Students started their design process by doing research in the form of seeking out examples and testing commercially available VR projects. This was a jumping-off point for group brainstorming and concept development. Students put together concept documents outlining their proposed locomotion system, including sketches and concept art for the final piece (Figure 1). Instructors reviewed this documentation and provided feedback to teams, guiding them to ensure their concepts were achievable and met the specifications of the design task.

After receiving feedback on their concepts, students revised and compiled a production calendar, defining team roles and responsibilities. This updated document included an asset list specifying all of the elements needed to complete the project. This asset list included items both in the game engine and any physical construction needed for the locomotion system. The prototyping and early production phase was focused on translating the locomotion concepts into playable demos within the Unreal Engine. As each group had vastly different locomotion systems teams had to work through understanding how the data from their tracked controller could be transformed into believable participant movement. During this stage, is when teams first started to experience the limitations of the software and hardware, either experiencing frame rate issues

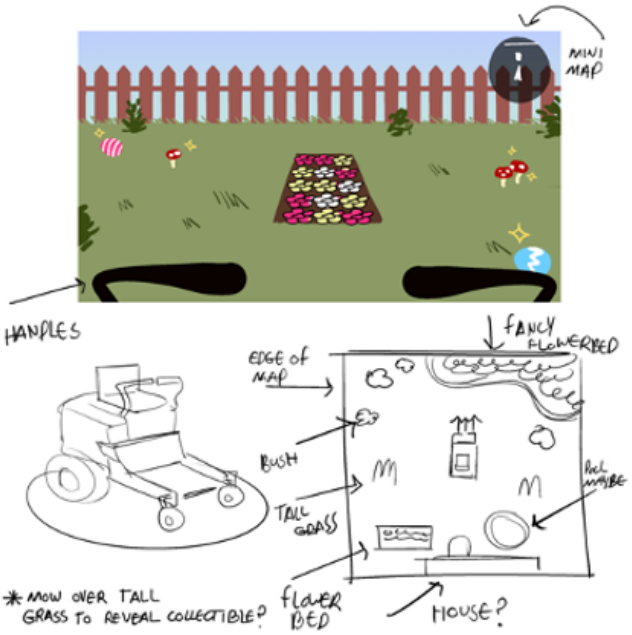


Figure 1: An example of initial concept sketches

or strange interactions with the physics system inside of Unreal Engine. A day was set aside in class for testing and demonstrations of prototypes where groups were able to get some initial user testing of their locomotion system. This informal user testing consisted of observations and verbal discussions of possible improvements between students and instructors. Following this, final touches were made to the projects to prepare them for the final deliverable, which included finalizing the user interface, virtual environment, locomotion system, and any physical props. Final demonstrations occurred during an end-of-semester showcase where teams were able to conduct user research, including pre-surveys and post-surveys, with a variety of participants outside of the course.

4 Student Projects

The students produced 7 VR projects in total, each presenting a unique approach to embodied VR locomotion. Below are three examples that illustrate the range of challenges and learning experiences that emerged.

4.1 Project 1: VR Kayaking

Concept Overview: This project aimed to recreate the immersive experience of kayaking within a virtual reality (VR) environment. To achieve this, the team ingeniously repurposed the Meta Quest controllers by attaching them to a length of PVC pipe, simulating a virtual oar that users could physically grasp. The oar's movements were accurately tracked within the virtual environment, allowing users to perform realistic paddling motions akin to real-world kayaking. In the VR experience, the user's objective was to navigate through the virtual environment and collect floating objects scattered across the level. This design not only mirrored the physicality of kayaking but also engaged users with an interactive and goal-oriented activity, enhancing both immersion and engagement.



Figure 2: Concept Art for the Project

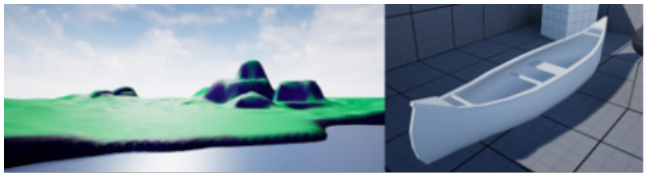


Figure 3: Digital Assets (Environment and Kayak)



Figure 4: The Meta Quest Controller attached to a PVC pipe to create a virtual kayak paddle.

Target User Group: The target audience for this piece are individuals who enjoy kayaking or want to learn kayaking and want a more convenient method to access the sport. The fidelity of the simulation in VR is of critical importance in order to align with user needs.

Interactions: The player uses a right controller attached to a PVC pipe to simulate a virtual oar, activated by the controller's trigger. By mimicking real paddling motions—pulling the pipe diagonally and alternating sides—the player propels the kayak, with speed and direction determined by the oar's movement and position. Propulsion begins when the oar registers contact with the water and stops when lifted out, replicating the mechanics of real kayaking.

User Feedback: The students presented their project and conducted both a pre-study and post-study survey on six participants.

Many participants reported being frustrated by the controls and not feeling in control over their kayaking experience. Below is an excerpt from the team's analysis from their user feedback.

> "People found the game rather difficult, mostly due to the responsiveness of the controls. We received comments about difficulty turning, or rowing backwards, and controlling speed, as well as a degree of frustration trying to use the controls as they wanted to. There were no comments on the pacing of the game. The objective was easily recognized without instruction.
> Overall, the general suggestions for improvement were to add sound and fix steering."

Student Experiences: The students spent a lot of time building and working on this project, with the biggest obstacles being getting the physics to function properly and getting the project functioning properly on device. Below are some excerpts from student experiences.

> "I think that the project could have been better…, primarily due to this being my first VR project, along with the Quest 2 in particular seemingly doing everything in its power to break the project. I will say that I did learn a lot, especially in debugging and working with physics. I greatly enjoyed it when I had a stable build and was able to just tweak and get the game feel right for the kayaking, which came out fairly well."
> "There were a lot of bumps along the way tech-wise, but overall I think we ended up with a really nice product that we can all be proud of in the end."

4.2 Project 2: Paperboy VR

Concept Overview: Paperboy VR is an immersive virtual reality game where participants step into the shoes of a paperboy, riding their bicycle through their neighborhood to deliver newspapers to the awaiting residents with precision. Participants are placed on a physical stationary bike and can pedal and steer to navigate a virtual environment. One VR controller is attached to the right handlebar of the physical bike, and the other controller is strapped to the user's leg to detect pedaling.

Target User Group: Users who want to enhance their workout experience through gamification at home. Safety and reduction of motion sickness are critical goals for this project's target users.

Interactions: The player navigates a virtual city by riding a physical bike. A VR controller on the right handlebar enables steering, while another strapped to the user's leg detects pedaling, moving the bike forward in VR. Player's "throw" newspapers by using the handlebar controller's trigger, aiming to deliver them to designated spots within 1 minute. The goal is to deliver as many newspapers as possible during the time limit.

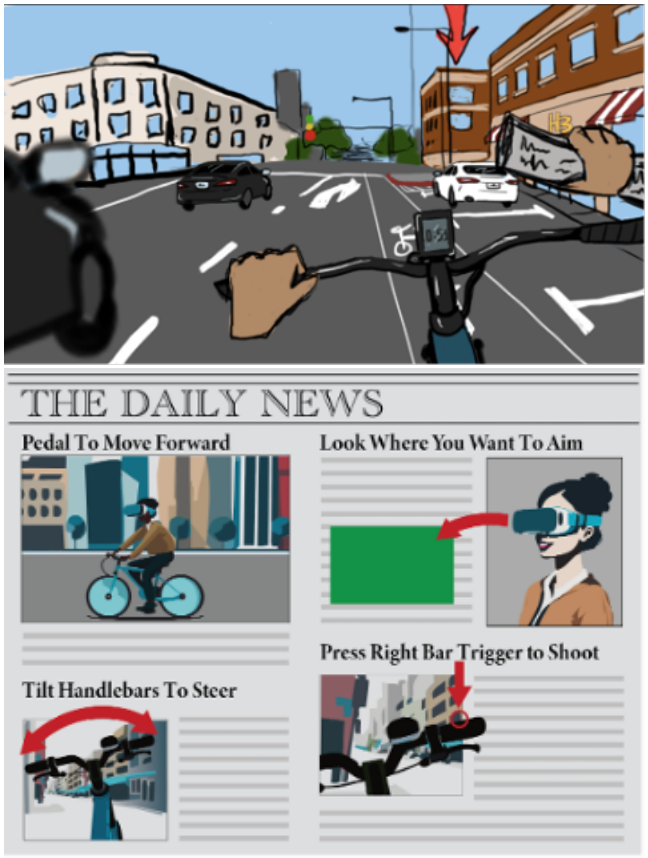


Figure 5: (Top) Concept sketch for Paperboy VR showing participant viewpoint, (Bottom) User Interface screen with instructions for how to operate the game.

User Feedback: The students collected 20 user responses during their demonstration with many participants enjoying the experience and reacting positively. However, nearly half of the participants reported feeling motion sickness and feeling unstable on the physical bike. The lack of stabilizing momentum and speed from the stationary bike created a mismatch between the real and virtual worlds. To address these issues, the physical bike setup would require a more robust setup that would allow users to have a more natural and safe experience.

> "Another big concern was the stability of the bike and control over it. For the most part, it seems that our users felt comfortable on the bike, but not totally in control. To help alleviate this, we could design a more stable setup to ensure that the bike is not wobbly and can handle those who want to pedal fast and turn quickly.… The overall motion sickness experienced by users was pretty good as well. Only 9 out of the 20 participants stated that they experienced motion sickness. To help combat this and lower those numbers though, we can incorporate some of the things mentioned above: more stability in the bike setup, and

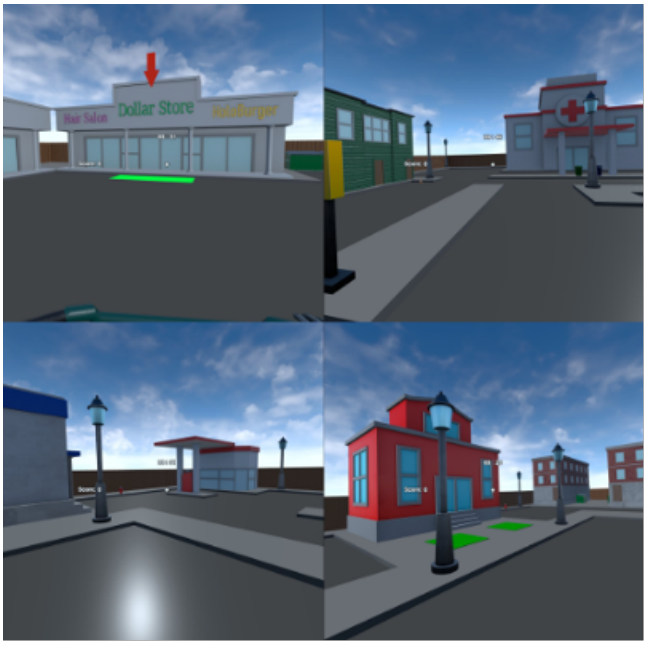


Figure 6: Virtual Environment of Paperboy VR



Figure 7: User tries Paperboy VR

gentler speed options. Lastly, as expected, users felt that being able to ride the physical bike enhanced the gameplay."

Student Experiences: During the final demonstration, Paperboy VR was one of the most popular experiences with many people waiting to test the game. The novelty of being on a bike while in VR, in addition to the gameplay elements, invited user engagement and participation. However, because of the unstable nature of the bike, participants could only play for a few minutes before needing to take a break and regain their balance.

> "I think this project is a very unique experience, but not something I would be able to play more than one round of at a time. I personally enjoy being immersed in the VR world for a few hours at a time, so if I was able to do some improvements to the unreal project, it would definitely be finding out how to make the player feel more comfortable with this new form of movement in VR."

> "The movement wasn't as hard to implement as I thought it would be, however, it is not perfect. There is definitely room for improvement such as stabilizing the bike a bit more and really nailing down the speed and feel of the movement."

4.3 Project 3: Rat-Scape

Concept Overview: In this project, users take on the perspective and locomotion abilities of a Rat trying to navigate a pantry. Participants use their hands as the primary locomotion method grasping onto objects within the world and jumping between them. In the game users must navigate up the pantry to find cheese and advance to the next level.

Target User Group: The target users for this experience are individuals wanting to experience a unique locomotion system in a fun setting. With the focus of the project being on enjoyment and fun, the mechanics need to be simple, intuitive and bug-free.

User Feedback: During user testing, it became apparent that Rat-Scape suffered from several issues that made the experience difficult to play and navigate. The shortcomings consisted of users not understanding the necessary motions needed to accomplish movement. Adding to this confusion was the inconsistency in how the locomotion system responded to user input, at times producing no motion and at others launching the player great distances. Finally, in certain areas of the virtual environment, the framerate of the application would drastically reduce, leading to motion sickness and inconsistent tracking.

> "Initial confusion regarding how to navigate the virtual space indicates a lack of clarity in the instructions. The grab and pull method may need more explanation and adjustments."

> "Inconsistent jumping physics at different spots, issues moving forward when jumping. "

> "Lag issues when the users look at the stacks of plates indicate the need to remove some assets for a smoother and more responsive experience."

Student Experiences: Part of the reason the team struggled to address these issues before the completion of their project was the initial setup of the development environment for the Meta Quest 2. Simply getting Unreal Engine configured and ready for VR development was a major challenge that cut into precious time. Contributing to these issues was also the practice of developing on a high-end PC and tethering the Meta Quest to the PC. This gave the team a false impression of the game's performance, which when



Figure 8: (Top) Concept sketch for Rat-Scape project showing how users will navigate the virtual environment, (Bottom) Virtual Environment Renders.

played on the lower specs of the Meta Quest drastically changed the playable experience.

> "We did a lot of learning and growth during this project, and I really enjoyed learning Unreal. The biggest challenges were in time management and the setup of a developer environment in Unreal. The first weeks of the project were crazy, having to buy cables and storage space, but once the ball got rolling I really enjoyed developing in Unreal. "

> "I wish I was able to help with the physics of the game, as the challenges associated with adjusting and enhancing the intuitiveness of the physics system became evident a bit too late."

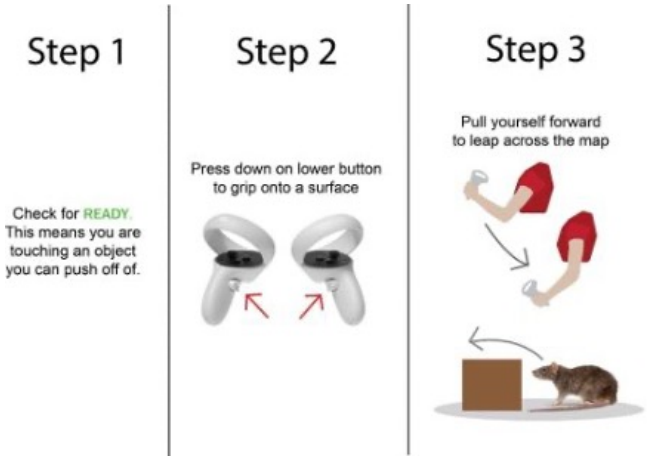


Figure 9: User interface screen from Rat-Scape explaining how to navigate the virtual environment.

5 Discussion and Strategies

In this course, students focused on creating embodied locomotion in VR environments inspired by real-life scenarios. The immense potential of virtual reality to transport users into new worlds and provide unique perspectives has been widely discussed [6]. However, creating compelling and seamless experiences with current technology remains fraught with barriers, especially for students and inexperienced developers. The journey of crafting immersive VR experiences revealed numerous challenges, ranging from technical limitations to design complexities. Achieving seamless interactions often proved difficult due to constraints such as limited expertise, hardware capabilities, and the steep learning curve of VR development tools. Drawing from our experience in running this course, as well as insights from student reflections and user feedback, we propose several strategies to help reduce these barriers and enable developers to create more immersive and accessible VR experiences.

5.1 Simplify Interaction Mechanisms

Each project faced challenges with user control and interaction in VR. For example, VR Kayaking struggled with the virtual oar's responsiveness, and Rat-Scape's grab-and-pull mechanics were difficult for users to grasp intuitively. Simplifying the control scheme by focusing on intuitive, recognizable movements can help users feel more comfortable and reduce frustration.

Strategy: Develop physical interactions that are closely aligned with natural human movement patterns. This approach minimizes the learning curve and the need for extensive user instruction, making VR more accessible to newcomers. Testing each mechanic with a wide range of users can reveal pain points and allow designers to adjust controls early in the process.

5.2 Optimize and Test on Target Hardware

The Rat-Scape project encountered significant lag issues because students initially developed and tested on high-end PCs tethered

to VR headsets, then encountered performance issues on the standalone Meta Quest 2. This mismatch led to a false sense of stability that did not transfer well to the final platform.

Strategy: Encourage development directly on the intended hardware whenever possible. If using PCs for initial development, regularly test on the target hardware throughout the process to address potential performance issues early. By optimizing for the hardware constraints of VR devices, students can create smoother, more enjoyable experiences for end users.

5.3 Enhance Technical Support and On-boarding

Several projects highlighted the need for better onboarding and setup guidance, both for users (e.g., instructions on how to use the controls effectively) and for students (e.g., configuring Unreal Engine for VR). Many student teams spent significant time on troubleshooting and configuration, which detracted from project development.

Strategy: Integrate comprehensive onboarding resources, including setup instructions, tutorial videos, and access to example projects, to simplify the learning curve. Offering workshops or hands-on sessions early in the project timeline can familiarize students with VR-specific development processes and reduce time spent on technical setup issues.

5.4 Implement Iterative User Testing

Each project benefited from initial user feedback but would have gained more from continuous, iterative testing. Paperboy VR, for instance, could have identified and addressed motion sickness issues with earlier and more frequent testing.

Strategy: Establish regular feedback loops throughout the project timeline, incorporating both informal peer testing and formal user testing sessions. Focus on key areas, such as control responsiveness, user comfort, and immersive qualities, and adjust based on feedback at each stage. User insights can guide refinements that ultimately make VR experiences more accessible and enjoyable.

5.5 Educate on VR Design Best Practices

Many of the challenges faced by students, such as motion sickness, hardware limitations, and user control difficulties, are well-documented in VR development literature. Teaching VR design best practices, including strategies to reduce motion sickness (like adding a virtual nose or lowering acceleration), could significantly reduce barriers to entry for students and end users alike [8].

Strategy: Integrate VR design best practices into the curriculum to equip students with foundational knowledge. By understanding common pitfalls and successful techniques, students can better anticipate and avoid design issues. Including real-world case studies on successful VR projects can offer students additional insights and inspire more user-friendly designs.

6 Conclusion

This study demonstrates both the potential and challenges of creating embodied locomotion experiences in virtual reality, particularly within the context of educational programs. The student projects highlight how intuitive physical interactions and multisensory integration can foster immersion and presence, aligning with prior research on embodiment. However, technical barriers such as hardware constraints, physics inconsistencies, and performance optimization frequently disrupted these experiences.

Moving forward, addressing these challenges requires a multifaceted approach. Simplifying interaction mechanisms, aligning development directly with target hardware, and embedding VR design best practices into educational curricula can enhance the learning process and improve user experiences. Moreover, iterative testing and robust technical support will empower novice developers to create smoother, more intuitive VR applications. Ultimately, these strategies not only advance the field of embodied VR but also equip the next generation of developers with the tools to push the boundaries of immersive technologies.

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Digital Media Art and Archaeologies of the Invisible: The Case of Mãe Soberana in Dialogue with Zielinski

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Abstract

Digital media art, an artistic expression emerging from contemporary technological culture, signals a revolution in how cultural experiences are transmitted and lived. In this context, the case "*Mãe Soberana* – Our Lady of Piety," in Loulé, exemplifies the convergence between art, technology, and intangible heritage. Using tools such as augmented reality, video art, QR codes, and artificial intelligence (AI), the project proposes an interactive and participatory reinterpretation of Marian devotion, integrating memory, faith, and innovation. Inspired by Zielinski's Media Archaeology, the study adopts a non-linear reading of technological history and explores relationships between the visible and the invisible, the sacred and the digital. The methodology combines an a/r/tographic, qualitative, and participatory approach, involving the local community in building digital narratives and safeguarding intangible cultural heritage. This proposal resonates directly with Siegfried Zielinski's Media Archaeology diagram by adopting a non-linear reading of media history and valuing the multiplicity of trajectories, layers, and technologies. Devotion to *Mãe Soberana* is reinterpreted as a hybrid territory of artistic expression, where digital technologies are not merely mediation tools but devices for creation, evocation, and participation. The research proposes an archaeology of the invisible, revealing symbolic and affective layers of the devotion through technological mediation. It thus contributes to reflection on the ethical and critical integration of digital art in the valorization of intangible cultural heritage.

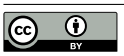
CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Human-centered computing** → Human computer interaction (HCI); Interaction paradigms; Mixed / augmented reality; Interaction design; Interaction design process and methods; Participatory design.

Keywords

Media Archaeology, Intangible Heritage, Mãe Soberana, Mediation

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1 Introduction

The development of contemporary creativity is tied to the ubiquity of digital technology [1], challenging traditional artistic practices and redefining modes of aesthetic and social participation. In this context, devotion to Our Lady of Piety – *Mãe Soberana* [2] [3] constitutes a paradigmatic example of the convergence between art, technology, and intangible cultural heritage (ICH).

Based on Zielinski's "media archaeology" [4], this article investigates how digital media art can reconfigure ways of experiencing and communicating the sacred, articulating past, present, and future through transmedia narratives that expand the participatory dimension, building bridges between tradition and innovation. Zielinski's approach privileges non-linear readings and multiple layers of mediation, offering fertile ground for reflecting on materiality and memory in digital media. Devotion to Our Lady of Piety, inscribed since 2020 in the national ICH inventory, includes unique rituals, music, lexicon, and iconography that express Loulé's cultural identity. This research proposes its digital reinterpretation, promoting a plural and collaborative reading of local culture.

In this sense, it is important to emphasize digitization as a form of participatory safeguarding of intangible heritage, as advocated by UNESCO [5] and Parry [6], who see technological mediation as an instrument to strengthen community engagement in the active preservation of their cultural inheritance. The reflection presented here makes it possible to question contemporary artistic practices, dematerialize creative processes, and assess the impact of new collaborative narratives on the public and the community. What challenges do these emerging languages pose to digital media art and, in particular, to the *Mãe Soberana* case?

2 Framework

2.1 Media archaeology

Media archaeology rejects the linearity and determinism of technological narratives, proposing instead a disruptive, discontinuous, and plural approach [4] [7]. This perspective privileges the critical excavation of forgotten, alternative, or marginal media, revealing the temporal and cultural complexity of media practices. In this context, devotion to Our Lady of Piety – *Mãe Soberana* can be understood as an act of symbolic and technological excavation, in

which invisible layers of memory, faith, and devotion are reactivated through digital media art.

Zielinski's approach is aligned with the concept of the media's "temporal depth" [8], underscoring that technological innovation does not replace the past but reinscribes it—transforming each new medium into a process of remediation and cultural re-inscription. These digital artistic practices also become an archaeological exercise in which the present critically dialogues with the materialities and sensibilities of the past. Zielinski's media archaeology rejects historical linearity and proposes a discontinuous, multidimensional view of media [4]. By exploring forgotten, marginal, or experimental forms of mediation, this approach offers critical tools for thinking about artistic practices that operate outside traditional models. The *Mãe Soberana* case is understood, in this context, as an act of symbolic and technological excavation capable of reanimating the invisible layers of collective memory while also revealing almost five hundred years of the manifestation's history.

2.2 Digital media art and technological convergence

Digital media art is a transdisciplinary field that integrates artistic, scientific, and technological practices, reflecting the media convergence described by Jenkins [9] and deepened by Paul [10]. This convergence manifests in the fusion of languages—sound, image, text, and video—and in the creation of immersive and interactive experiences that transform the spectator into an active participant in the artistic process.

In the context of the *Mãe Soberana* project, this convergence translates into the creation of a hybrid territory [11], where the sanctuary and the digital space intertwine. The result is an expanded aesthetic experience that articulates the physical, the symbolic, and the virtual, shaping new forms of cultural and spiritual mediation.

2.3 Intangible cultural heritage and participatory digitalization

The digital transformation of cultural processes has introduced new ways to preserve, communicate, and experience intangible cultural heritage. Beyond simple documentation, contemporary digitization is proposed as a form of participatory safeguarding in which communities cease to be mere objects of recording and become co-authors of their own representation [5].

In this context, digital media art practices converge with the principles advocated by UNESCO by promoting inclusive, collaborative, and critical processes of cultural mediation. The interaction between technology and heritage does not replace ritual but amplifies it, creating spaces of collective memory and forms of intergenerational transmission.

Parry argues that digital heritage initiatives should be understood not as mere technical projects but as acts of social curatorship in which the public participates in building cultural meaning [6]. Thus, integrating technologies such as augmented reality, QR codes, or artificial intelligence in the *Mãe Soberana* case helps reconfigure community experience, making the sacred more accessible and relational.

Digitization therefore plays a dual role: it is an instrument of preservation and a means of creative reinterpretation, in keeping with an archaeological and participatory approach to media.

3 Methodology

The study follows a qualitative, exploratory approach grounded in a/r/tography and the use of a digital logbook as a reflective device. A/r/tography develops as an open, interactive communication system with dynamic characteristics that articulate relationships between disciplines through contexts, narratives, memories, dialogues, and collective encounters, fostering sensitive and focused communication [12]. As a methodology, a/r/tography combines the roles of artist, researcher, and teacher, articulating reflective and participatory practices [13]. This approach allows integration of lived experience with theoretical analysis, promoting an immersive view of the articulation between digital media art and cultural heritage. Data collection took place between April and September 2024 through participant observation, audiovisual recording, informal interviews with community members, and collection of existing archives at the Loulé Museum and Municipal Archive [14]. About 25 participants took part—devotees, local artists, cultural technicians, and members of the event's organization—in laboratory workshops.

The workshops focused on exploring augmented reality, video, and sound resources, as well as gathering testimonies about the experience of the devotion to *Mãe Soberana*. All meetings were documented in a digital logbook, allowing cross-referencing of visual, sonic, and textual observations.

The analysis followed qualitative criteria centered on three main dimensions:

- **Interaction** – modes of participation and engagement of participants in digital practices.
- **Aesthetic perception** – evaluation of participants' emotional and symbolic reactions.
- **Community involvement and cultural impact** – identification of perceived transformations in the relationship between technology, faith, and collective memory. The project's impact was assessed descriptively and interpretively, privileging narrative and experiential density over quantitative metrics. This choice is consistent with the artistic and participatory nature of the research, allowing us to understand how digital technologies foster co-authorship, mediation, and safeguarding of intangible heritage.

4 The *Mãe Soberana* case study

4.1 Context and objectives

Devotion to Our Lady of Piety – *Mãe Soberana* is a tradition deeply rooted in the community of Loulé and represents one of the most emblematic religious expressions in southern Portugal. The research proposes to reinterpret this manifestation through immersive digital experiences that articulate faith, memory, and innovation.

The main objective is to broaden access to and understanding of intangible heritage through interactive and inclusive technologies, promoting the participation of the local community in the production and mediation of digital content.

Table 1: Digital Tools and Languages

Technology	Main function	Practical application in the project
Artivive (App)	Activate Augmented Reality Content	Overlays digital videos and images onto the iconography and spaces dedicated to the devotion to Our Lady of Piety.
QR codes	Access to contextual information and narrative	Directs visitors to oral testimonies, historical records, and audiovisual elements.
Augmented Reality (AR)	Creation of immersive experiences	Integrates visual and sonic elements that reconstruct moments and rituals of the manifestation.
Artificial Intelligence (AI)	Image generation and fusion	Produces visual compositions by combining historical photographs, contemporary records, and symbolic textures linked to the devotion and to the author's lived memories.
Video and Sound	Documentation and artistic creation	Includes real-time capture and soundscapes that evoke the procession, music, prayers to Our Lady of Piety calling for rain, chants, and orations.
Digital narrative portals	Structuring the immersive route	Organize the different layers of access to interactive content.

4.2 Digital tools and languages

Digital tools and languages the development of contemporary creativity is tied to the ubiquity of digital technology [1], challenging traditional artistic practices and redefining modes of aesthetic and social participation. In this context, devotion to Our Lady of Piety – *Mãe Soberana* constitutes a paradigmatic example of the convergence between art, technology, and intangible cultural heritage (ICH) (Table 1).

The use of generative AI was explored experimentally, especially in creating characters fused from historical and contemporary images, such as the peasant woman who appears in the video art's introduction.

This technique sought not only aesthetic creation but also the poetic reconstruction of collective memory, making visible the relationships between past and present. Water, a central symbol of the devotion, was treated as a visual and sonic metaphor of transition and transformation—linking fertility and hope, the original themes of the devotion, to the Algarve's current environmental concerns.

The artifact is thus mediated by digital layers, becoming an expanded territory of aesthetic and community experience, in which the visitor actively participates in constructing the narrative and symbolic configuration of the sacred space.

4.3 Water and symbolism

Among the technologies used are the *Artivive* app, augmented reality, QR codes, and narrative portals. These tools enable constant interactivity with the artifact, creating a close relationship between the visitor and the atmosphere of the festivities dedicated to Our Lady of Piety – *Mãe Soberana.* Rainwater, a symbol associated with this Marian devotion, is treated as an element of transition between past and present, material and immaterial.

5 Thematic analysis

5.1 Digital artistic communities

Active participation by the local community is the project's core. Through collaborative workshops, testimony collection, and co-creation of digital content, Loulé's residents become narrative agents and symbolic curators of the devotion [9]. More than mere participants, community members take on the role of co-authors of a shared digital heritage, in a process that reflects the participatory and relational ethics of digital culture [15]. This model inverts the logic of vertical mediation, enabling heritage safeguarding to be built horizontally, collaboratively, and in a socially situated way.

5.2 Digital technologies and creative processes

The project uses digital technologies not only as instruments of representation but as devices for meaning-making. Technological mediation acts as a space of symbolic translation in which the visible and the invisible, the sensorial and the immaterial, are intertwined [16]. Augmented reality becomes a means of re-enchanting space, reactivating memories and affects, and inviting visitors to a poetic and critical immersion. Thus, technology ceases to be a mere technical support and becomes integrated as artistic and cognitive material.

5.3 Territories of digital art

The Sanctuary of Our Lady of Piety becomes a hybrid territory [10], where the physical space dialogues with digital layers of image, sound, and interactivity. This process of virtualization expands the artistic and devotional territory, breaking geographic and symbolic boundaries and offering visitors an amplified aesthetic experience.

Nevertheless, critical reflection is needed: to what extent can the virtualization of the sacred displace the ritual and affective sense of religious experience? This tension between physical presence and technological mediation requires rethinking the role of digital art as a tool for translating the spiritual—not as a substitute, but as a sensitive mediator between the tangible and the transcendent.

5.4 Digital Narratives

The devotion's narrative is reconstructed from visual, sonic, and textual fragments, presented in a non-linear and interactive way. Users build their own path, activating content through mobile and sensory interfaces [17].

This approach aligns with the concept of participatory narrative [18] [19], in which stories emerge from the interaction between creators and audiences. By turning the visitor into a co-author of the experience, the project proposes an aesthetics of engagement that unites memory, imagination, and community sharing.

5.5 Digital Narratives

The *Mãe Soberana* case is inscribed in the tradition of electronic art and new media, establishing a dialogue between ancestral devotional practices and contemporary artistic languages [20]. Rather than replacing the devotion, digital media art reinscribes it in the present, updating its symbolic and social meanings and demonstrating how new media can serve the creative preservation of intangible heritage.

6 Comparison with other cases

Using a case-study methodology, three examples of Marian and religious manifestations in the Iberian Peninsula were analyzed—Sanctuary of Fátima, Holy Week in Braga, and the *Romería del Rocío*—with the aim of understanding different strategies of digital mediation, institutionalization, and community participation. This analysis situates the *Mãe Soberana* project in a broader Iberian context, highlighting its singularities as a participatory, artistic proposal for safeguarding intangible heritage.

6.1 Our Lady of Fátima

Fátima is the largest Marian pilgrimage center in Portugal and one of the most relevant worldwide. Its institutional communication is strongly structured and centralized, reflecting a model of hierarchical mediation of the sacred. The official website of the Sanctuary of Fátima presents a cohesive visual identity, accessible language, and a diverse offering of religious and cultural content. Live broadcasts of celebrations and the availability of digital resources ("Pray with the Message of Fátima") exemplify a strategy of global presence and symbolic standardization.

However, this logic tends to reinforce a vertical communication model guided by institutional authority and an experience of faith mediated at a distance. In contrast, the *Mãe Soberana* project proposes participatory, decentralized, community-based mediation in which the digital is used not to reproduce the devotion but to reconfigure the collective experience of devotion.

6.2 Holy Week in Braga

Holy Week in Braga constitutes an intermediate model between tradition and innovation. The official site combines historical documentation and immersive visual narrative, reinforcing the event's touristic and heritage dimension. The valorization of the procession as an urban spectacle reveals a tendency toward spectacular ritualization [21], where religious heritage is also a platform for cultural identity and territorial promotion. Although it integrates digital mediations, community participation remains mediated by religious and municipal institutions, contrasting with the direct and co-authorial engagement observed in Loulé.

6.3 Romería *del Rocío* (Andalusia, Spain)

The *Romería del Rocío,* in Huelva, Spain, exemplifies a hybrid model in which devotion, spectacle, and popular tradition coexist. The confraternity's digital presence privileges symbolic and affective dissemination, sustained by the pilgrimage's identity-based and emotional dimension. Here, technology acts as an extension of community faith and not merely as a communication instrument. This approach resonates with the *Mãe Soberana* project, which likewise mobilizes digital resources to reconnect dispersed communities and update devotional practices in hybrid environments.

6.4 Comparative Synthesis

The comparative reading shows that the *Mãe Soberana* project stands out for its balanced integration of technology and community, adopting a critical stance toward the spectacularization of the sacred (Table 2). Fátima stands out for its international scale and strong institutionalization, with vertical communication and a focus on devotion. Braga presents medium mediation and a hybrid character, combining religiosity and spectacle. *El Rocío* combines popular tradition and international scope, with moderate use of digital platforms and high collective participation, sustaining a community-based, emotional model. *Mãe Soberana*, in turn, is distinguished by technological innovation and participatory engagement, promoting horizontal, collaborative communication. Loulé fits into a paradigm of participatory media art in which technology becomes a device for co-creation and collective memory. We thus observe a shift from hierarchical, devotional models to more participatory practices, digitally mediated and community-centered.

7 Final Considerations

The *Mãe Soberana* project demonstrates how digital media art can expand the experience of intangible heritage, promoting dialogue between tradition and innovation. From the standpoint of media archaeology, this research proposes a symbolic excavation of the invisible layers of faith, history, and memory, reconfiguring the relationship between art, technology, and spirituality. The digital devices used here—augmented reality, artificial intelligence, video, and sound— do not replace the sacred but expand its perception, making it accessible in sensitive, critical, and collaborative ways.

Table 2: Comparative Analysis

Case	Scale & Institutionalization	Digital Mediation Community Participation Communication Model
Fátima (PT)	International; strongly institutionalized	High. with global streaming and online content. Limited, centered on devotees. Vertical, centralized, hierarchical.
Braga (PT)	Regional/national; municipal & religious support	Medium. Multimedia and touristic outreach. Partial, mediated by institutions Hybrid, between ritual and spectacle.
El Rocío (ES)	National/international; traditional and popular	Medium; use of community platforms and confraternity sites. High; collective and spontaneous organization. Community-based and emotional.
Mãe Soberana (PT)	Local/regional; community focus	High; AR, QR, AI, video, and sound. High; co-creation and participatory workshops. Horizontal and collaborative.

The project's participatory dimension, centered on the Loulé community, reveals that digital media art can act as cultural and social mediator, strengthening identity-based and emotional ties. From a scientific perspective, the study shows how digital media art can function as a living instrument for safeguarding intangible heritage by combining preservation and creation, memory and innovation. By integrating co-authorship practices and technological mediation, the project helps rethink contemporary paradigms of participatory cultural mediation. Future work envisions ongoing iterations, exploring the development of new immersive experiences and applying public-reception metrics to assess the aesthetic, social, and heritage impact of these practices.

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Semiotic Sculpting: Modeling and Meaning-Making with Second-Order Semiology

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Figure 1: Left: Digital Sculpture of Kaiming Beast; Right: Digital Sculpture of Chinese Dragon Character

Abstract

This paper introduces a *Semiotic Sculpting Model* as a structured approach to digital sculpture creation based on Roland Barthes's *Second-Order Semiological System*. In response to the prevalent focus on technical accuracy in current 3D sculpting practices, the proposed model emphasizes the integration of meaning into visual form. It divides the creative process into two stages: visual reconstruction and meaning-making. Through two practice-based case studies, i.e., a mythical beast embodying intrinsic traits called *Kaiming Beast* and a culturally coded *Chinese Dragon Character*, this paper demonstrates how symbolic elements can be methodically embedded into sculptural forms. The results indicate that the proposed model and approach enhance the construction of layered symbolic meanings within digital sculpture, offering a practical pathway for integrating semiotic thinking into 3D creative workflows.

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CCS Concepts

• **Applied computing** → **Media arts**.

Keywords

Sculpture, Digital Sculpting, Digital Modeling, Meaning Making, Semiology, Roland Barthes, Second-Order Semiology.

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1 Introduction

With the rapid advancement of digital media technologies, digital sculpture has become an indispensable medium in various industries, including digital filmmaking, cinema, gaming, and extended reality (XR). Digital sculpture plays a crucial role in conveying complex cultural meanings and emotional expressions to its audience [16]. However, current research in this field remains largely centered on technical, rational, and data-driven aspects, focusing on precision modeling [8], digital documentation of architectural forms [6], or quantifying the efficiency of sculpting tools [12].

Although advanced 3D technologies have enabled highly accurate visual reconstructions, a significant research gap persists in exploring how digital sculpture can deliver cultural narrative with philosophical reflections. In practice, many 3D artists remain at an initial level of digital sculpting that prioritizes technical construction and surface-level visual fidelity, while overlooking the more sophisticated level, where symbolic imagery and cultural resonance begin to shape and influence the form itself.

As a result, many 3D artworks struggle to externalize meaning during the modeling process, lacking coherent symbolic logic. They frequently fail to articulate cultural essence or construct layered structures of signification. Even when these works achieve technical excellence, they often fall short in semiotic meaning-making, revealing a fragile connection between cultural essence and its visual representation. Addressing this gap requires a shift toward integrating semiotic and philosophical inquiry into the digital sculptural process, moving beyond surface-level fidelity to embrace culturally embedded symbolic structures.

This paper proposes and validates a semiotic sculpturing model for creating meaningful digital sculptures based on Roland Barthes's theory of *Second-Order Semiological Systems*. The model is a structured methodological framework to guide the creators' design process. It emphasizes a two-stage creative process that enables artworks to carry deeper emotional resonance and cultural meaning, going beyond the conventional paradigm of digital sculpting that prioritizes technical precision. This approach addresses the prevailing issue of "symbolic absence" in contemporary digital art practices and offers a practical strategy for creators to connect form and meaning in their sculptural works. Sec. 3 introduces our Semiotic Sculpting model, grounded in Barthes's theory of *Second-Order Semiological Systems*. We further apply the proposed model in Sec. 4 to study two of our practical cases, i.e., *Kaiming Beast* and a *Chinese Dragon Character*. Finally, the other sections analyse, discuss, and conclude our work.

2 Related Work

Research relevant to this study falls mainly into two areas. The first concerns the application of Roland Barthes's model in visual design, communication, and cultural analysis. These works examine how Barthes's *Second-Order Semiology* can be adapted as a tool for generating and interpreting layered meanings in visual form, offering a theoretical basis for extending his ideas into digital sculpture practice.

The second area involves methods and creative processes in digital sculpting, focusing on the relationship between form-making, technique, and expression. Studies in this field examine how digital tools and workflows can move beyond technical precision to support more conceptually driven creation. Together, these two strands of research provide the theoretical and practical context for the Semiotic Sculpting Model proposed in this paper.

2.1 Design Applications of Barthes's Model

Roland Barthes's theory of the *Second-Order Semiological System* has long been widely applied in design-related research. Jeong employed this framework to analyze the visual identity of the ACE conference, identifying "technical *Signifier*" and "playful *Signified*," and demonstrating how the layered structure of *Signs* can enhance cultural narrative [15]. Similarly, Wang and Zhao argued that traditional elements such as calligraphy and color function as first-order *Signifiers* that establish basic visual recognition in their study on "Chinese-style" branding; in contrast, their recombination in contemporary contexts evokes second-order meanings tied to cultural confidence [13]. This provides an important reference for this study, as it applies Barthes's theory to the extraction and analysis of symbolic elements in digital sculpture.

Meanwhile, McDaniel et al. proposed the concept of "cardboard semiotics" in game prototyping, in which interchangeable symbolic components, such as character archetypes, act as first-order *Signifier*. These elements are recombined into narrative sequences that function as second-order Signified, thereby operationalizing Barthes's hierarchical model of meaning-making [17]. Their approach provides practical insights into how this semiological model can be re-applied in the construction of digital sculpture, as discussed in this paper.

2.2 Construction Methods in Digital Sculpting

Zheng et al. proposed an augmented reality platform that integrates the Unity3D engine with ARCore technology, enabling multi-user, real-time collaborative modeling within a shared virtual environment [12]. Ma et al. compared physical and digital sculpting in terms of tool usage, visual-tactile interaction, and creative workflow, from the perspective of perceptual engagement, revealing fundamental differences in user experience between the two modalities [14].

Current construction methods in digital sculpture tend to emphasize form generation and tool efficiency, while paying relatively little attention to cultural semantics and symbolic systems. This study addresses this gap by focusing on the potential and methodological framework for meaning-making within 3D modeling processes. In addition, Sikici further explored the distinction between symbolic modeling and symmetrical modeling, arguing that the core of digital image creation should extend beyond technical reproduction to emphasize symbolic reconstruction and meaning generation. His work provides key insights for our proposed "Semiotic Sculpting Model," which divides the process into two layers: visual form and semantic construction.

3 Semiotic Sculpting

Building on the theoretical and methodological foundations outlined above, this section introduces the *Semiotic Sculpting Model*. This model explores how meaning can emerge through the manipulation of visual and material forms. Rather than treating digital modeling as a purely technical or representational act, this approach positions the sculpting process itself as a site of meaning-making, where symbolic elements are embedded, layered, and transformed. The following subsections outline the model's structure and illustrate its application through selected case studies.

3.1 Roland Barthes's Second-Order Semiology

Semiology provides an adequate theoretical framework for systematically integrating "representation" with "meaning" in this context. Semiology was first defined by the Swiss linguist Ferdinand de Saussure as "the science of *Signs*" [7]. As a discipline, it is closely

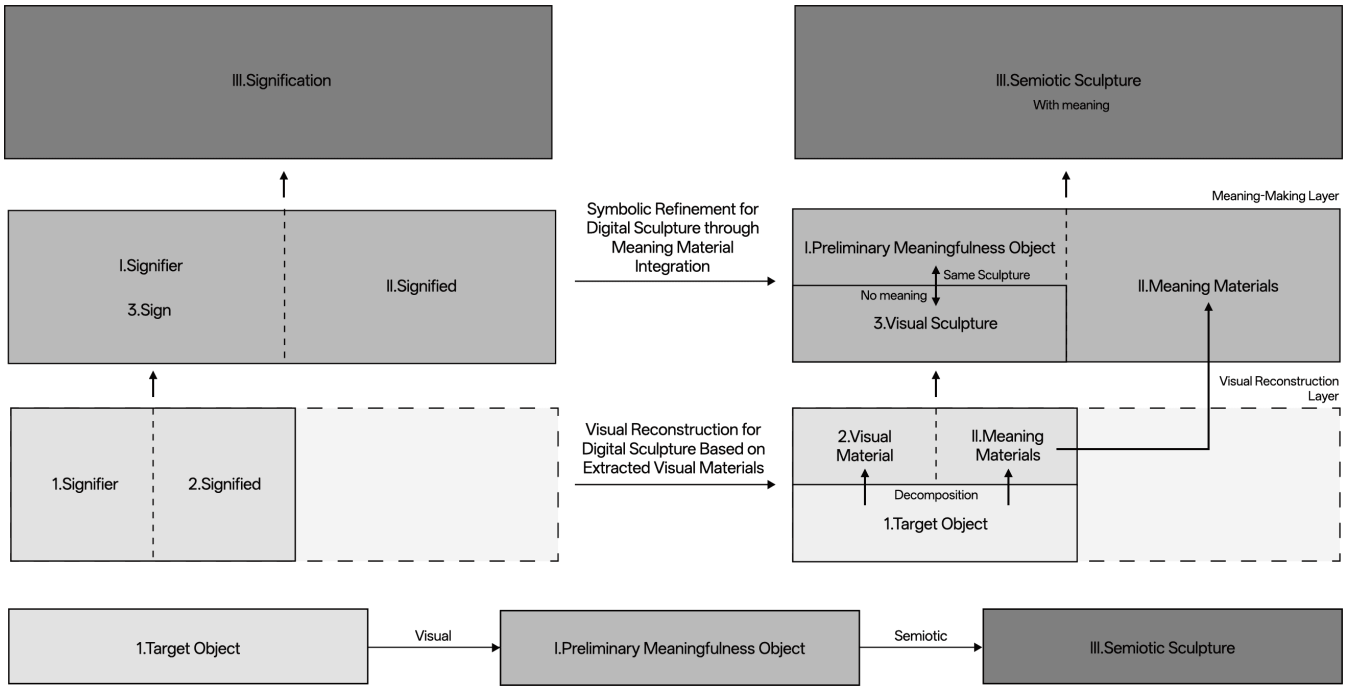


Figure 2: Semiotic Sculpting Model

associated with the concept of "semiotics," a term used to describe the generation and interpretation of *Signs* [5]. Saussure, as one of the founding figures of modern semiology, distinguished *Signs* into two interrelated but independent components: the *Signifier* (the form) and the *Signified* (the concept), thus laying the groundwork for the fundamental structure of the discipline [1].

French theorist Roland Barthes expanded Saussure's ideas by applying linguistic semiotics to broader cultural analysis [4]. In Barthes's semiotic theory, anything material can be endowed with meaning [2], leading to his formulation of the *Second-Order Semiological System* in Fig. 3. In the first order, language functions as a *Signifier* paired with a *Signified* to form a basic *Sign*. In the second-order, the complete first-order *Sign* becomes a new *Signifier*, which is then linked with a new *Signified* to generate a *Sign* that carries ideological or cultural connotation [3] [10]. In this process, the original meaning is obscured, while the new cultural meaning is rendered in a "natural" or self-evident manner.

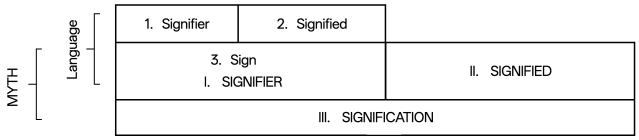


Figure 3: Roland Barthes's *Second-Order Semiological System.*

This process represents a symbolic interaction between the denotative and the connotative meanings. Denotation is the first level of *Signification*; it describes the literal or obvious meaning of the *Sign*. Thus, the denotation of the visual image refers to what all people see, regardless of their culture, ideology, or society [4]. In contrast, connotation emerges as the second level of *Signification*. It describes the interaction that occurs when the *Sign* meets the feelings or emotions of the users and the values of their culture [9]. Barthes's connotation relies upon the prior existence of denotation; it always works in the borrowed territory of the denoted [11]. Together, these two levels of *Signification* form the foundation of Barthes's *Second-Order Semiological System*.

3.2 Semiotic Sculpting Model

Extending on Barthes's *Second-Order Semiological System*'s original analytical function, we revise it as a generative tool for digital sculpting. This section investigates how digital sculptures can be conceived by integrating second-order semiological processes, thereby producing works rich in emotional tension and narrative coherence. It proposes a conceptual framework that transforms the analytical logic of *Signification* into a structured creative method for digital sculpture. It provides a systematic methodology for identifying and transforming foundational visual elements into forms imbued with layered cultural meaning and emotional depth.

Fig. 2 illustrates our proposed *Semiotic Sculpting Model*, a conceptual framework constructed based on Roland Barthes's *Second-Order Semiological System*. This model systematically divides the digital sculpture creation process into two progressive layers, i.e., Visual Reconstruction and Meaning-Making Layer, forming a step-by-step generative process.

3.2.1 First Layer of Visual Reconstruction. In this initial layer, the process begins with a target object, whether existing in reality

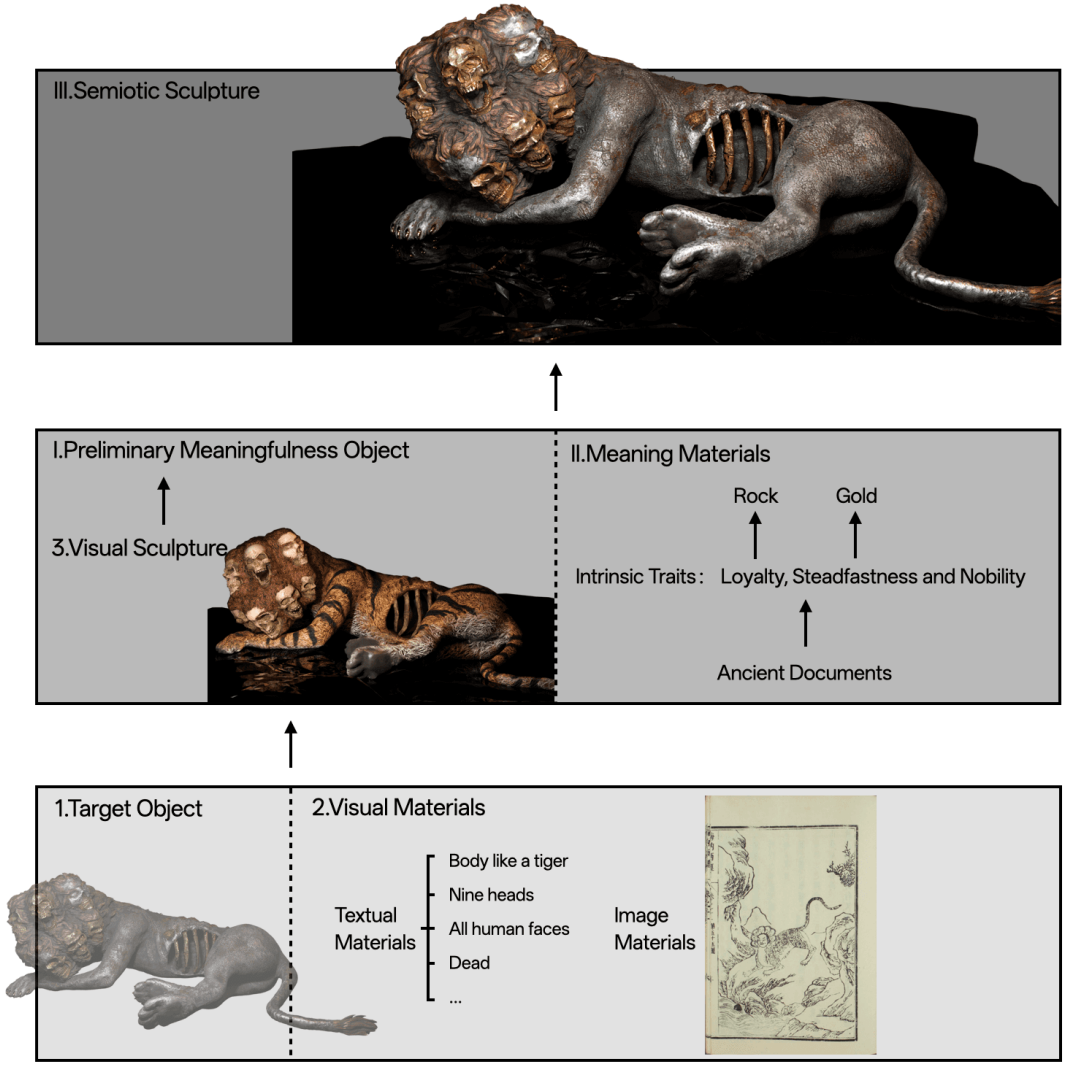


Figure 4: Construction Process of the *Kaiming Beast*

or imagined, to be reconstructed, which is regarded as the *Signifier* within a symbolic system. The initial preparation will collect materials of the target object and divide them into two types:

- Visual Materials: visual references, descriptive sketches, and textual records.
- Meaning Materials: symbolic, cultural, or thematic interpretations.

The visual reconstruction process uses only visual materials to construct a visual sculpture. Based solely on these materials, the creator conducts a visual collage and modeling to reconstruct the object's appearance. The resulting visual sculpture thus forms the initial Sign in the model. It is important to emphasize that the Visual Reconstruction Layer focuses solely on accurate form reconstruction and technical modeling, without engaging cultural, symbolic, or emotional meanings. This corresponds to conventional 3D modeling practices and serves as the technical foundation common in most digital art workflows.

3.2.2 Second Layer of Meaning-Making. Meaning-Making Layer introduces the critical turning point that fundamentally distinguishes this model from conventional 3D workflows. In this layer, the visual sculpture, i.e., the *Sign* constructed in the Visual Reconstruction Layer, is redefined as a preliminary meaningfulness object, i.e., the *Signifier*, for further symbolic transformation. A preliminary meaningfulness object will undergo meaning modeling based on the meaning materials; the meaning materials, as the *Signified* in this layer, encompass the deeper and more abstract meanings the artist intends to embed in the digital sculpture, such as cultural symbolism, spiritual connotation, or ideological positioning.

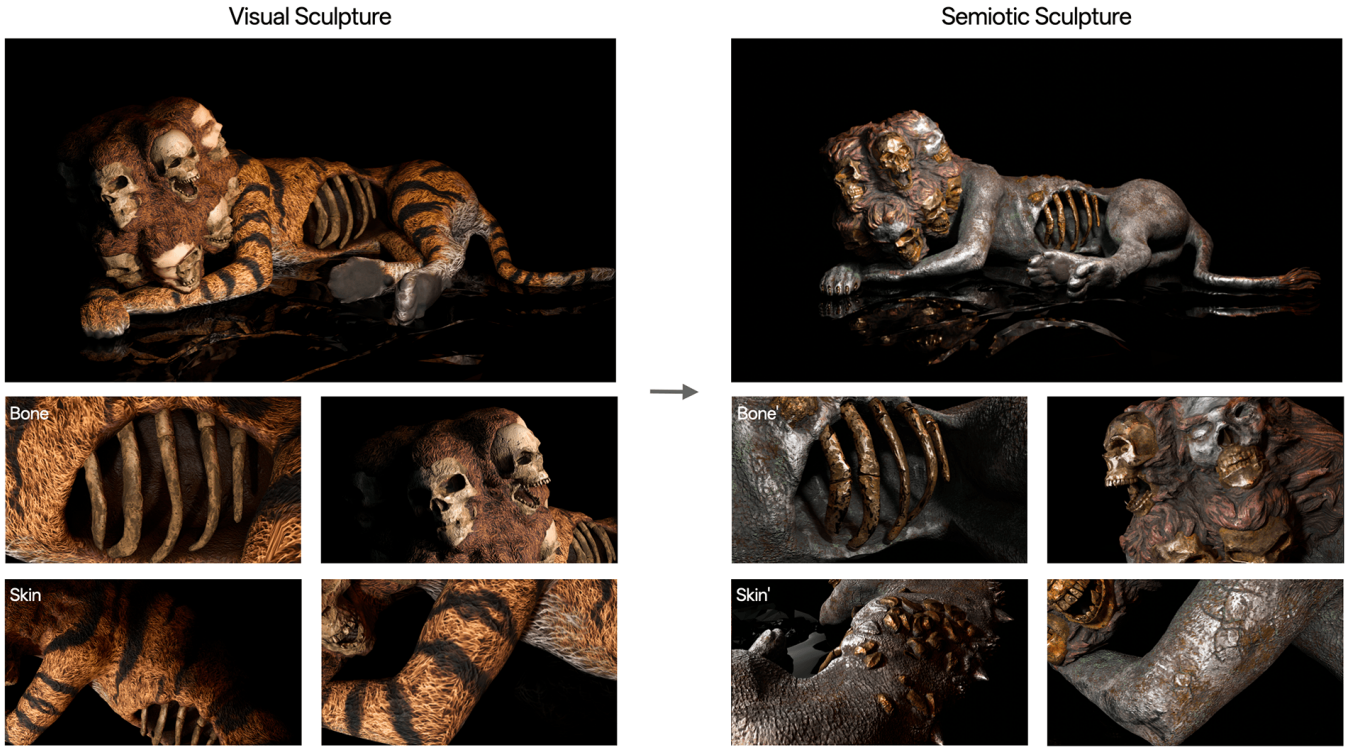


Figure 5: *Kaiming Beast* – Modeling from Visual to Semiotic Sculpture

Through visual translation and symbolic construction in the *Meaning-Making Layer*, the creator transforms these abstract meanings into visual and cultural *Signifier*, embedding them into the sculpture via targeted modifications and secondary modeling. These embedded visual elements serve to infuse the work with new layers of cultural or emotional *Significance*, resulting in the production of a semiotic sculpture.

Rather than calling for a complete redesign of the sculpture, this layer proposes a strategic embedding of meaning through a series of micro-level visual modifications. These may include changes in material texture, spatial orientation, gesture dynamics, symbolic props, or even subtle distortions of form. Though seemingly minor, these cumulative interventions are governed by an internal symbolic logic that shifts the symbolic meaning of the sculpture. The object remains structurally consistent with its original appearance, yet begins to function differently.

4 *Kaiming Beast*

This case presents a digital sculpture in Fig. 4, based on the *Kaiming Beast* - a mythical creature described in *The Classic of Mountains and Seas*, and illustrates how the *Semiotic Sculpting Model* can be applied to represent intrinsic and spiritual traits through digital form.

4.1 Collection and Categorization of Materials

In the *Visual Reconstruction Layer*, the *Kaiming Beast*, derived from ancient Chinese mythology, is taken as the target object (the *Signifier*). The process begins with the systematic collection of relevant materials, which are categorized into two types: visual materials and meaning materials. The visual materials consist of textual and visual descriptions extracted from classical sources, such as: "The *Kaiming Beast* is large, tiger-like, with nine heads, all human-faced, and stands facing east on *Kunlun Mount*." These are further supplemented with related historical imagery and textual materials serving as references for modeling.

To enrich the narrative depth of the sculpture, the creator introduced a fictional backstory: "A thousand years later, though long deceased, the *Kaiming Beast* still guards *Kunlun Mount*," and thereby extended its cultural context. Meanwhile, the meaning materials draw upon ancient records that characterize the *Kaiming Beast* as "guarding *Kunlun Mount* for a thousand years," from which core character traits such as loyalty and steadfastness are inferred.

4.2 Visual Reconstruction of the *Kaiming Beast*

Subsequently, all visual materials (the *Signified*) were distilled into key descriptive elements, such as "body like a tiger," "nine heads," "all human faces," and "dead," which were then organized and incorporated as references for visual modeling. The *Visual Reconstruction Layer* of creation included hand sketching, digital sculpting using *ZBrush*, and texturing via *Substance Painter*, ultimately resulting in the completion of the visual sculpture (the *Sign*).

4.3 Symbolic Transformation of Meaning

Upon entering the *Meaning-Making Layer*, the visual sculpture (the *Sign*) constructed in the *Visual Reconstruction Layer* is regarded as

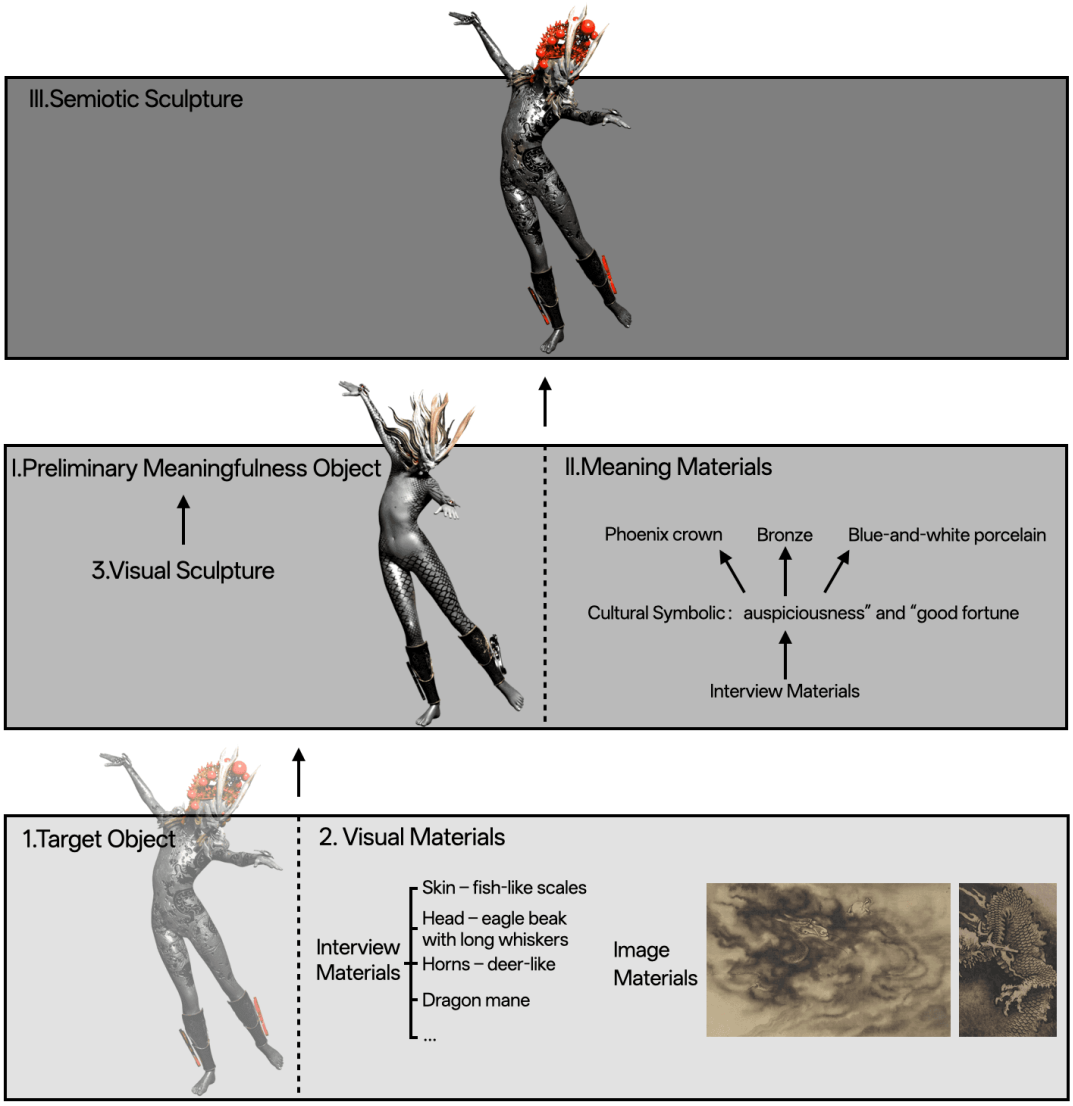


Figure 6: Sculpturing of the Chinese Dragon Character

the preliminary meaningfulness object (the *Signifier*). The *Kaiming Beast* is then subjected to meaning modeling based on the meaning materials (the *Signified*), in which intrinsic traits, such as loyalty and steadfastness. While shaping these traits, it is also necessary to retain the creature's fundamental identity as a divine beast, thereby maintaining the symbolic consistency of its mythological prototype throughout the Meaning-Making process.

To effectively transform these characteristics into concrete visual expressions, the study employs methods of metaphorical corpus analysis and symbolic motif extraction. In traditional Chinese culture, rock is often associated with steadfastness, hardness, stillness, and time, all of which closely align with the spiritual image of the *Kaiming Beast*. To further emphasize its divine status, gold, a precious form of "rock" is selected as a symbolic medium representing a composite of strength and nobility, thus establishing a visual translation path from character traits to mythological identity.

4.4 Integration of Meaning Materials into Semiotic Sculpture

Ultimately, the symbolic imagery of rock and gold is seamlessly integrated into the digital sculpture's structural composition. The sculpture is divided into two parts: the internal skeleton and the external skin. In terms of material treatment, the skeleton is replaced with golden material to reinforce its symbolic implication of nobility and endurance; the outer skin is reconstructed using rock textures and bluish-gray stone surfaces, overlaid with rough stone texture maps. Fig. 5 shows the completed construction of

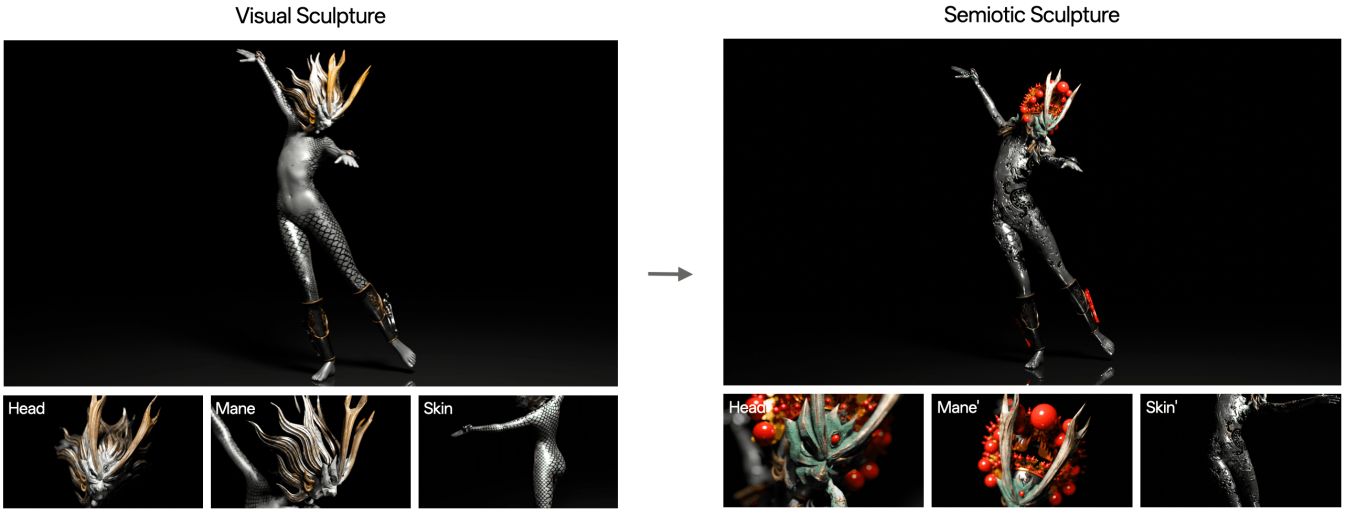


Figure 7: Dragon Character – Modeling from Visual to Semiotic Sculpture

the semiotic sculpture (the *Signification*) through the "gold within, stone without" visual structure.

5 *A Chinese Dragon Character*

Fig. 6 illustrates the second case, which applies the proposed model to create a *Chinese Dragon Character*. Unlike the first case, which investigates inward spiritual attributes, this example focuses on external cultural symbolism — how visual signs and formal language can communicate shared cultural values.

5.1 Collection and Categorization of Materials

In the preparation stage, with the *Chinese Dragon Character* as the designated target object (the *Signifier*), the project conducted interviews to collect a wide range of public impressions regarding the Chinese dragon character's appearance and associated cultural meanings. The collected data were then categorized and distilled, resulting in two distinct types of inputs: visual materials and meaning materials.

5.2 Visual Reconstruction

In the *Visual Reconstruction Layer*, the visual materials (the *Signified*) were extracted from the interview responses. These included:

- Skin: scales resembling fish,
- Horns: similar to those of a deer;
- Head: combining an eagle's beak and long whiskers.

Based on the extracted features, a series of concept sketches were developed, followed by the construction of a visual sculpture using 3D software, culminating in the finalized visual sculpture (the *Sign*).

5.3 Symbolic Transformation of Meaning

Upon entering the Meaning-Making Layer, the visual sculpture (the *Sign*) is redefined as the preliminary meaningfulness object (the *Signifier*) and further developed through meaning modeling. By incorporating meaningful materials — such as symbolic associations with "auspiciousness" and "good fortune" — these cultural values are embedded in the sculpture's form to enhance its symbolic dimension.

To visualize this symbolic meaning, the study conducted further analysis of traditional cultural motifs frequently linked to auspiciousness. These included: blue-and-white porcelain that symbolizes purity, refinement, and blessings, phoenix crown in Peking Opera that represents nobility and divine femininity, bronze ritual vessels that evoke ancestral worship and solemnity, and red color which commonly represents joy, celebration, and good luck in Chinese culture.

5.4 Integration of Meaning Materials into Semiotic Sculpture

In the end, these symbolic elements were strategically integrated into the Meaning-Making Layer:

- The dragon's scale textures were replaced with blue-and-white porcelain patterns;
- The dragon mask's material was transformed into a bronze texture;
- The dragon's mane was replaced with a phoenix crown inspired by Peking Opera; and
- Accents of red were selectively applied to reinforce the auspicious message.

Ultimately, Fig. 7 demonstrates the completed construction of the final semiotic sculpture (the *Signification*).

6 Analysis and Discussion

The two case studies demonstrate the flexibility and applicability of the *Semiotic Sculpting Model* in guiding the creation of different types of digital sculpture. The *Kaiming Beast* case emphasizes the visualization of intrinsic traits such as loyalty and Steadfastness, illustrating how abstract psychological qualities can be effectively

translated into visual forms through symbolic materials like rock and gold. This process illustrates how layered meaning can be embedded into a digital sculpture through symbolic refinement, enriching the depth of its intrinsic narrative traits.

In contrast, the dragon character case focuses on culturally shared symbols, utilizing public perceptions and traditional motifs to construct a visual language of auspiciousness. Through this process, the digital sculpture evolved from a neutral form into a culturally charged artifact, embodying symbolic meanings rooted in Chinese visual culture. In this context, the model proves effective in organizing collective symbolic references into coherent sculptural expressions. Collectively, these cases demonstrate the model's versatility in conveying a wide range of meanings, encompassing both personal psychological interpretations and broader cultural visual expressions.

At the same time, a key issue concerns the theoretical transformation of Roland Barthes's second-order semiology from a critical framework into a generative one. Barthes originally conceived the second-order semiological system as a critical tool for deconstructing ideology. In contrast, this study reconfigures the model as a creative methodology. Such a shift inevitably alters Barthes's original purpose and necessitates careful reflection. The intention here is not to overlook his critical stance but to retain his awareness of ideology and power while extending the operational potential of his theory within artistic practice. The *Semiotic Sculpting Model* treats the process of sign layering as a design logic, applying Barthes's ideas to digital practice and turning critique into conscious meaning-making.

On the other hand, the methodological structure of this model can be used to adjust existing models (including those created by others), which requires less technical expertise and workload than building a new model from scratch. This explanation aligns with one of the intended applications of the model, even though the case studies in this paper all stem from a new modeling process. The two-stage workflow is designed to provide a practical and flexible framework suitable for various production environments, where modeling and semiotic design tasks can be handled by different contributors.

7 Limitation and Future Work

Although this paper has demonstrated the feasibility of the *Semiotic Sculpting Model* in endowing digital sculptures with internal traits and cultural symbolism through two case studies—the *Kaiming Beast* and the *Chinese Dragon Character*, the scope of symbolic meanings and sample types remains relatively limited. As such, the model has yet to fully address the broader demands of meaning construction across diverse contexts. Future research should apply this model to a wider range of symbolic categories and object types to test its generality and adaptability in embedding varied meanings.

Moreover, the current model focuses solely on the construction process of static digital sculptures, without exploring temporal dimensions such as dynamic expression or narrative progression. Future work will aim to expand the structural framework of the current model to support dynamic digital sculpture, allowing creators to animate sculptures over time. This extension will not only refine the symbolic Meaning-Making workflow and enhance its practical effectiveness but also provide a theoretical and methodological foundation for producing culturally rich and narratively expressive digital sculptures that meet the needs of broader creative scenarios.

8 Conclusion

This paper proposes and validates the *Semiotic Sculpting Model*, grounded in Roland Barthes's *Second-Order Semiological System*. Through the empirical application to two representative cultural symbols, the model successfully embedded deep symbolic meanings into digital sculptures. Experimental results show that the model not only enables creators to systematically integrate meaning beyond technical execution but also offers an operational methodology to support symbolic logic and narrative depth within digital sculpture. It helps creators more clearly realize their original creative intent.

Future work will extend the model toward dynamic sculpture, enabling its application across immersive media, game design, and digital heritage. This expansion aims to support the development of narrative works in digital media that are rich in cultural depth and semiotic structure. In summary, the *Semiotic Sculpting Model* provides a generalizable framework that bridges semiotic theory and 3D creative practice, opening new directions for digital sculpture modeling with *Significant* theoretical and practical implications.

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The Mouth and You: A Walk Through Beckett's Not I in Virtual Reality

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Abstract

This paper documents the technical process behind adapting Samuel Beckett's *Not I* into a virtual reality experience. It features Unreal Engine, MetaHuman Animator and facial capture techniques. Originally staged with only a disembodied mouth visible in darkness, this immersive encounter recreates the experience for a technologically engaged audience. This article discusses the pipeline and conceptual opportunities of translating canonical theatre into extended reality, offering a new perspective on Beckett's emphasis on disembodiment, presence and the voice.

CCS Concepts

• **Applied computing** → **Performing arts**.

Keywords

Storytelling, Immersive Installation, Virtual Reality, Embodied Immersion, MetaHuman, Design, Non-interactive Immersion, Historical Replication, Art Preservation, Cultural Arts, Digital Art, Theatre, Extended Reality, Samuel Beckett, Intangible Cultural Heritage.

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1 Ideation, Genealogy and Related Work

1.1 Ideation

Not I (1972) [1] is a dramatic monologue by Samuel Beckett featuring a main character known as "Mouth" and a minor secondary character called "Auditor." In the original stagings of the 1970s, the isolation of Mouth was achieved by the use of dark makeup and a curtain with a hole in it to conceal the body of the performer. A tightly focused spotlight then isolated this dominant visible element, creating a disembodied and fragmented presence. Although *Not I* originally existed as a textual work written for the stage, it was later adapted for film (by Beckett himself) within a tightly controlled framework (according to script and stage directions), which preserved the integrity of the original [20]. Given this intermedial heritage, the play has experimental scope to be reconceptualised for new media formats [10]. We drew on the work's genetic past, as well as its epigenesis [27], to guide the development of the play within immersive media environments.

1.2 Genealogy and Related Work

Not I VR emerges as the most recent chapter in an extended line of practice-as-research experiments reimagining Samuel Beckett's theatre through emergent extended reality (XR) technologies. The project's genealogy can be traced through: 1) infra-departmental collaborations between PIX-ART and the Trinity Centre for Beckett Studies, 2) broader internal institutional collaborations between the School of Creative Arts and the School of Computer Science and Statistics (specifically the V-SENSE research group [26]), and 3) the main proponents' wider, international scholarly communities including: Reading, Beckett and Technology, etc. Out of such rhizomes the *XR Play* projects have emerged to continually test the intersection of performance, computer vision and immersive media.

The *XR Play Trilogy* (2017–2019), began with *Intermedial Play*, a telepresent reinterpretation of Play that substituted Beckett's 'inquisitor' (the interrogating spotlight) with a robotic PTZ camera and broadcast the live performance to a remote audience [7]. This experiment foregrounded surveillance, simultaneity and digital liveness as dramaturgical conditions. The second iteration, *Virtual Play*, translated the piece into a fully immersive VR environment, using volumetric video (VV) capture and a game engine to situate the immersant (viewer) at the centre of the action. Here, the spotlight was aligned with the immersant's gaze and they became the interrogator, activating the urn-bound figures through looking [17]. The third iteration, Augmented Play, extended these questions into the architectural and site-specific domain via augmented reality (AR), situating volumetric performers within the vaulted brick chambers of an eighteenth-century warehouse [18]. Across this trilogy, Beckett's dramaturgy served as both a conceptual and structural testing ground for new forms of liveness, digitally mediated performance and audience agency.

Building upon this legacy, *Not I VR* shifts focus from the triadic composition of *Play* to the singular voice of a disembodied mouth, by employing Unreal Engine and MetaHuman technology to create a digital double of the live performer. Where *Virtual Play* explored the audience's active gaze as interrogator, *Not I VR* re-examines the boundaries of embodiment and identity through the hyperreal precision of facial capture and motion-tracking. The project thus extends Beckett's 'subtractive dramaturgy' into a post-human register [16], where the actor's mouth becomes both human and synthetic – an avatar of speech and gesture.



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The genealogy of *Not I VR* is not only technical and aesthetic but also intellectual and epigenetic, evolving through the symbiotic exchange between two overlapping international research ecologies. On the one hand, Néill O'Dwyer's epistemic trajectory from digital media art through scenography [15] to XR firmly situates the project within global dialogues on extended reality performance [19], post-human embodiment and digital scenographic design. These networks – spanning organisations such as the (performative) IFTR Scenography Working Group [4], the (philosophical) Digital Studies Network [3] and various (creative) digital arts research communities [2] – provide ongoing exposure to emerging, cutting-edge technological, material, dramaturgical and aesthetic methods, influencing the project's subjective grammar and experimental ethos. In parallel, Nicholas Johnson's long-standing engagement with Beckett scholarship and practice – through the Samuel Beckett Society [23], the IFTR Samuel Beckett Working Group [5] and their various engagement with Beckett's questions concerning technology [11] – anchors the work in rigorous textual, performative and historical inquiry. Johnson's sustained dialogues with international directors, editors and scholars of Beckett ensure that each adaptation remains attentive to the author's aesthetic discipline and philosophical concerns [6]. The convergence of these two lineages produces an epigenetic model of creative research, where Beckett's subtractive aesthetic is continually rejuvenated through new media forms, and where scholarly discourse actively shapes, and is reshaped by, practice-led experimentation in XR.

2 Scripting and Storyboarding



Figure 1: A still from *Not I* by Samuel Beckett, adapted for broadcast media in collaboration with the author as part of *Shades* by the BBC, 1977. (https://www.youtube.com/watch?v=M4LDwfKxr-M).

In the filmed version, Beckett chose to have the area around Billie Whitelaw's mouth painted black, so that only the lips and internal features (tongue, gums and teeth) were visible. The visual framing also portrays the actor in an incessant close-up format, creating a visceral sense of intense proximity and inescapability. The theatrical experience, by contrast, would have been of a floating mouth quite small and far away, with the audience communally observing, together with the actors in the dark. The broadcast version of *Not I* was experienced on screens by separated and solitary viewers all over the United Kingdom.

In reworking the text for contemporary media, our aim was to investigate the possibility of creating an immersive version in a virtual world while remaining true to the original aesthetic, thus broadening its accessibility in the evolving landscape of twenty-first century audiences and exploring the extent to which the original form can be reinterpreted in the context of digital extended reality (XR) technologies. The project also aimed to provide an immersive, one-on-one experience where only the (virtual) actor in the form of an avatar and the physical audience exist in a liminal space, between virtuality and reality [16].

In our VR version, the viewer is plunged into a darkened space, the only visible objects being the grass underfoot and a hovering, disembodied mouth in front of the viewer. The Mouth is visualised at a higher level than the eye-line of the viewer – approximating the "8 feet above stage level" [1] directive in Beckett's original stage script – and in a scaled-up form, which is a nod to Beckett's film version, in which he used an ultra-close-up camera shot on the mouth for the entire duration of the performance, leaving the Auditor character altogether absent. Our intention with this VR version was to increase the viewer's sense of being present in the fictional world with Mouth, and to hold the viewer's captivation through an inescapable confrontation with the Mouth and its incessant torrent of words, which describe the tormented life and memories of the protagonist.

3 Design Pipeline

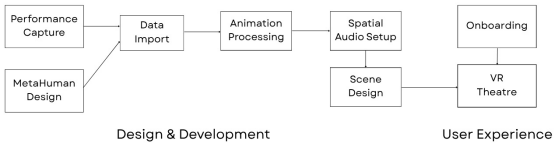


Figure 2: Overview of the design pipeline, showcasing the key stages of design, development, and user experience.

The production process followed a multi-layered approach, as illustrated in the flowchart (figure 2). It can be broadly divided into two phases: 1) Design and Development – performance capture, avatar and scene design, and animation implementation – and 2) User Experience, which focuses on onboarding through embodiment and the immersive interaction where viewers engage with the virtual actor.

3.1 Pre-production Environment and Filming

Before the recording process with the actor commenced, a series of preparatory steps were undertaken to ensure the effectiveness of the Live Link Face [12] facial capture software for capturing the performance. These included 1) testing the face-capture pipeline – consisting of calibration through several runs on a dummy sequence to refine the technical setup – and 2) defining optimal lighting conditions and camera proximity by framing the actor's face within

the screen so that the Unreal Engine [25] software could process the capture effectively. This foundational phase was essential for the establishment of a high-fidelity performance capture that would be a precursor to the animation and virtual embodiment.

The filming was conducted in a sound recording studio, because it was determined that the need for high-fidelity audio was paramount; apart from some decent lighting on the actor's face (to capture facial movement data), there was no need to consider the visual context for the recording, because the visual scenographic elements (such as the character) would ultimately be designed and developed within the game engine. The room setup included a television monitor, a Schoeps CCM4 Cardioid microphone, and a mobile phone (iPhone 14 Pro) running the Live Link Face app. The director was also present with the actor in the recording room, because their presence was essential to guide the rhythmic and emotional delivery of the monologue to align with Beckett's original vision.

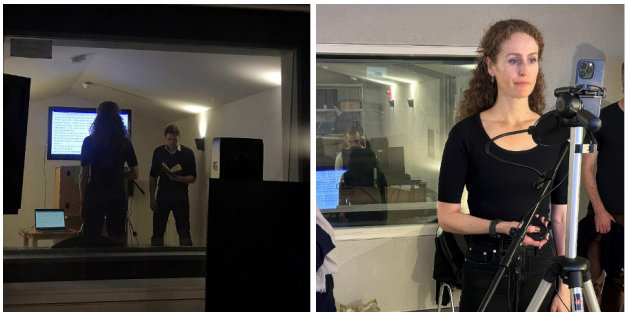


Figure 3: Room setup of the recording studio which contained a television monitor, facial capture and microphone setup: (left) Director Nicholas Johnson and actor Brenda Meaney in the recording studio; (right) actor in front of the microphone with the Live Link Face app running on an iPhone, post calibration.

The recording session was conducted over a period of three days. As the monologue is about thirteen minutes long and notoriously difficult to perform, to facilitate the actor the performance was broken down into multiple scenes and takes. However, for performance consistency, some uninterrupted takes of the entire sequence were also recorded, usually at the end of each day. For the purpose of this project, an unsegmented version was eventually selected because the complete, uninterrupted take 1) provided the most consistent tone, rhythm and intensity, aligning with Beckett's stated preferences, and 2) caused the least issues in the game engine at the post-production stage.

3.2 Data Import, Avatar Design, Scenography, and Animation

This project was designed and developed using Unreal Engine [25] and its MetaHuman Animator [14] on a Windows 11 machine, and tested on a Meta Oculus Quest 3 head-mounted display (HMD). For better project management, recovery and backup, and future collaborations and enhancements, Unity Version Control [24] was integrated with the game engine as our version control system.

The MetaHuman pipeline was structured over four distinct phases: data import, avatar design, scene integration, and animation clean-up and processing.

Data import, which serves as the foundation phase, marks the transition from raw performance footage to a synchronised digital animation. The recorded facial data – captured via the Live Link app – was manually linked and imported into Unreal Engine. During the recording stage, the video files were organised according to the takes and scenes. On each filming day, a calibration take was established to ensure that the performance aligned precisely with the facial rig of the selected MetaHuman. The recorded data was analysed to be approved or rejected before transferring the data onto the project file in the game engine. The approved takes were then imported by establishing a local connection between the data and Unreal Engine. One of the key challenges during the animation pipeline was managing the substantial volume of data generated during the recording sessions. Each take produced large and cumbersome amounts of data, including high-resolution video footage along with the corresponding quantitative motion-capture metadata required for facial animation. Over the course of time (and after multiple takes), data storage space and its transfer between devices was encountered as a significant obstacle and limitation of the technology. Additionally, the demand to manually link/update the file locations poses difficulties such as missing file paths, which can contribute to data loss and failed animation errors.



Figure 4: Screenshot of a template version of an older woman available on MetaHuman Animator.

The second phase involved designing the digital avatar using the MetaHuman Animator. As the original play focused only on the actor's face, particularly the mouth, the goal was not to create a hyper-realistic likeness of the actor, but rather to represent the implied age of the protagonist in Beckett's story: "nothing of any note till coming up to sixty when—… what?… seventy?… good God!" [1]. Hence, our design phase focused on developing the facial features of the avatar to signify old age and femininity, characteristics that Beckett de-emphasized (given his casting preference for Billie Whitelaw) when using the straightforward photo-mechanical technologies of film. To begin with, an already available template

was selected and further stylised with respect to skin texture, teeth and colour-grading. While the visual design of the template version suggested an elderly character – particularly through features such as sagging skin around the face and neck – the expected intricate details such as receding gums and worn, yellowing teeth were noticeably absent. As these were the only visible features of our 'Mouth' character, we adjusted them using the design filters in the animator, modifying the digital actor to accurately achieve a desired representation the protagonist (figures 4 and 5).

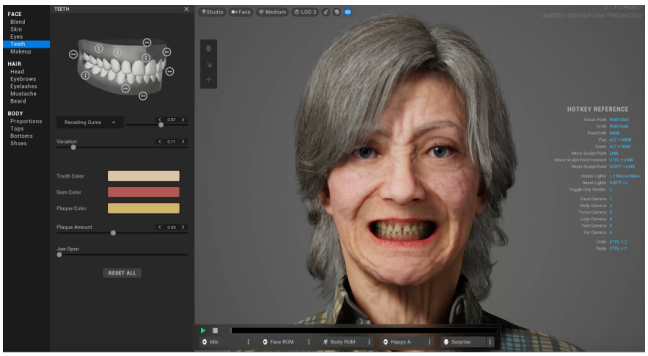


Figure 5: Screenshot from the MetaHuman Animator which details the options to modify the avatar according to the designer's preference.

Within the animator itself, there is a lack of additional options or filters that allow exploration of different makeup styles on the digital human. It was not possible to directly represent skin darkened with face paint to replicate the visual effect used by Beckett in the stage and film versions, a method used to obscure all but the actor's lips and the interior of her mouth (tongue, teeth, etc.) However, this limitation was addressed during the scene development stage in Unreal Engine by carefully adjusting the spotlight's qualities (e.g. focus, brightness and intensity) and modifying the RGB and roughness parameters of the material textures used to represent the MetaHuman's skin (figure 6).

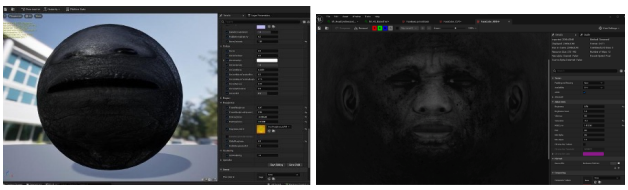


Figure 6: The Material Instance of the MetaHuman textures in Unreal Engine which allows the developer to adjust various parameters to obtain the desired black-paint look.

The third phase comprised importing the avatar into the virtual environment and designing the scenographic elements. To mirror the minimal dark environment of the original work, an empty unlit box-room was added into the scene with the MetaHuman placed in the centre. To prevent the immersant from experiencing groundlessness or vertigo, 3D grass-foliage was placed on the ground, and a small area beneath the mouth was dimly lit using an overhead spotlight. Grass appears in the monologue's text as well, mentioned as the site where the uncontrollable eruption of speech is triggered: "back in the field… morning sun… April… sink face down in the grass…" [1]. This scenography further created a haptic mirror of the physical grass under the immersant's bare-feet (see section 2.5). The lighting setup from the original stage notes – "faintly, lit from close-up and below" [1, p.376] – was also replicated in this virtual dimension, with a spotlight placed in front of the mouth to highlight only the lips, teeth, and gums. The epidermal region around the mouth is barely visible, because almost all the colour pigment was pulled out of the texture. Other than the mouth and the small grassy patch upon which the immersant is spawned, the scene consists entirely of an enveloping blackness.

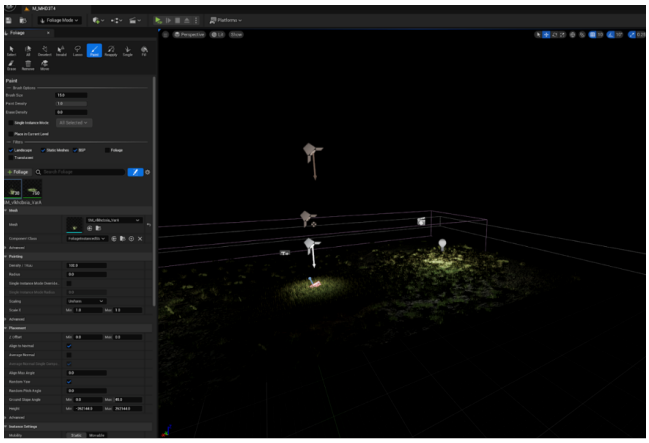


Figure 7: Addition of grass in the scene using the Foliage Tool in Unreal Engine

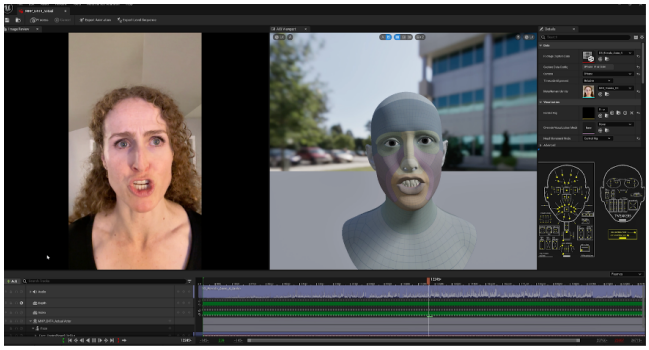


Figure 8: A still from the animation process after the MetaHuman performance has been processed. The left panel shows the actor (Brenda Meaney), and the right panel represents the skeletal mesh which has successfully captured the animation.

The final phase of the technical integration is focused on the animation clean-up, calibration, and processing. This involved calibrating the MetaHuman avatar to the actor's facial structure to

create a skeletal mesh which works as the MetaHuman identity. This step is critical, because it ensures that the avatar's facial rig accurately responds to the recorded performance data. Once the calibration was completed, the full-length performance take was processed (or 'baked') into a working animation. This processed animation was then added to the MetaHuman, completing the animation pipeline. These steps were carried out using Unreal Engine's multi-track editor, Sequencer. To construct an in-game cinematic sequence, the Level Sequence asset was utilised within which all the dynamic actor assets in the scene were added. The default skeletal mesh – which was generated when the animation was processed – was replaced with the MetaHuman skeletal mesh. During this process, the MetaHuman breaks into two, separating the head from its body. Hence, an additional step has to be completed to reattach the two with naturalistic movement, between the face and the neck, retained. While this additional step was completed to emphasise the mobility in the neck based on the mouth movement, the body was removed from the scene as our sole focus was the Mouth, aiding the disembodied aspects of the play and reducing the processing load in the final application. (This is a notable improvement on the stage technology of hiding behind a curtain.)

3.3 The Voice

In VR, sound plays an important role in enhancing the level of immersion and sense of presence [21]; specifically, for the VR adaptation of *Not I*, it was critical that the environment sonically replicated a black-box theatre environment. Unlike the traditional stereo audio elements which offer basic left and right panning, the sound in VR demands fully spatialised audio, in terms of direction and the distance between the listener and the sound source. To achieve this level of realism, a binaural spatialiser was included in the project, allowing the sound to respond to the viewer based on their location and movement. Another essential feature was to achieve a subtle reverb within the room to support the sense of externalised audio. To facilitate these audio features, which enabled spatial audio and room acoustics, the Meta XR Audio plugin [13] available in Unreal Engine was utilised. We collaborated with Trinity College Dublin-based sound designer Enda Bates, who had worked on previous Beckett reinterpretations for extended reality [8] [9].

During development, an audio-animation mismatch was observed, which significantly impacted the quality of the experience and disrupted user immersion. This lag was mitigated by synchronising the clock source of the project with the audio source, ensuring temporal alignment with the facial movement of the avatar and the accompanying voice. Additionally, the assets in the scenes were also pre-loaded, and a short delay was added to ensure that all objects were available in the scene before the Level Sequence was activated using Unreal Engine's Blueprint system.

3.4 Lighting and Cinematics

With all key elements in place, the final step focused on enhancing the actor–viewer relationship to improve the fidelity of the scene by adjusting the lighting and cinematics.

Firstly, the spotlight was subtly animated to follow the movement of the mouth throughout the performance. The Sequencer, which is a tool present within Unreal Engine that is also used by the MetaHuman animator, was used to achieve this. Using key-frames, the spotlight was adjusted to move dynamically in response to the subtle movements of the actor's head, which bobbed and oscillated during the live-action capture (figure 9).

During the testing phases of the experience, a primary concern was the viewers' sense of disconnection from immersion due to the "plastic" appearance of the avatar. Although an elderly avatar was used and MetaHuman technology promises a high degree of realism, its rubbery aesthetic tended to push viewers into the "uncanny valley" [22]. To address this, multiple parameters, such as lighting intensity and attenuation radius, were adjusted to create a more narrowly focused spotlight. Additionally, manual refinements were made at specific key-frames, contributing to a heightened sense of immediacy within the scene. These factors ensured that the Mouth remained illuminated throughout the experience while retaining the theatrical intensity that was initially envisioned for the performance.

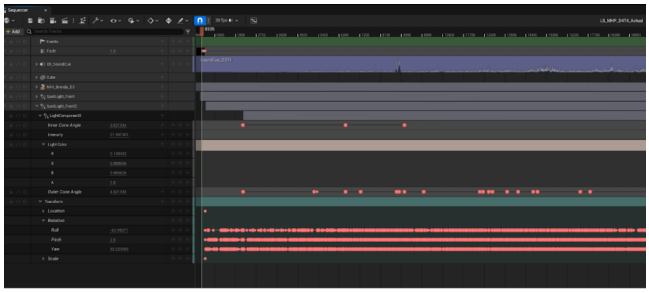


Figure 9: A look at the level sequence where the spotlight has been key-framed to move dynamically with the animation, along with the details panel which displays the selected settings.

3.5 Meeting the Mouth

The complete immersive experience unfolds in two distinct stages: 1) the onboarding process, and 2) the VR theatre. The goal was to capture the essence of the original while elevating the connection between the viewer and the synthetic, digital double of the actor – the avatar.

The first stage begins before the headset is worn by the participant. Viewers are invited to embody the Auditor character in an onboarding ceremony that takes place either outdoors in a grassy field (figure 10) or, if shown indoors, on an area of grassy sod that is brought into the gallery. The viewers are invited to remove their shoes and to walk barefoot on the grass whilst also donning a loosely-fit black djellaba with a hood, as described by Beckett [1]. The real patch of grass mirrors the virtual patch which is also present in the virtual dimension, creating a strong haptic link. The specific manner in which the viewer is embodied forms a correlation between the physically embodied viewer and their disembodied virtual self, projected into the virtual world and the virtual character who is ultimately a data trace of an originally embodied human actor [16].

The goal is to help them embody the character and, while not directly giving them agency to interact with the Mouth character, to elevate their sense of belonging through silent gestures of "helpless compassion" [1].



Figure 10: Images showcasing the onboarding experience (barefoot on the grass and wearing the djellaba, or hooded cloak, for embodiment purpose.)

In the second stage, the viewer wears the HMD and enters the VR experience, which is approximately thirteen minutes. The entire one-on-one encounter brings the viewer into a seemingly constricted space charged with an atmospheric intensity actuated by the rapid-fire nature of Beckett's monologue. The 'subtractive' [16] disembodied format of the play is maintained in the lack of visual referents in the darkened space (figure 11). As envisioned in the creative decision-making during the initial phase of this project, the scene in which the viewer materialises is dark with specific region-based lighting on the Mouth and the grass foliage underneath. There is a transfer observed here from the physical world to the virtual world; while the viewer is physically present, their presence in the virtual environment (a space of interaction and play) is rendered invisible and disconnected. The purpose of the grass patch and the hooded djellaba is to spark a sort of embodied, haptic oscillation between the virtual and the physical dimensions – the HMD representing one end of the spectrum, the grass anchoring the other, while the enveloping cloak (the costume, the mask) manifests as a mediator between fact and fiction.

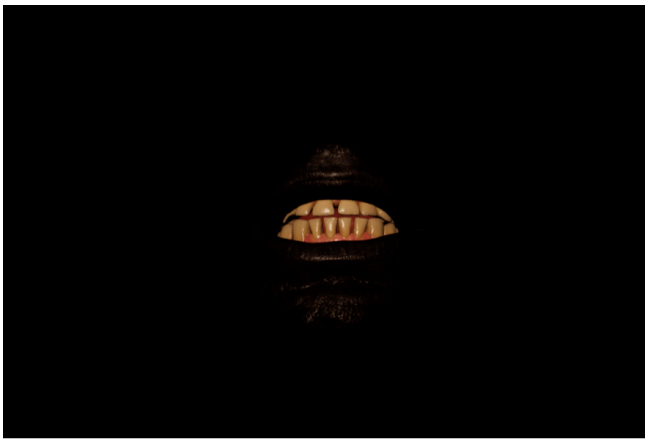


Figure 11: A screenshot from the experience in the virtual medium which represents the dark space, the disembodied Mouth in animation, lit by an angled spotlight.

4 Conclusion and Future Work

In its VR form, *Not I* set out to explore the possibilities of adapting and replicating a play originally created for a conventional theatre (auditorium) setting. By leveraging XR tools, the adaptation not only preserved core elements of the play, such as presence, disembodiment, and visual and auditory intensity, but it also expanded on the immersive potentialities of the original performance, which Beckett was already trying to explore in his own lifetime, as evinced by his pivot from theatre to film in the context of this text. The use of digital avatars, dynamic lighting, spatial audio and scene design demonstrates the ability of immersive technologies to recontextualise and preserve theatre works, making them accessible to new audiences while offering different modes of engagement and immersion where the viewer is the priority and has a direct, intimate connection with the character.

The project presently exists in a non-interactive format, and any form of interaction is controlled by the experience handler. In the film version, the role of the Auditor (the minor character who appears as a silent spectator in the text and early versions of the play) was left out. Within the VR environment, we combined the viewer's physical presence and the invisible virtual presence through a ceremonial onboarding process. The character was retained through the viewer, amplifying embodiment and establishing a link between the participant's physical sense of being and their disembodied virtual presence in the immersive state. This approach points towards increasing levels of agency, where the viewer moves from a silent participant wholly transfixed by the monologue towards someone who can actively control the experience, adding deeper levels of engagement with the source. In a future enhancement, one of the potential avenues that can be explored is adding gestural control or interactivity via the VR controllers. Furthermore, this individual experience could be adapted in a social VR context, to investigate how the collective and communal format originally present in Beckett's theatre would translate in a virtual environment.

Finally, a key feature that would technically enhance the accessibility of the VR adaptation and make it robust is the development of a fully stand-alone version of the experience that is untethered to a PC or other hardware. This criteria was actively worked on during the development of the project, and while it was possible to package the project for PC, it failed for Android packaging. Additional files required for successful packaging and deployment to the headset consistently failed to cook during the build process. Though the MetaHuman itself could be loaded onto the headset, it appeared without the associated animation. This limitation points to the unresolved compatibility (between MetaHuman technology and Android mobile computing) that needs to be investigated further, particularly in the newer versions of Unreal Engine, which may offer improved compatibility and stability.

Acknowledgments

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AI.R Taletorium: Preserving Culture Through AI Storytelling

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Abstract

AI.R Taletorium is an interactive art platform where children become co-authors and illustrators of original fairy tales in collaboration with artificial intelligence. The system integrates 2D image generation using state-of-the-art diffusion models, enhancing narrative visualization and accessibility. Children influence storylines through drawings and interactive prompts, which are interpreted by AI and woven into an unfolding narrative. By combining AI-generated composition, a responsive drawing interface, and personalized character generation, the project creates a collaborative art environment that fosters creativity, inclusivity, and engagement. The next phase of AI.R Taletorium focuses on deepening interaction with children through storytelling rooted in diverse cultural and ethnic traditions. By incorporating conceptual themes and folklore from multiple heritage sources, the platform aims to preserve and transmit cultural knowledge to younger generations in playful, immersive formats. The artwork explores the intersection of artificial intelligence, interaction design, and visual storytelling, offering a dynamic and adaptive experience that supports imaginative expression while revitalizing intangible heritage in the digital age.

CCS Concepts

• **Human-centered computing**; • **Interaction design**; • **Collaborative and social computing**; • **Applied computing**; • **Arts and Humanities**; • **Computing methodologies**; • **Artificial intelligence.**;

Keywords

AI storytelling, generative art, interactive narrative, imco-creation, inclusive design, child-computer interaction, Human-AI interaction

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1 INTRODUCTION

Storytelling has long served as a powerful medium for imagination, cultural continuity, and self-expression. It plays a central role in shaping identity and fostering emotional and intellectual development, particularly in early childhood. As artificial intelligence transforms the landscape of narrative creation, new possibilities emerge for immersive, participatory storytelling that transcends traditional media and cultural boundaries. [1 - 4]

AI.R Taletorium is an interactive, AI-powered art platform that invites participants to become co-creators of original fairy tales through a dynamic and adaptive narrative experience. From the moment a participant start to interact with the system, AI analyzes their facial features, interpreting expressions, shapes, and emotional cues, to assign them a character archetype. This AI-selected character becomes the starting point for an evolving storyline, immediately immersing the participant in a personalized story world.

The experience deepens through a drawing interface where participants create objects, environments, animals, or additional characters. These hand-drawn elements serve as visual prompts that the AI interprets and integrates into the ongoing narrative, utilizing large language models and 2D image rendering capabilities powered by diffusion architectures. This results in a responsive, co-creative storytelling process where human and machine imagination and machine intertwine in real time. By incorporating diverse folklore traditions and encouraging users to contribute from their own cultural contexts, *AI.R Taletorium* fosters creativity, empathy, and a sense of belonging, providing a meaningful artistic space for engaging with heritage.

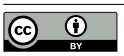
2 PROTOTYPING

AI.R Taletorium is a sophisticated, character-centric, multi-modal artificial intelligence platform designed for collaborative storytelling and creative engagement among diverse users. Its architecture comprises three main parts, each integrating advanced AI technologies and interactive systems:

2.1 Facial Recognition and User Identification Module

The system utilizes facial recognition algorithms, including FaceNet, MxNet, AgeNet, and GenderNet [5], to extract facial features, attributes, age, and gender from live webcam input. This process is grounded in a hybrid methodological approach that combines supervised image classification, facial landmark detection, and the interpretive analysis of psychological and culturally informed character archetypes. By matching users' facial features with a set of predefined story characters, the system facilitates personalized story adaptation, enabling a narrative experience that is both responsive and contextually meaningful from the outset.

2.1.1 Character-Centric Interaction Framework. The platform maps users' facial attributes to virtual characters within the story environment, enabling their personal characteristics to directly influence the narrative's progression. This mapping forms the basis for dynamic avatar creation, supporting real-time interaction between



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users and their AI-generated counterparts, thereby enhancing both immersion and emotional engagement. Furthermore, facial analysis is employed to detect and reflect users' emotional states, which adds expressive depth to character interactions and contributes to the evolving storyline, reinforcing a sense of agency and personalized authorship within the co-creative experience.

We developed a hybrid framework for facial analysis and narrative generation to create personalized story characters for children. The system combines supervised image classification, facial landmark detection, and psychological–cultural trait analysis to associate users' faces with predefined story archetypes.

Given the symbolic nature of fictional figures, the algorithm integrates AI-driven abstraction and stochastic variation, allowing users—especially children—to regenerate avatars that better reflect their self-image. This interactivity promotes digital self-presence and emotional engagement within the narrative space [6].

2.1.2 Facial Analysis Pipeline. The first prototype utilized several pre-trained neural networks: FaceNet [7] for facial embedding, MxNet [5] for feature extraction, AgeNet [8] for age estimation, and GenderNet (based on Caffe) for gender classification. These models jointly extracted facial features from webcam images and matched them against a library of 24-character archetypes—such as *prince*, *wizard*, *panda*, or *mermaid*. The grading algorithm assigned each user the most visually similar character, while ensuring uniqueness within a shared story space.

In the refined version, ArcFace [9] replaced FaceNet to achieve higher precision via additive angular margin loss. EfficientNet [10] supplanted MxNet, offering improved efficiency, and Vision Transformers (ViTs) [11] were incorporated to capture global spatial dependencies across facial attributes. Multi-task frameworks such as HyperFace and MTCNN further enhanced detection, alignment, and pose estimation [12] [13]. The pipeline also integrated VGGFace2 [14] embeddings and the DeepFaceLab model for improved cross-pose consistency and age–gender inference.

2.2 AI-Generated Collaborative Storytelling Engine

The storytelling engine employs neural network-based Natural Language Processing (NLP) models [3, 4] to generate interactive narratives. It comprises two sub-models: a story planning model that constructs multi-step plot structures based on selected characters, and a story content generation model that produces rich, descriptive fairy-tale segments.

To embed user avatars within dynamic storylines, we implemented a plan-and-write NLP architecture [15]. A planning submodel generated sequential steps for each detected character ($Ci \rightarrow S_1 \ldots S_{10}$), producing a Complete Insertion Story Line (CISL), subsequently expanded by a generative sub-model. Both were trained on a dataset of 890 fairy-tale stories.

To ensure thematic cohesion, a modified Rapid Automatic Keyword Extraction (RAKE) algorithm [16] was used to extract salient terms per segment, creating guiding prompts for narrative synthesis. The model then selected the most recurring avatars as story protagonists and produced concise, emotionally engaging stories of approximately 60 words each. The models were trained on a curated dataset of 800 fairy tales from a Southeast Asian corpus, embedding regional mythologies, archetypes, and narrative structures into the generative framework. This culturally rooted dataset enables the AI to produce stories that are not only imaginative but also reflective of diverse traditions, fostering intercultural engagement through personalized, adaptive storytelling (Figure 1).

As a result, we generated the following storyline:

[Title]: THE STORY OF THE OLD MAN WHO MADE WITHERED TREES TO FLOWER..

[Characters]: elephant, mermaid, elephant, panda, cat.

"I am the only living creature who has come to this tree," said he; "but I have no other master." "But you have not done enough for me," said a voice in his ear. The tiger was silent and he felt nothing but hunger; so she went up with him on her back towards home as if dead from fright at what had befallen them all that day: then they set food before their eyes without stopping till supper time came round again–so great were these appetites!

> Remove characters to: cat, elephant.

"I am afraid of the Cat; but I will do it no more." And so he went to sleep. He did his best with hunting and catching birds in autumn time till there was nothing left on earth that would give him any hope at all against this dreadful monster who lived outside human habitations: then came upon himself what an animal could be like! " And she ran as fast and well in her shoes. The cat came running after them all day long till it reached a village where dwelt an old woman who was ill-natured about cats because they were so ugly to look at: he had just come from his work when one night there happened something that made him very angry with himself for having behaved badly towards such animals!

Our hybrid framework unites computer vision, affective computing, and computational storytelling, enabling co-creative engagement where children actively shape narratives reflecting their own identity and imagination [17] [6].

2.3 Visual Content and Illustration System

The system generates dynamic scenes aligned with the unfolding story content using integrated AI-based image synthesis tools [18]. Participants can further contribute by drawing or inserting additional objects and characters, which the system seamlessly embeds into the evolving narrative. This approach supports real-time, adaptive visual storytelling that responds to user input, fostering a participatory and immersive experience where narrative development becomes a collective, co-creative process (Figure 2).

3 VISUAL STORYTELLING FOR COGNITIVE AND CULTURAL DEVELOPMENT

AI.R Taletorium is conceived not only as a digital artwork, but also as a participatory and socially responsive platform that fosters emotional expression, intercultural dialogue, and creative confidence, with a special focus on children. By enabling young users to co-create evolving narratives with AI, the platform introduces storytelling as a living, adaptive process that reflects not only imagination but also identity, values, and heritage.

The collaborative structure of the platform encourages social interaction and shared authorship, creating a meaningful and inclusive learning environment that supports both individual expression and group dynamics. It becomes a space where cultural traditions

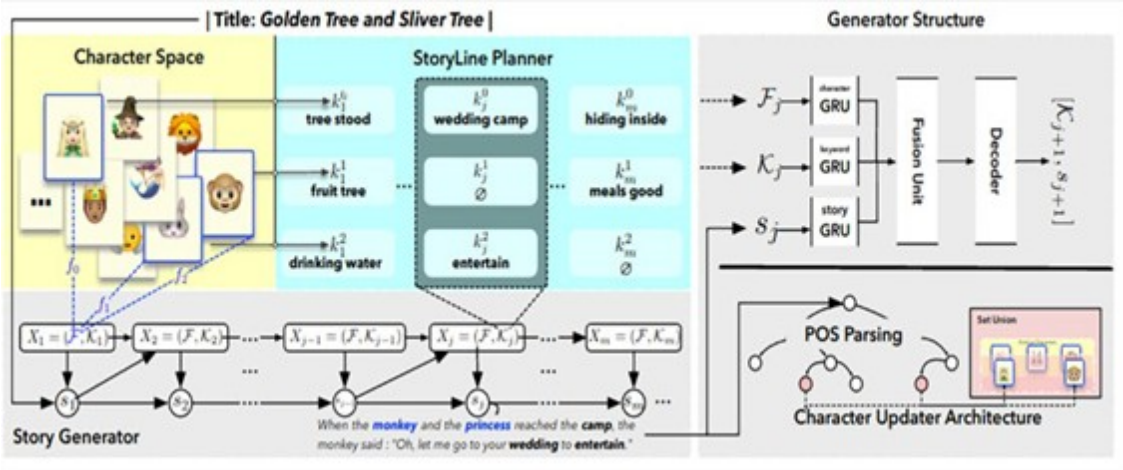


Figure 1: The narrative engine adopts a character-driven approach that combines a dynamic plan-and-write framework with evolving character attributes to compose each segment of the story. Rather than relying on a static plot outline, the system generates each new fragment in real time, adapting to the progression of the previous scene and the current emotional or narrative state of the characters. This adaptive, character-centric model enables meaningful co-creation between participants and the AI, allowing users to influence the direction and tone of the story by modifying or introducing characters through their visual inputs.

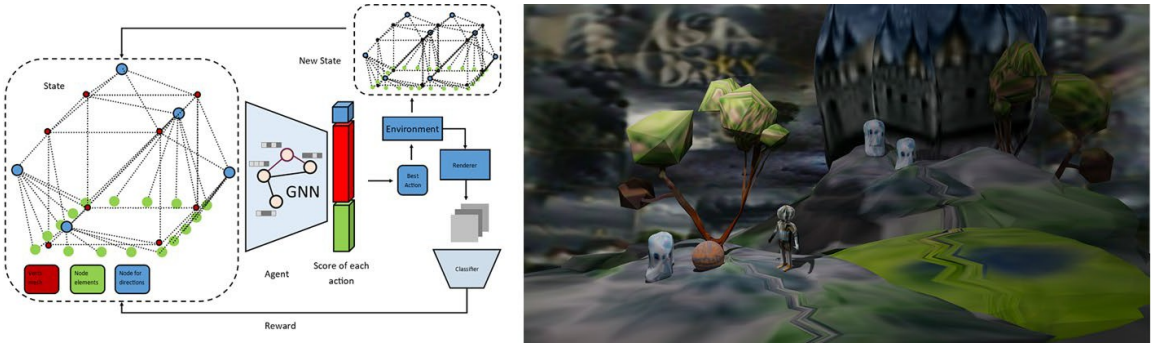


Figure 2: Neural Network architecture: The agent predicts the next move given a graph representing the state. Nodes represent the verts of the mesh, the available direction of expansion for the structure, and locations for architectural elements (left). Sample image: A knight, a ghost, and a Halloween pumpkin near a dead tree. A Gothic Castle on foggy hills in a dark night (right)

can be revisited, reinterpreted, and kept alive, embedded in the gestures, symbols, and characters users contribute. In doing so, the platform fosters early cultural awareness and a sense of belonging, while facilitating new forms of peer-to-peer and intergenerational exchange.

Artistically, *AI.R Taletorium* explores a new aesthetic of co-authorship, where image generation is not a passive byproduct of AI output but a site of real-time negotiation and meaning-making. Participants, especially children, are not merely consumers of content but active collaborators who shape and question the narrative through their drawings, choices, and creative responses. The result is a hybrid storytelling environment that bridges oral tradition, visual language, synthetic intellect, and machine imagination.

4 CONCLUSION AND FUTURE DIRECTIONS

This paper presents the ongoing evolution of AI.R Taletorium as a generative, interactive storytelling system rooted in cultural engagement, inclusivity, and creative participation. With its integration of 2D image generation, character-based narrative logic, and multimodal user interaction, the platform offers a rich and immersive co-creative experience that is particularly valuable for education, therapy, and artistic practice.

Looking ahead, future developments will emphasize the deepening of intercultural and multilingual narrative support, enabling the platform to better reflect global folklore, languages, and traditions. Adaptive personalization will further support users from diverse backgrounds and learning needs, while extended deployment in

educational and public cultural spaces will enhance its impact as a tool for both learning and preservation.

As generative AI continues to shape the cultural and creative industries, *AI.R Taletorium* proposes a model of socially sustainable and ethically grounded innovation, where technology serves as a bridge between past and future, personal expression and collective memory. In this context, the project becomes not only an artwork but a living archive, nurturing the transmission of cultural heritage through participatory storytelling and digital imagination.

Acknowledgments

The manuscript explicitly documents and incorporates AI-generated content. Detection of such content is therefore expected and reflects the study's subject.

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Affordances of Behavior for Interactive Digital Narratives: A Poetics for Interaction

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Abstract

The aesthetics in Interactive Digital Narratives (IDNs) are narrowly understood following a conventional path that does not consider the intricate interplay of feedback loops. Being artifacts that influence the trajectory of a reader through the work, and how meaning emerges from that, we look at the aesthetic of IDNs managed at the code level. Adopting a systems-thinking approach, where behavior is a central part of it in its presented form, we identify and define the components of the system. Following that, we analyze how these components operate together as an integrated whole, while remaining sensitive to environmental changes.

Through this lens, we call for an aesthetics of behavior that is contextually situated with tools, spaces, and bodies, and that is distributed between the system, narrativity, and the reader. Claiming that these three elements, such as any element of the material and social world, are actors, we develop a model of the affordances of behavior that can help us to structure patterns that establish spaces of meaning tuned during the execution and contact with an IDN. Exploring and presenting SCHEMA (Will Freudenheim, 2023) as a case study, we propose that this model of the affordances of behavior can be used as a theoretical tool for developing IDNs.

Finally, our analysis contributes to an understanding of how IDNs function as dynamic, meaning-making systems that are shaped by and shape the interactions between their components, readers, and the broader computational environment.

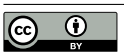
CCS Concepts

• **Applied computing** → Arts and humanities; • **Information systems** → Information systems applications; Multimedia information systems.

Keywords

Interactive Digital Narratives, Aesthetics of Behavior, Construction of Meaning, Reader, System, Narrativity

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1 Introduction

Imagine a procedurally generated world where animals, plants, and entire solar systems emerge algorithmically, creating singular environments across more than 18 quintillion planets. The reader can explore these planets, helping to catalog flora and fauna, extract resources, and construct bases, in an emergent system where the narrative is formed from the readers' decisions and actions in the generated world.

This is the context to explore No Man's Sky (2016), developed by Hello Games. The artifact offers a lens to examine agency, progression, completeness, and computational co-authorship. However, most significantly, it demonstrates how Interactive Digital Narratives (IDNs) become experienced and engaged in ongoing feedback loops between system, narrativity, and reader. These performative exchanges generate what Simon Penny [1] terms the aesthetics of behavior.

Reading an IDN is mostly about making choices within a system that allows narrativity and permits each reader to construct their own narrative. An IDN's computational system, designed to support actions and outcomes in significant ways [2], responds to readers' inputs and transforms them into different forms. It is the contact with complex subfaces, which are the algorithmic processes that we usually do not have direct access to, capable of conveying a multi-dimensionality, that, most importantly, operates [3]. Since these systems have a core computational architecture and consist of procedural operations, we cannot examine IDNs solely from how they are experienced. We must also consider their operational mechanisms, the composition of their underlying structure, and how this drives the interface presented to readers.

The existing approaches to IDN aesthetics remain constrained by an artificial duality between narrative and ludic dimensions [4]. The narratology-ludology divide as oppositional narrative and play, rather than recognizing their entanglement within procedural systems [5]. On the other hand, even when interactivity and narrative are acknowledged as both significant, the focus tends to be on the architecture of choice. More than analyzing whether the information takes place in human or machine, it is important to converge on the continuous feedback loop that makes the two sides homogenous and inseparable [6].

IDNs become dynamic media systems. Just as we must understand words and their contextual meaning in books, we must understand how the system is used to express and construct meaning in computational artifacts. Beyond just knowing the code or programs

used to create it, we need to consider how their logic functions as an expression of the design of their movements, as well as the ways readers can interact with them, and what kind of outputs and thoughts result from there. There is a set of "expressive processes" as "processes that clearly shape the meaning of the works" [7] created to embody an appropriate behavior of the system concerning a particular end. This determines the design cues and affordances that steer the reader into an understanding of the system, determined by the objects presented and possible actions. The playable model of the computational system is related to internal modularity [8], referring to the internal construction of the IDN, the way it contributes to defining its aesthetics, the meanings it incurs, and the uses it can have. Modular parts comprise objects, properties, behaviors, and relationships [9], which both the designer and the reader can arbitrarily arrange.

The interplay and interdependence that embrace the operational logic and their playable model, as two big configurations of any IDN, help us to structure a set of possibilities for deploying an axis concerning the system and narrativity in which the behavioral intent is encoded in an estranging play [10] between these two entities.

2 A Situated Approach to Narrativity

Long before the concept of narrativity started to be used to grasp the narrative potential of computational media, it had been recognized in various other modes, such as illustrating, retelling, evoking, and interpreting [11]. This way, the focus here is to scrutinize how narrativity has evolved in relation to computers and algorithms, becoming the crystallization of a closed system that allows readers to adopt specific goals, constraints, and feedback loops that shape their experiences in a distinct and intensified way.

Narrativity appears as a formal and aesthetic structure [12] related to the technique of cut-ups in seminal works such as The Soft Machine (1961) or The Ticket That Exploded (1962) by William Burroughs. In these works, there is a process of taking pages or fragments of the text, cutting them up, and forming new pieces of work that combine different lines. It happens to be a reflexive concept that is situated and organized prior to its manifestation [13], which is not "a quality inherent to a text but rather an attribute imposed on the text by the reader who interprets the text as narrative, thus narrativizing the text" [14]. For Scholes [15], the term refers to the process by which any perceiver actively constructs a story from the fictional data provided by any narrative medium. There is a double-layered tension between observing what is being presented to us, mainly in the form of a narration, and that guides us, and on the other hand, judging and putting our narrativity to seek and complete the process of developing responses that will rely on formal rules [16].

Moreover, we can perceive narrativity by a performative approach that helps frame and project how the reader informs and is informed by the computational system. There is a process in which the system's operational logic [17], constituted by the rules, procedures, and objectives, is constructed by the designer and later activated by the reader. It has a syntagma function since it supports a database of choices (Manovich 2001) from which it is possible to combine various elements in a given space.

As the reader proceeds through the IDN, she gradually discovers the interactive loops that organize and represent the space of possibilities with a narrative dimension that is being created. Furthermore, through narrativity, a reader can execute an algorithm, activating the subface of the artifact and uncovering its playable model. Here, a set of elements, mainly objects that carry with them meaning and function, invites readers to test the possibilities and limits of rules. By inputting decisions, the reader discovers the fragmentary and non-sequential structure that leads them to navigate the surface and construct its narrative. The reader engages in specific behaviors and cognitive activities [18] that powerfully shape the unfolding narrative and, consequently, their intrinsic experience.

Through narrativity, the readers become involved in the IDN's internal construction and the artifact's aesthetic, semantic, and affective experience [8]. Furthermore, our concept of narrative combines David Herman's definition as a "forgiving, flexible cognitive frame for constructing, communicating, and reconstructing mentally projected worlds" [19] with Espen Aarseth's concept of ergodicity [20], where the reader's actions are an essential part of the experience. This way, the narrative is the reader's experience with the artifact. It is the dialectical process through which they become conscious of the artifact's functionalities, backgrounds, and contexts [21], anticipating and incorporating their actions into the computational system.

We converge now with an endless negotiation between content and dynamics. This mediation reveals how narrativity operates as a space for interaction that does not exist in isolation but requires activation through specific actions. In this moment of activation, where the potential of narrativity transforms into a concrete experience of narrative, we must investigate the reflexive nature of action with IDNs.

3 From reflexivity to a performative agency

Building upon this understanding of narrativity as a situated and performative actor[1], we turn to analyzing how this potential is realized through action. The context in which IDNs operate encompasses a fundamental notion of reflexivity, provided by the various perspectives on action. Narrativity unfolds into a narrative through a modular and non-linear organization of information that allows the reader to create their traverse [20]. The narrative that appears as an output is operationalized through instantiation, with the generation of multiple variations being emulated or simulated through a set of reflexive loops.

This reflexive action dimension in IDNs must also be grounded in what N. Katherine Hayles identifies the embodied nature of action within computational environments. The reader's actions become part of the cybernetic circuit that emerges from their situated position with the technological apparatus. The production of meaning is not only registered, but above all, constructed since "each living system thus constructs its environment through the 'domain of interactions' made possible by its autopoietic organization" [22].

[1]We define actors according to Bruno Latour's Actor-Network Theory, which considers that humans and non-humans can be existing actors in a network. Graham Harman (2009) explains that Latour "grants all [actors] an equal right to exist, regardless of size or complexity, all things natural and artificial must count as [actors].

Since the computational system is autopoietic and structurally coupled, it can observe and respond to patterns of reader behavior in a self-examination and reconfiguration mode. This turns every action into a response to the current state of the computational system and a contribution to its evolving narrativity:

> "It is the circularity of its organization that makes a living system a unit of interactions. And it is this circularity that it must maintain in order to remain a living system and to retain its identity through different interactions." [23]

Façade (2005) is an interactive drama created by Michael Mateas and Andrew Stern. The reader has access to a real-time 3D virtual world inhabited by computer-controlled characters, where it is possible to move around and have conversations with them through text input. It was one of the first attempts to move from hypertext and one-branch narratives, bringing to the forefront "the connection between what the interactor does and the behavior of the main characters" [24]. The dialog capacity provided by natural language processing allows the reader to interact with the computational system and be concerned about the fact that their actions can provoke consequences and new states in the characters' lives. They experience a dramatic agency where the actions reinforce a state of belief in what is happening in the fictional world [24].

The readers' action in an IDN is also relatable with procedural rhetoric that poses action as a learning effective tool, concerned about how meaning can be inferred from the computational system's rules and the meaning generated by the readers' performance each time they access the narrative [25]. In Papers, Please (2013), the reader embodies a border immigration agent who analyzes the necessary documentation of immigrants who want to enter the country. The speed with which he carries out his work is what allows him to improve his socio-economic conditions, while at the same time gaining advantages in the fictional world. Through the actions allowed, a set of logical consequences is presented that follows a model of predefined rules and forces the reader to confront a set of ethical dilemmas mediated by the system.

In 80 Days (2014), an interactive fiction inspired by Jules Verne's classic novel "Around the World in Eighty Days," the reader takes on the role of Passepartout, the valet of Phileas Fogg. Readers are tasked with making crucial decisions regarding routes, transportation, and how to navigate various challenges encountered during the journey. Each playthrough illustrates how the same initial premise – circumnavigating the globe in 80 days – can yield profoundly different outcomes, highlighting the performative relationship between choice and consequence. This interplay creates a dance of agency, resulting in various stylistically distinct descriptions that emerge from an exploratory and dramaturgical process. Routes may open or close based on prior decisions, cities reveal different facets of themselves depending on the approach taken, and the journey narrative is actively constructed through the dynamic interaction between reader agency and the system's responses.

Furthermore, we can understand agency according to the actions the computational system allows and the reader executes, the effect these actions can have on the narrative world, and the system's ability to modify the narrativity [26]. Constituted by a set of multiple dimensions, there is a cybernetic chain where the readers' input influences the computational system's reaction, which requires a reactive environment and the importance of the outcomes of these actions for the construction of meaning, which the same authors denominate Agency Scope and Agency Dynamics, respectively. In turn, this cybernetic chain shapes and creates a codependence between the reader and the narrativity, creating an Agency Relationship that can have an immediate and localized impact in real-time and space, being able to afford and constrain every action [27].

The actions taken are controlled and enabled by the same structures that those actions serve to reinforce or reconfigure [28]. They become intra-actions [29], causing the computational system to change its affordances in a broader pattern of an autopoietic process that generates behavior.

4 The Affordances for the Aesthetics of Behavior

Our ability to interact with an object relies heavily on our perception of that same object. Perception is not an inherent property of an individual body; it is constructed due to the mutual influence and co-emergence of intra-actions [29]. These intra-actions change the affordances of the computational system, the visibility of its materiality, and the way the reader explores narrativity [30]. Additionally, interacting with an IDN involves a multi-sensory experience and bodily engagement with the artifact, structured in some aesthetic considerations that involve the technological apparatus, the reader, and the emergent and relational condition of the computational system.

The term aesthetic can be found in every act of our everyday lives. Living in society, relating to others around us, handling objects, and doing a range of activities such as eating a meal or visiting a museum are all expected to produce results that will be motivated by the aesthetic factors rooted in our culture. They are known as what John Dewey [31] defined as everyday aesthetics, which explores the diverse aspects of people's aesthetic lives. Arnold Berleant [32], in his works on the aesthetic field, talks about aesthetics as an interactive process between an agent and the object of experience:

> "I call this view 'aesthetic engagement', for not only does it recognize and extend the connections of aesthetic experience, but it invites our total involvement as active participants. Aesthetic engagement is more a descriptive theory than a prescriptive one: it reflects the activity of the artist, the performer, and the appreciator as these combine in aesthetic experience. And it is a theory that reflects the world we participate in, not the illusory splendor of a philosophical fantasy." [32]

In this way, we can say that trying to understand what happened to Marissa Marcel, in Immortality (2022), appreciating the development of a romantic teen relationship between Mord and Ben in Wide Ocean Big Jacket (2020), or the simple act of choosing from two actions and wait to see what the consequences of it are in Bandersnatch (2018) "would lead to visuomotor resonance processes, allowing the understanding of the intentions and emotions" [33]

that are being represented. We can say that the aesthetic engagement becomes a functional activity that deals with "various kinds of experience that philosophy of perception can help us to understand better" [34]. Since IDNs are created to realize an intention, while remaining sensitive to variable environmental changes, we argue that the behavior of the computational system plays a crucial role in characterizing those aesthetic experiences.

According to Simon Penny [1], the aesthetics of behavior is concerned with the cognitive dimensions of what designers do and how their work is understood. In this way, building systems that react in real time allows the creation of behavior in the sense of an action modulated by external events. Because IDNs change their nature in real time due to changes in the environment, we understand the aesthetics of behavior in IDNs through the representation of affordances. Since the affordances represent possibilities for action that emerge from the relationship between an agent and their environment [35], we will observe the actions readers can perform on an artifact based on its *subface* characteristics. These behavioral affordances show how a computational system, aligned with narrativity, enables or limits specific meaning-making associations.

In this context, we have defined four affordances that have helped us structure the relationship between the computational system and narrativity, revealing how narrative emerges as an individual experience through each reader's unique journey with the artifact. They are the logical, agential, sensorimotor, and configurational affordances.

"Logics are specifically communicative, algorithmic, and connected to play — each one names a way that games procedurally represent their worlds to players, operate internally (at a high level), and have opportunities for state change and interaction" [7]. Saying that, the logical affordance is about the arrangement and combination of elements that help to structure the relation between the system and the narrativity axis. It is about how readers are enmeshed with the interface and their representations, evoking possible ways of interaction.

Following, the system-narrativity axis affords not only the performance of the code, but also the performance of the self, shifting between a self-reflective attitude, allowing readers to have an aesthetic engagement with phenomena that are not usually appreciable to human perception. The agential affordance reconfigures IDNs into artifacts that act between a dynamism of forces in which all the selected "elements" are permanently exchanging and diffracting, constituting a dance between material and human agency [36]. At the same time, they become material objects that we can touch and interact with, but also as entities with which we are entangled with our bodies [37].

The system-narrativity axis also creates a multimodal sensory experience that challenges readers to understand not just the physical aspects — movements, gestures, and bodily practices — but also all the knowledge and abilities that account for perception. This perception encompasses the receiving and interpreting sensory information [38] and the dynamic interplay between motion capture and its resulting affects [39]. The sensorimotor affordance is quite helpful in describing the structurally coupled relations between the computational processes and the readers, which are always spatially and temporally immersive and interactive.

Finally, the configurational affordance modulates how readers process and integrate the atmosphere created by the system-narrativity axis, directly influencing their meaning-making processes. Jenifer Tidwell [40] emphasizes that taking into consideration an incremental construction accentuates responsive changes that keep the user in a state of continuous flow. According to that, IDNs should gradually and responsively enable the construction of meaning through contact with the sensual properties of code that can amplify or redirect a set of behaviors. There is a reciprocal process of configuration that addresses the changeability and modularity of the attributes of both the readers and the environment that surrounds them.

Following a phenomenology of the aesthetics of behavior, we will now observe the defined affordances in the IDN named SCHEMA (2023) by artist, game designer, and researcher Will Freudenheim. We will follow the artist's making process, the computational system that behaves, and the heterogeneous relationship it creates with the reader.

5 SCHEMA: an emergent creature that reinforces behavioral patterns

Schema (2023)[2] was presented as an interactive installation in an online gallery named "Caldo Worldwide" and features a forest creature whose behavior and emotions are being controlled by readers in real time, using the platform *Twitch*. Through textual inputs typed into the platform's chat, readers can manipulate the creature's attention and enthusiasm, triggering complex emotions ranging from curiosity to anxiety or conflict. The readers trigger these emotions and directly influence how the creature behaves in the environment around it and how it confronts other creatures and entities that appear. In addition, the creature's mission is to collect glowing "pearls" during the day and then transform them into algorithmically generated melodies at night. This feature triggers a dynamic feedback loop between the reader's interaction with the textual input and automated artistic creation. Thus, "Schema explores how collective digital participation can generate emergent, unpredictable behaviors and narratives, examining the complex effects of many voices collaborating to shape a single evolving story within a virtual ecosystem"[3].

Through a forest creature in a state of continuous transformation, it is possible to establish the multimodal sensory experience that has been crafted in order to conjure affect and associations in the mind of the experiencer [1]. As an artifact that materializes an intelligent interaction with its environment and how the digital media is expressed, we will analyze how Schema articulates the logical, the agential, the sensorimotor, and the configurational affordances of behavior.

The primary characteristic of the interface of Schema is that it affords and communicates a clear model that supports the interaction experience. By implementing a system that allows a modulation between introverted states, showing more anxiety and aggression, and extroverted states with contentment and curiosity, the forest creature presented to us creates dynamic behavior patterns. The

[2]Available at: https://caldo-worldwide.com/pages/will-freudenheim-schema-sub
[3]Citation retrieved from: https://www.1e9.community/artists/caldo-worldwide-schema-by-will-freudenheim



Figure 1: Schema by Will Freudenheim[4]

system in which these behaviors are implemented "should be a consistent abstraction of the overall process and especially of the material being manipulated" [41]. In this way, the reader can focus on the task at hand, which consists of talking to the forest creature, helping to build a symbiotic relationship between it and their participation in the Twitch platform chat. It becomes important to be enmeshed with a worldness as a concept defined by a complex interplay between the world being represented and the forms of interaction within that world and the agents that populate it [42]. This complex interplay highlights a behavioral grammar that, in the work of Raph Koster [43], is responsible for a set of key elements. They are the reader's intention, the possibilities for action on the IDN, the inputs that enable the action, the action itself, which in turn feeds a "black box", the resulting changes presented through feedback loops, and finally, the resulting changes in the reader's model, through which they form new intentions. Combining these elements structures the logical relationship between the system and the narrativity it affords, creating specific possibilities for interaction.

As we interact with the forest creature represented in Schema, we realize that it behaves in a way that allows it to take the initiative for action, make requests, and respond assertively to the textual commands of readers. In this way, it begins to be experienced as an extension of our mind and can interrelate with our emotions. Thus, the narrative emerges in a co-emergent process comprising the readers' intra-actions via chat and the creature's performative agency through its behavioral algorithms. The creature does not just react to textual inputs but adapts and anticipates in a performative dance that conveys meaning. This performative dance that informs readers and itself is the source of entanglement that carries style and meaning and presents the substrate of our constitutive organization [37]. With this entanglement, the system's satisfying and predictable use contributes to a sense of companionship, reinforcing the behavioral infrastructure.

Through a sensorimotor feedback loop established through a digital haptic between the reader and the forest creature, there is a process of language that is being constructed through autonomy. This autonomy regards the actions taken and the way these same actions shape the represented world into significance. This means that perception is connected with new forms of sensorial literacy that "far from remaining unchanged, can transform itself through emergent behavior" [22]. The sensorimotor affordance presents the reader with a mental model in which it is possible to gather the information that will allow one to guess what will happen next [41]. As soon as readers understand that the creature forest is collecting "pearls", they can expect that some kind of action will happen. Later, when the creature transforms the collected pearls into melodies, the algorithmically generated actions by the system become visible to readers, reinforcing the mental models that will allow the understanding of the visual and sound behaviors of the creature. There is a structural symbiosis where the creature does not exist without human interaction, but the readers only access the artifact through the mediation of the narrative.

For the configurational affordance, we can observe a reconfiguration process in both the reader and the artifact, since both are transformed through interaction. However, this reconfiguration takes place between the frontiers of emergence and control. Readers can influence the creature with specific emotions, but can never completely control it. There is, therefore, a productive tension that manifests itself in the temporal structure of the work. The day is represented by the direct influence of the reader's input on the actions of the forest creature, creating unique configurations for each session. In contrast, the night represents the algorithmic creation made upstream by the programmer. Through this accountability, readers learn how to make sense of the world around them,

[4]Available at: https://caldo-worldwide.com/blogs/artists/will-freudenheim

specifically narrative sense, through the learning of syntactic rules concerned with the operative functions and objectives [44].

Therefore, we visualize in Schema a system-oriented media [17] that first operates in a specific way and secondly is designed to communicate a set of intentions in a "formal system that subjectively represents a subset of reality" [45]. As per the discussion, the four affordances of behavior show that they are mutually dependent, contributing to a poetic dimension of the feedback loops and an overall construction of meaning.

6 Conclusions

Through this article, we have proposed a system approach to IDNs from a challenging perspective on conventional aesthetics. Analyzing IDNs with a perspective that poses behavior as a central aspect of the aesthetic experience, we establish the affordances of behavior that help us to understand how the system, the narrativity, and the reader not only influence each other, but also become actors that influence the construction of meaning. This systemic understanding of IDNs is an effective analytical tool for assessing interaction that permits allusion, association, and metaphor [1], allowing the analysis of the very medium as a cultural and phenomenological singularity.

As Rosalind Krauss [41] claimed about video not being a physical medium, but a psychological one, we can bring that affirmation to the discussions of IDNs. Through the logical, agential, sensorimotor, and configurational affordance, we observe IDNs as autopoietic artifacts that create a navigation process as a communication event that helps distinguish IDNs from other media.

The system operates through continuous feedback loops, consisting of rules-constrained behaviors. Narrativity is an organizational and aesthetic principle that structures narrative potential through a database of possibilities formalized within the system. It requires reader activation, becoming an implied reader [46] with the power to take meaningful actions through cognitive and physical participation. Therefore, a set of formalized encoded possibilities produces the experiential object. At the same time, the reader perceives and activates actualized sequences through a double measure of technicity [47]. First, the computational system inscribes a perceptual apparatus released through the mechanics available. Secondly, the reader also brings their accumulated technicities to the system, informed by accumulated competencies.

IDNs modulate our temporal and affective experience of life and challenge the phenomenological basis of human perception, forcing us to develop new forms of embodied literacy that can accommodate and impact the sensory experience on a level of attention and awareness. There is an extension of the reader's cognitive system into the computational architecture, forming a vicarious experience, in the sense that the construction of meaning only starts when there is a correlation with the temporal rhythms and spatial configurations distributed across the technological apparatus. In doing so, the interface that is expected to behave surprisingly becomes a tool for interaction and a constitutive element that requires human embodiment of the reader's cognitive ecology.

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EDNI. Rehearsing the Embodied Co-Creation of Emerging Trans-Spatio-Temporalities

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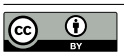
Abstract

The discussion about the irreversible effects of AI across various areas of knowledge and human action, envisioned through either catastrophic or salvific models, has critically captured the attention of public opinion and all kinds of social, political, and economic agents. Less frequent are approaches aimed at exploring other modes of interaction and co-creation, capable of enhancing renewed, sensitive experiences of the fluid and emergent character [17] of the (dis)limits that both tension and approximate the physicality of bodies and technological virtuality. The organic and dynamic nature of human ontology imbues the relationship with the non-human environment with a complexity that is not entirely predictable. To question and explain the implications or potentialities of such a liminal relationship, to understand the transformations at the level of perception [19, 23, 24] of what redesigns and co-constitutes us, is fundamental.

EDNI (*Dense Space Not Unlimited*, from Portuguese "*Espaço denso não ilimitado*") is a transdisciplinary project that brings together media arts, performance/dance, music, and scenography as a means of exploring the embodiment of renewed space-temporalities. Provoking the notions of linear time that impregnated the disciplinary paradigm of utopian modernity [12, 18], in this scientific-artistic experimentation, time, unexpectedly, goes back, not as a repetition of the same, but as a memory that permanently (re)actualizes and destabilizes the meaning of the past-present-future. Through AI, reciprocity effects are co-created between the physical body and the virtuality, challenging the most widely held preconceived notions about the possibilities, both human and machinic, of co-construction. Seeking to free themselves from the shackles of a nostalgic feeling or prisoners of the false dichotomy between utopia and dystopia (or heterotopia), the authors of this proposal propose to contribute to broadening the vision of the role of AI in the redesign of feeling [31], of moving, and of being-with.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Human-centered computing** → Interaction design; • **Computing methodologies** → Artificial intelligence.



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Keywords

EDNI, AI, Embodiment, Perception, Performativity, Trans-Spatio-Temporalities

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1 Introduction

The work analyzed and discussed in this publication combines the performative body, body projections generated through AI, and a pendulum sculpture. It is a transdisciplinary project (combining science, technology, and the arts) and colaboration under the direction and choreography of Né Barros, with João Martinho Moura overseeing the dimensions of media art and music, featuring a vast team. This performance was developed within the scope of Aveiro, Portuguese Capital of Culture 2024. Taking the form of a magnetic field: "EDNI is an expression that designates a Dense and Not Unlimited Space, which in this project takes the form of a magnetic field".

From EDNI, we can formulate a double question: How does the living, organic body (body-flesh) move to the non-human environment? To what extent, in our ontology, are the human and the non-human co-constituted?

More than aiming for a safe and definitive answer, we propose to seek to achieve the following objectives:

- To question and explain the implications or potentialities of the liminal relationship between the human, in its embodied and organic/perceptual condition, and the non-human (animal, dense matter, post-photographic or technological/virtual image).
- To understand the transformations, at the ontological level, of what is redesigning and co-constituting us, from the (dis)limits of embodiment and the center-deviation dialectic.
- To rehearse other modes of embodied relationship with the non-human, and in particular with technology (AI), considering its effects concerning the renewed spatio-temporal perception.

1.1 Perception, embodiment, and performativity: previous theoretical reflections

First, it is important to emphasize that our reflection is rooted in the (post)phenomenological approach. In particular, the concept of perception, which designates the relationship between the living body and the sensible universe, or the awareness of oneself concerning the understanding of this connection, is presented as fundamental in this publication. Thus, we propose to discuss:

> "... the living relationship of the perceiving person with his body and with his world" as perceived [23, p. 241].

To perceive the limits of perception is, in turn, to perceive the limits of one's own body, as well as the sensitive relations between different entities:

> "... my body is not just one object among many, a complex of sensitive qualities among many, it is an object sensitive to all others, which resonates with all sounds, vibrates with all colors" [23, p. 273].

If we add to this problematic of the body-flesh, in the terms of Merleau-Ponty [23, 24], the condition of technological experience in contemporary times, this discussion will have to summon the question of the displacement of the face-to-face body to the virtual body. In the same way that perception, from a phenomenological perspective, is determined by the relationship of the subject with the sensible universe, so the relationship with technology is, today, co-constitutive of our ontology. Thus, how our perception of the body and our relationship with the world are affected by technology produces a sense of embodiment, as argued by Ihde [19], among others. The relationship with technology implies movements of double meaning, sometimes streamlining an active body, occasionally passive, in the author's terms, thus alternating the epistemological point of view, in a gradual and not necessarily dichotomous way, at the same time as in a register that is not always evident to the senses:

> "Technologies do not determine directions... At the same time that humans, when using technologies, use them in interactive situations... using and being used by technologies, and these relationships are always interactive, the possible uses are always ambiguous and multistable" [19, p. 131].

Both the notion of perception and embodiment raise the question of limits. In particular, this publication is of interest in that it encourages critical thinking about the technological implications of redefining these same limits. From the outset, cyberculture presupposes a juxtaposition between cybernetics and culture, meaning precisely that it is not possible, in contemporary times, to understand culture disconnected from technological experience [29]. Since its foundation, as outlined by Norbert Wiener [38], the discipline of cybernetics, initially conceived as the science of control, has become increasingly complex. Notably, in the 1980s, authors such as Turkle [37] contributed to discussions of cultural transformations at the level of identity, exploring the effects of technological devices on the production of a *second self*. In turn, Haraway is an author whose work is essential for us to rethink the paradigms and binomials —such as nature-culture, human-animal, and human-machine —that structure our thinking and have repercussions in the dichotomous view of race, gender, or other criteria of identity classification. In his famous "Manifesto" [14], a work produced in a specific socio-political context marked by the conservative government of Reagan and by important technological innovations driven by space exploration, Haraway challenges this paradigm, defending the hybrid character of our ontology. Authors such as Braidotti [5] have also focused on the problems of the post-human, based on the new experiences that technology has generated, with implications for feminist approaches, studies on the impact of technology on knowledge, and even on identities, whose nomadic and unstable character has been accentuated.

More recently, the effects of AI have been the subject of extensive discussion and study. In particular, the relationship between art and technology has always existed. Moreover, as Kerchove [10] argues, the very invention of language, and especially of writing, is, in itself, a "technological" structure, a "skin of culture". Even so, the dominant perspective, which understands technology as an instrument rather than a creative force, is what this publication seeks to counter. Although this is not a new relationship, what AI brings new are the new possibilities of neural networks, machine learning mechanisms, and the new possibilities for technological devices to acquire "learning capacity" through algorithms, already identified, namely by Hayles [17], as "emergency" capabilities that, in a way, seem to escape complete human control. In his media artwork, already foreshadowing some of the most complex current problems with AI, entitled "How Computers Imagine Humans?" (2017), João Martinho Moura warned: "Artificial intelligence (AI) can bring unprecedented benefits to society but also can generate risks from its misuse. Do not forget that AI is us, made by us, and it is being fed and improved by us every second"[1]. In the relationship between AI and art [35, 36] new challenges today lead to questioning the role of intentionality in art, the importance of the originality of the work, the issue of authorship (copyright and intellectual property), the replacement of the human being (autonomous agent) versus collaborative production, the recognition (disclosure) of creation by AI, the changes in the art market (attribution of value; art as investment), the reproduction of dominant patterns (uniformity) and mechanisms of exclusion and inequality, authenticity (an issue already identified by Walter Benjamin, regarding the most primary mechanisms of technical reproducibility) and artistic falsification, and also the impact on work and the disappearance of competences.

In addition, there is research that has discussed, through the study of the use of technology in art, the limits of the perception and ontological status of the human, from a philosophical and critical perspective, namely concerning the relationship with non-human entities, such as the works of authors such as Mengozzi [22] or Armand [1].

In particular, it is pertinent to this publication to consider artistic works presented as performances. More important than discussing what the works tell us, it will be essential to question what they do when they say, what their effects are in the production of the permanent reconfiguration of meaning. As early as 1962, the philosopher of language J. L. Austin challenged us with his famous work *How to*

[1] https://jmartinho.net/how-computers-imagine-humans/

do things with words [3]. Thus, by analogy with the linguistic model, it is necessary in this publication to think about language in act, in its triple locutionary dimension (the action of saying), illocutionary (the action of doing while saying), and perlocutionary (the effects of the performativity of language). For Parker and Sedgwick [27], it is especially relevant to discuss the performative dimension of language in the artistic genre of performance. What new uses of the instituted grammars are inaugurated by each performative act? What new potentialities (affordances)? How are new dramaturgies reimagined and fictionalized? Jacques Derrida and Judith Butler, in turn, contributed to thinking about how performativity contributes to the reconstruction of identities. From theatre to performance art (see, for example, Marina Abramovic's work), not forgetting computer simulations, the various ceremonials and conventions that mark the dramaturgies of the body have been, in different ways, rehearsed and deconstructed. More recently, performativity, initially associated, as already mentioned, with acts of language, has become a lexicon in its own right within deconstruction. In particular, there have been creative exercises that focus on signifying forms folded in on themselves, in the sense of their self-referentiality. The performative, therefore, often acquires a non-referential character (dispensing with a reference external to the act itself), characterized, instead, by a kind of mutual torsion between the performative and the reference. In this way, language, body, and identity [8] are permanently reconfigured with each new act. Representation (translated into the mimetic function or action of that which "is instead of") is not, therefore, what mobilizes performativity, which we perceive as an action of *doing* and not of *representing*. As an exercise that creates renewed meanings, "iterability" - pointed out in particular by Derrida - is an intrinsic resource for the performative act, by enhancing the repeated estrangement of codes and conventions and lending them new directions.

Bruno Latour [20] discusses the problem of entities in their condition of being in a necessary relationship with all the devices that produce the various entities with which we coexist. Existing is, therefore, a continuous performative act. Garoian and Gaudelius [13] discuss, drawing on the work of artists such as Stelarc, the exploration of the limits of the materiality of the body, taking into account the possibilities that technological culture offers. The authors say:

> "... embodiment carries with it an understanding of the cultural location and the specificity of the post-human body. It suggests a self-reflexive skepticism of our bodies, an unwillingness to accept their naturalized constructions. Embodiment is not about identity per se, a topic of earlier performative representations, but about subjectivity. As such, embodiment is not an immutable signifier of identity, but is a signifier of multiplicity existing within a complex web of cultural understandings and significations" [13, pp. 338-339].

The intersection between the performing arts, new media technologies, techno-culture, and human-machine interfaces has been the subject of several research studies in recent decades [2, 4, 6, 7, 9, 26], starting from a critique of the limits of Ihde's [19] post-phenomenology, since it is limited to an understanding of the static body and the perception of the individual subject and discusses the potentialities of "technoperformances", recognizing that "technology is not merely a tool but also takes on a stronger, often non-intended role: not so much as 'mediator' but as choreographer, director, and conductor of what we experience and do" [19, p. 557]. In line with the author's position, the agentive role of technology, accentuated by AI, is one of the dimensions adopted in this paper. Likewise, Coeckelbergh [9] considers the importance of using metaphor in such a creative context, an issue that we will also address, more or less explicitly, in our analysis, as a particularly stimulating strategy, with the aim of understanding, by analogy, the connections that cross different (sub)systems, in their implications with the status of the human and, in particular, its physicality. Ultimately, metaphors can be perceived as moving figures, which remind us that "humans are not necessarily the ones who are fully in control of the meanings, experiences, and actions" [9, p. 557].

2 EDNI: a case in discussion

About the project

At the intersection of performance and media art, Né Barros and João Martinho Moura have developed a work that articulates presence, memory, and the duplication of universes in alternative narratives. EDNI is a hybrid show where the body and the installation materialize a magnetic field, and the poetic relationship between necessary movement and deviant gesture is explored. EDNI features scenography by the FAHR 021.3 collective and performance by Vivien Ingrams, and is a co-production with Teatro Aveirense, within the scope of the National Capital of Culture.

The concept

EDNI is the expression for a *Dense and Not Unlimited Space* that João Martinho Moura uses to describe a space inspired by macro and nano spaces, with its particular characteristic of human extension through instrumentation. The density to which this space refers is one of its fundamental characteristics. Its density can be high or low, depending on the size of the light beams passing through it. It is a space that is intended not to be unlimited. This limit is understood as an important boundary, the *membrane* described by Maturana and Varela [21], or the *contour* described by Merleau-Ponty [23, 24]. With this positioning, we aim to move away from the intensely virtualized, boundless space. The *EDNI* space is not fiction; it exists in reality. For this project, EDNI takes the form of a magnetic field in which gesture tests forces in relation to distances.

The route

This new project, EDNI, follows on from Distante- Paisagens, Máquinas e Animais (2023), Una (2020), Co:Lapse (2018), Co:Lateral (2016), Nuve (2010), and Labio, a research laboratory whose title results from the union Lab with IO, two terms widely used in technological language and that together allow us to visualize a contact connection, give an image of approach, and carnal: lip. In Nuve, performed by Né Barros in 2010, the relationship between the choreographic body and its artificial double was explored in space-time, where it was projected and extended in an intimacy with the virtual. In Co:Lateral (2016), the immaterial space expanded, the image drew closer to the audience, and, between the moving body and the audience, transparent realities were presented, mixed, and incorporated. In an admittedly experimental approach, and from a perspective of installation and performance, Co:Lapse was also



Figure 1: Video frame of Né Barros by João Martinho Moura.

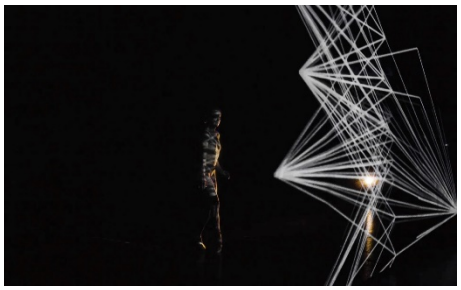


Figure 2: Co:lateral, 2016. Picture: Raúl Sousa

born in 2018, where much of what had been creatively explored in previous projects converged. UNA (2020) is an experience of total immersion where the audience, one spectator at a time, witnesses the body in motion, again expanding. Finally, in Labio (2022), the notions of contact and strangeness run through the performance, exploring the body and its virtual affiliations.

Dramaturgical Hypothesis

Device

In the center, one pendulum. In physics, studying simple harmonic motion is beneficial, as it helps us identify energetic imbalances in people, objects, or environments. In this theatrical space, the pendulum is a suspended point always in motion, even if micro, of apparent stability where the world is supported. Around it or on top of it, everything is movement, cycle, and repetition. On two side columns, two macro projections, produced by AI from real images of the choreographer and the performer. A performer who appears in dialogue with the pendulum, reproducing translational and rotational movements, evolving into a more abstract dialogue and ending in fusion with the pendulum, being part of its geometry.

Pseudo-alien birth

The performer detaches herself from the magnets. From here, it has a connection of forces and an umbilical cord. A metaphor of connections can be perceived. Throughout the piece, circles and cycles of gesture recur, alternating between mechanical and undulatory movements. In this journey, the body sheds its metals, its weapons. The body is initially a machine, dressed in metallic armor and extensions whose function is to fight and defend, to be attracted to and magnetized by the pendulum. In the end, the body becomes primordial, bare, and fused with the hardness of the material that supports it - two distant realities, yet complementary and limited. Should have been born naked, but we have reversed the meaning of the world.

Test the world

In performance, beyond the staged, the predetermined, there are moments of unpredictability in which attractions and repulsions are explored, and forces between the pendulum and the extensions of the body are tested. This body contrasts with the projected images, which are generated by AI and reinvent the choreographer's and performer's original ideas. The choreographer's matrix movement, reproduced by the performer's familiarity with gesture, places us in this illusion of continuity and what connects us in the same universe. This method of choreographic construction informs the various projects of Né Barros and, in EDNI, grounds the very determination of time and memory. The projected images of the two women embody the poetics of the images, evoking memory, distortion, and repetition. The women projected there are origins and developments, past and future, made of the same material. They are perfect in their contours, cadence, and strangeness. The distortion places those bodies on the edge of perfection and imperfection. With such a presence of images, the bodies on stage become minimal, points in space, more primitive beings, obstacles to the lightness of the images. The projected images are artificial trees that reproduce movements of the world. The bodies on stage are singular and busy machines that sometimes reveal their animal origin, just like horses, from the projected images, which reveal their anthropomorphized elegance.

Final: the collapse of images

The superimposition of all the elements, the flesh, the projection as texture, the metal, the magnetism, the gravity, the continuous movement in a non-unlimited space. A point of convergence for everything and procedural memory. The metallic extensions attracted by the pendulum recall how that woman's body was freed from its ties and its weapons, just as the image, projected on the body and the pendulum, creates a matrix of form that has become hyper-transformed, degenerating into formlessness. Rotation is the determination of a physical space that transcends us.

As mentioned in the device's description, the pendulum in this invented and performative space is a suspended point that is always in motion, bringing the world together and collapsing images and memories - end of cycle.

Analysis: methodological considerations

After presenting the object of analysis – EDNI – and recognizing that it is not possible to exhaustively frame all the multidisciplinary lines of inquiry that it triggers, we will then present some of the methodological options, as well as the structure of the problem that will guide us in the more detailed critical reading that follows. The analysis of EDNI took into account three axes of discussion, all of which were articulated in relation to the theoretical problematic that frames it. The first axis corresponds to the (un)limits that are produced in EDNI in an unstable way. In Merleau-Ponty's terms, a limit is understood as a permanently renegotiated boundary between one's own body and the surrounding universe [23, 24]. The metaphorical notion of "membrane", discussed by Maturana and Varela [21], in the sense of a limit that is situated between the self and the surrounding environment, designating a border that is both protective and restrictive, or even a self-regulated border that permanently rebalances the relationship between, by analogy, a given organism and its surrounding environment, is no stranger to this understanding. Furthermore, the term "relation" can be discussed

in this regard, considering its shift to the term "connection", once the (dis)limit is accepted as a fluid and porous threshold, permeable to the effects of mutual contamination and capable, in particular, of realizing, more than a relationship, a fusion between human bodies and technological devices [25]. It may be asked what transformations these limits produce in both embodied presence and virtuality. Additionally, this same threshold constitutes itself as a place between tensions and resistances, reconfiguring the unstable balance between centrality and deviation as perceived.

The second axis of the problem, as analyzed in this publication, concerns precisely the center-deviation binomial. On the one hand, we can today question AI in terms of its subordination to the more or less subtle mechanisms of individual and collective control of action. On the other hand, it is essential to examine its creative possibilities, its seemingly unpredictable character, and the sense of "emergency" already identified, in particular, by Hayles [17], which the new technological potentialities produce. It should be noted that the notion of cybernetics, founded by Norbert Wiener [38], is defined in itself as the science of control. Still in the 40s, understanding human behavior, by analogy with the machinic mode of functioning, was a priority objective aimed at minimizing deviations and the unpredictability of human action. Likewise, the communication models that emerged in the following decades, unidirectional, and that lasted until the 70s, some of them inspired by the theories of social psychology at the time, aimed to privilege the effectiveness and minimization of channel noise, to ensure the transmission of a one-way and controllable effect on the recipients.

Finally, the last axis concerns the coexistence of different temporalities. This means a critique of the linear time of utopian modernity [12, 18], that is, a critique of time subjugated to the logic of productivity and the principle of the division of labor or technological innovation. Instead of a single paradigm, which imposes the mechanistic experience of "clock time", we can admit the possibility of coexistence, not always harmonious, between different temporal experiences, from the time of "nature", marked by the cycles of ecosystems, to mnemonic time, which introduces into the present the irruption of the updating of past experiences, to the repetitive and circular time that the perception of sameness and routines, of everyday common life, stimulates [18].

From these three axes - (Dis)limits, Center-deviation, and Temporalities - we will attempt a brief analysis of EDNI (Non-Unlimited Dense Space).

For the purpose of analysis/reflection of the work EDNI, the following were considered: The face-to-face screening of the public presentation of EDNI, as part of the Serralves em Festa programme (30 May 2025); Informal conversations with the creators João Martinho Moura and Né Barros; Photographic images (EDNI production); EDNI public presentation texts (exhibition sheet and dissemination to the media); Fundamental theoretical/bibliographic references, some of them shared, defining a certain epistemological position on the relationship between the human (body) and the non-human; Previous collaborations and joint publications from Helena Pires, João Martinho Moura and Né Barros.

2.1 (Dis)limits

Examining EDNI, we can begin by asking: what defines embodiment when the body is present and reconstructed? What is the boundary between the real and the synthetic? In the words of João Martinho Moura and Né Barros, EDNI is a project that encompasses the cohabitation, at the level of perception, of three spatio-temporal stages: Virtuality, the presence (living body), and poetic incorporation; Thus, in EDNI, what is rehearsed are the limits of the body and the digital world. In the words of the creators, "as AI becomes more present, the performer faces another limit, struggling between organic and artificial presence"[2]. It should be noted that by artificial presence one can understand both the imagetic presence (projected photographic images, having Né Barros as a referential model of the image), and the objectual (sculpture in the form of a pendulum that is located on the stage where the performance takes place and with which the dancer interacts). In EDNI, through AI, reciprocity effects between the physical body and virtual reality are co-created. The weight, thickened by the dancer's body and the pendulum, is observed, and, on the other hand, the counterweight is illustrated by the lightness of the images (produced using AI). On the one hand, the stability of the physical bodies, on the other, the movement (of the performative body, but also the repetitive movement of the pendulum in the center, in addition to the fluid succession of images).

Another threshold is that between the organic and the non-organic, the performative and face-to-face body, and the post-photographic image (which does not necessarily establish a relationship with a real reference but is co-created using AI). As the creators say:

> "AI, in EDNI, acts as an artificial membrane, mediating between the live performer and her projected digital counterpart. The performer does not engage with a passive reflection of herself, but rather with an evolutionary and autonomous presence shaped by AI's capacity for synthesis and transformation"[3].

In this way, EDNI creates a liminal space, simultaneously physical and fictional, while also acknowledging the relationship between the dancer's body and the material body that counterpoints it on the physical stage. In one way or another, it is an unstable, fickle space. Namely, the projections of the images approach distortion, continuously transforming themselves into becoming-other images, in the manner of the rhizomatic assemblage problematized by Deleuze and Guattari [11]. As *Non-Unlimited Dense Space* (EDNI), the work under analysis is a composite space, co-constituted by human and non-human beings:

> "AI in EDNI is not just a tool, but an active agent in shaping presence, embodiment, and perception in a hybrid space where human movement is captured, synthesized, and reinterpreted"[4].

[2]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.
[3]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.
[4]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.

EDNI is a work stimulated by a set of complex questions that it is important to retain: How does a machine perceive and reconstruct the human figure? How does an artificial system project the body, identity, and presence? What are the limits of corporeality? Instead of opposition, we witness in EDNI the coexistence (not the full fusion) between human bodies and machines, observing a relationship of tension and resistance: "the primacy of flesh over code, of presence over simulation, and of nakedness over the algorithm"[5]. How is such a tense/confrontational relationship and, paradoxically, one of surrender configured? A more detailed analysis enables us to identify an indexical sense that the magnetic wires, metaphorically and by analogy with reins, are associated with the relationship between the horse (depicted in the images) and the machine, suggesting a symbol of the "domestication" of the machinic. In fact, we can ask ourselves whether the horse and the machine, as "prosthetic" extensions of the "natural" human body, impose themselves as figures of resistance, or not, to this same connection. In Haraway [15, 16], we find a broad discussion about the meaning of deconstructing the binomial "nature-culture". The naked female body is itself a symbol of "nature" ("nature" as a system of production and reproduction). Furthermore, the analogy between the naked body of the performer who "rides" the *pendulum* (already in the final part of the dramaturgy) and the relationship with the horse (an animal subjugated to a historical relationship of domination), symbolizing (and deconstructing) the binomials human-animal, human-machine, body-abstraction, reality-algorithmic construction, is a relevant aspect to retain. The question remains whether EDNI is, precisely, rehearsing, by analogy, the dilution of the boundaries between body, nature, animal, and machine. Is the organic body obsolete today, or is the body permanently reinvented in its relationship with the non-human? Talking about the perceptual limits of the co-creation of one's own body implies, briefly, discussing the triple problematic of agency, authorship, and, ultimately, the identity of the status of the human, which AI enhances: "AI operates precisely on this perceptual threshold, where the organic and the synthetic converge, questioning authorship, agency, and identity"[6].

2.2 Center-deviation

The relationship between the human and the non-human in EDNI is a poetic relationship between:

1) the mechanical and repetitive movement (paradoxically necessary for liberation and re-orientation to a center).

2) and the deviant, purposeless, contingent gesture.

Seeking the deviation of the single and vectorial direction, in EDNI, we witness the (ir)repeatable movement (movement that reproduces the same, but which at the same time is, by nature, ephemeral) of the sensitive body. In the first place, the mechanical, repetitive movement is symbolized by the pendulum's regular oscillations, a dense sculpture that, at the center of the stage, marks a mathematical division of space and time, indifferent to the perceptive experience of what is lived as performed by the dancer. The latter, in turn, sometimes approaches the pendulum, co-creating a choreography that incorporates this same regularity, thus metaphorizing a kind of condition of surrender, sometimes moving away, tensioning this same relationship with movements that vary between unbalanced, deviant gestures, and timely articulation, as if it were a two-voice staff, punctuated by order, but also by contingency and lack of purpose. Thus, in part, this relationship between the dancer's body and the pendulum becomes a dialogue among bodies, gravity, and attraction. The creators say:

> "A center oscillates, orients, and attracts, translating a limited and dense space that follows its laws. A pendulum is central, symbolizing human gravity, balance, and limitations. It exposes physical constraints, while magnetism suggests an artificial layer that surrounds the body, pulling it towards its center"[7].

The pendulum is thus an anchor and attractor, a constraint (symbolizing the density of the body) and freedom (suggesting that repetition produces a movement not of sameness but of reproduction that opens up to renewed possibilities of recreation), a combination of mechanical repetition and potential liberation from deviation. In the final analysis, the pendulum can be perceived as a metaphor for the living, moving body, at once a constrained body and a body that frees itself. In this regard, we can admit that EDNI questions us about the "natural" and cultural need for domination [14–16], as an ideological and political dimension (bio-political body), while opening space for the possibility of producing, from the conditions that apparently limit us, a creative and liberating relationship [19]. The "domestication" of the body is perceived as a non-unlimited phenomenon. Establishing an analogy between the relationship between the human and the horse, figured, as a metaphor, in the projected images, it can be said that also in its relationship with the virtual (materialized in the synthesis images), the human body (a bio-political condition constitutive of our ontology) is streamlined through an ambiguous space-time, between resistance and surrender, liberation and embodiment. In this permanent pendulum movement, it reconfigures itself into a body-other, assuming the opacity of its nature, necessarily unstable and emergent.

João Martinho Moura and Né Barros discuss a "poetic relationship between the necessary movement and the deviant gesture: freedoms and limits," as well as "(in)visible relations of force (and violence): distance and proximity". Thus, in EDNI, we observe the non-unlimited fusion of the body with technology. Contrary to the prosthetic body, what is proposed is the understanding of a body that resists and thus (re)exists. In this regard, it is appropriate to summon, in a symbolic way, the discussion developed by Maturana and Varela [21], according to which the body can be perceived as an autonomous (self-referential) living unit/system, characterized by circular organization and *autopoiesis*, which means by the ability to reconfigure itself in the face of the effects of mutual contamination generated by its relationship with the surrounding environment. It is not too much to emphasize, once again, that in EDNI, paradoxically, the body is both a body that resists and a body that surrenders, in a perpetual game of adaptation in the face of surrounding alterities and identity redefinition.

[5]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.

[6]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.

[7]Reproduction of an excerpt from the EDNI presentation briefing, provided by the creators.

Finally, still with regard to this axis of analysis, it is relevant to introduce the question of the centrality or deviation of anthropocentrism [32], a dominant paradigm in Western culture that is today shaken by the awareness of phenomena as pressing as the Anthropocene, on the one hand, and AI, on the other. In both cases, the recognition of the limits of human action, as well as the perception of its condition of interdependence vis-à-vis non-human entities, forces us to reposition the hierarchical and dominating structures of modern thought, in the face of the need to incorporate the multiple alterities with which we cohabit and which co-constitute us ontologically. Still, in EDNI, this position is not evident. The use of nudity (the dancer progressively undresses) may (intentionally or not) symbolically suggest a certain naturalistic and humanist essentialism. Admitting this interpretation, we are led to question whether we are facing a work that rehearses strategies of resistance in the face of the loss of human status, affirming, on the contrary, the remnants of a nostalgic and essentialist humanism.

2.3 Temporalities

Time, in EDNI, unexpectedly goes back, not as a repetition of the same, but as a memory that permanently (re)updates and destabilizes the sense of past, present, and future. Thus, we observe the "devolution" of the ephemerality, of the unrepeatable, to the past-present-future, through the permanent reintroduction into the present time of images of synthesis of the past, generated using AI, from which the cohabitation of different temporalities arises. In the counterpoint of speed (principle of modernity), the repetition of the non-sameness/the non-identical is what characterizes the temporal experience in EDNI. The female body, in particular, is perceived as an archetypal symbol of a mythical and original spatiotemporal paradigm, suggesting the enigmatic symbolic nature of the sphinx (in the case of EDNI, figured as the horse-woman/pendulum-woman), as discussed in Perniola [28], based on Egyptian art.

In EDNI, AI reinforces the notion of transtemporality, as movement, which is ephemeral, is reprocessed and reintroduced into space. Instead of a nostalgic feeling, which the perception of the "eternal return" could produce, we observe, instead, the redesign of feeling-with [30] as a trans-temporal phenomenological experience, not resulting from a linear and sequential notion, but, instead, defined as an objectual sensology [28], heir to a kind of "sensible communion", archetypal and primitive, with the universe, of which Merleau-Ponty [23, 24] already spoke to us.

Women (in both performative and face-to-face female bodies, on the one hand, and virtual imagetic bodies, on the other) constitute central figures, such as the pendulum itself, and are a fundamental element in this work. These bodies, transtemporal (displaced beyond historical time and presentification), evoke serenity and memory, embody the primordial and the sensual, and confront "a dramaturgy where the female body, the cosmos, the animal and the strange converge" [15, p. 12]. Some concerns plague us. Do we observe a body (or bodies, if we admit the face-to-face and the virtual body) that is freed by repetition (ecstasy) or just a sequence of machinic gestures, subordinated to a disciplinary temporality? By freeing ourselves, through a body-in-becoming that permanently overflows, we free nature from its absolute subjugation to (technological) culture [15, p. 12].

It should be noted that, as João Martinho Moura and Né Barros put it in EDNI, the "Representations of women evoke serenity and the suspension of a memory of a matrix and sensual body, unveiling the female condition as trans-temporal images"[8].

Thus, presence, matter (density), and memory tie the ontology of the human to a kind of salvific gravity that prevents the absolute dematerialization of one's own body, and thus avoids the total loss of identity meaning. As a bargaining chip, the permanent instability of the co-creation of space-time, of being and of doing is assumed, after all, the condition of the post-human that is not subsumed to a dialectical overcoming of an antithesis, but rather surrenders to the unpredictable performativity of a dance whose choreography is not, definitively, pre-designed.

3 Final considerations

In EDNI, the body is inscribed halfway, between freedom and surrender: "EDNI does not use AI as an external imposition, but rather as a dialogical force, exposing the tensions between organic and synthetic movement, control and unpredictability, and memory. It becomes a poetic and performative AI that does not replace the body, but that prolongs, distorts and reimagines it, making the performer a liminal entity between the human and the machine, between the past and the present, between control and delivery"[9].

Can we read, in this project, the tragic condition of the living body? AI, in EDNI, is not a mere aesthetic choice, but an ontological question – a challenge to the nature of presence, authorship, and embodiment in the post-digital age. Not being understood, or used, as a mere external tool, AI is, in EDNI, "an agent of perception and transformation"[10], interposing itself on the threshold of presence and absence. Thus, this essay calls for a redefinition of the limits of the self and embodiment. Returning to the membrane, as a metaphor, adopted from Maturana and Varela [21], one can here think of the EDNI performance itself as a membrane, a porous threshold of permanent exchanges between the physical and the digital. What is rehearsed in this project, on a subjective scale, can be extended to a broader consideration of the relationship between our contemporary society and technology, a relationship shaken by the vulnerability of the boundaries that make it difficult to distinguish between human agency and machine autonomy.

The body is the in-between, mutant and unstable, in redefinition of its relationship with the universe and with the other bodies with which it cohabits, a world "increasingly populated by synthetic entities, algorithmic decisions and hybrid identities"[11].

In its post-phenomenological condition, the body is a body-in-becoming-with, an agentive and mediated body, a composite body, co-created in its ambiguous and opaque relationship with technology. In this essay, we aim to explain the terms of our identity and ontological condition, acknowledging the forces of resistance, particularly epistemological, that still shape our thought structure.

[8]Reproduction of an excerpt from the EDNI presentation briefing provided by the creators.
[9]Reproduction of an excerpt from the EDNI presentation briefing provided by the creators.
[10]Reproduction of an excerpt from the EDNI presentation briefing provided by the creators.
[11]Reproduction of an excerpt from the EDNI presentation briefing provided by the creators.

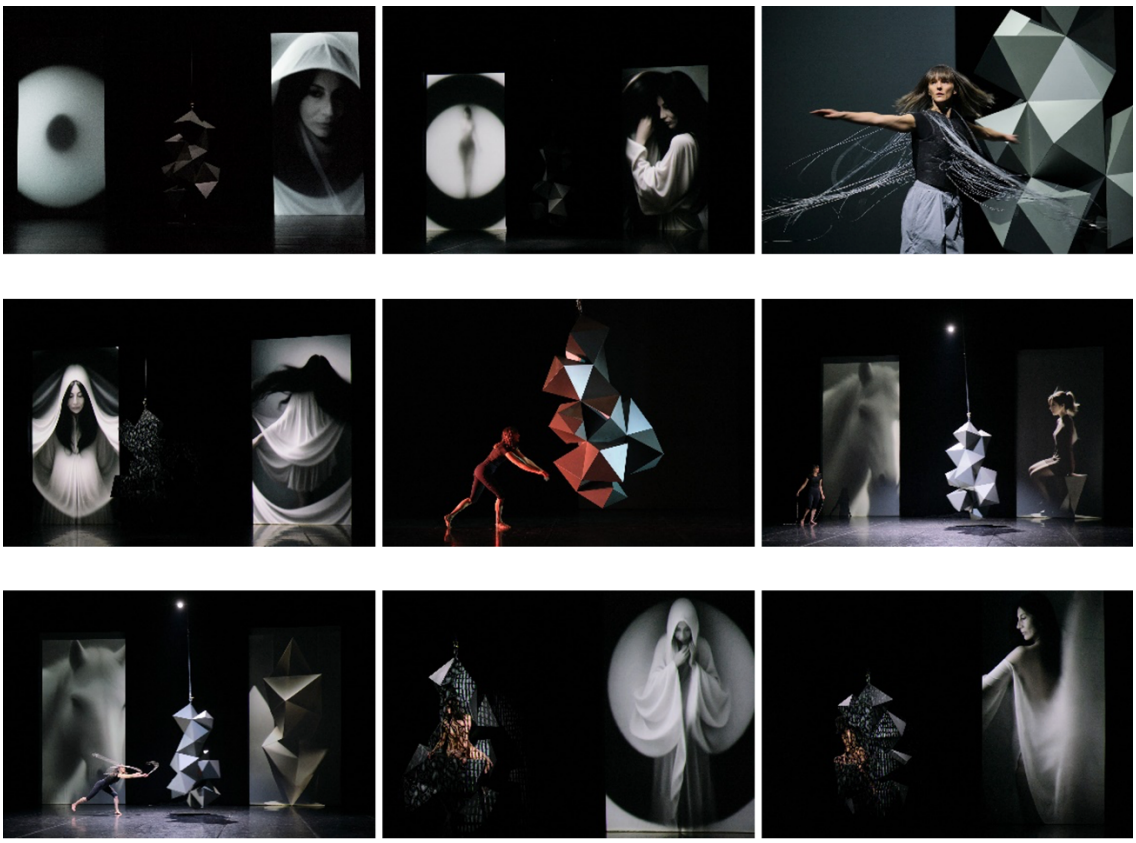


Figure 3: EDNI presented at Aveiro, Portuguese Capital of Culture 2024. Pictures Susana Neves.

Even so, we aimed to adopt a perspective distant from the shackles of anthropocentrism, avoiding alignment with a catastrophic position or a blind, hasty dazzle.

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Eros, Constructor of Identities

An Object based Videotaping Project

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Abstract

This article provides an analytical and methodological approach to the artistic research project, "Eros, Constructor of Identities", an object-based videomapping installation that operates as an aesthetic-methodological apparatus for critical praxis and media literacy. The work is founded upon the articulation of Martin Heidegger's critique of technology (the Gestell), Zygmunt Bauman's sociology of identity dissolution (Liquid Modernity), and Byung-Chul Han's philosophy of overexposure (The Transparency Society). It is postulated that the intrinsic collision between the ephemeral digital image and the Crystal Body promotes an act of phenomenological resistance that interrupts the ontological reduction of Being to Bestand (standing-reserve of resources). The analysis focuses on unveiling how the instrumentalization of desire and the mandate of compulsory gender performance are co-opted by the logic of performance. Through the study of the technical processes of mapping and masking, the article establishes that these function as operative metaphors for the calibration and psychological editing of the self in the face of the algorithmic gaze. Finally, it is argued that the aesthetic shock generated by the work is a mechanism to restore meditative reflection (Sorge) and project the urgent need for a sustainable psychosocial ecology against the precarity and agony of Eros in the Non-Thing society.

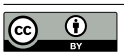
CCS Concepts

• **Applied computing** → Arts and humanities; Arts and humanities; Media arts.

Keywords

Object-Based Videomapping, Artistic Praxis, Performative Objectification, Psychosocial Ecology, Projection of Identities, Care for Being, Technology

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1 Introduction

The comprehension of the contemporary subject demands a profound inquiry into the technological and sociological matrix that shapes it, a matrix articulated around a triple crisis: ontological, sociological, and ethical. Martin Heidegger defined the ontological crisis as the Gestell (Enframing) [1], the metaphysical essence of modern technology, whose imperative is to mobilize, order, and summon the totality of beings, including Being (Dasein), to present themselves exclusively as Bestand (standing-reserve), a resource available for calculation and maximum exploitation. This coercion into Bestand is the root of the ontological unsustainability of contemporary existence, where calculative thinking (rechnendes Denken) absolutely displaces meditative thinking (besinnliches Denken) and its consequent Sorge (Care).

This existential instrumentalization merges with the sociological crisis. Zygmunt Bauman described Liquid Modernity, a context where identity becomes unmoored from traditional institutions and transforms into a provisional project, a performance of constant self-creation marked by obsolescence and precarity [2]. In this incessant flow, Byung-Chul Han situates the ethical crisis, characterized by the transition from the Thing, anchored in matter, history, and resistance, to the Non-Thing, an unceasing flow of intangible information, data, and communication that substitutes presence and closes off the experience of deep meaning [3].

The object-based videomapping project "Eros, Constructor of Identities" [4] emerges as a device for active resistance and a counter-device that, paradoxically, utilizes technology to deconstruct the mandates of the Gestell. The work seeks to interrupt the logic of efficiency by confronting the reduction of the self to mere productive data and proposing the rehabilitation of Sorge through aesthetic alienation. The central thesis of this research is to unveil how the methodology of projection onto the Crystal Body manages to articulate a critique of the dissolution of Being in the digital age.

It is fundamental to differentiate this analysis from other works derived from the same creative project. A prior approach, titled Proyección de Identidades Fragmentadas (Projection of Fragmented Identities), focused on the artistic production methodology and the technical potential of object-based videomapping as a form of audiovisual narrative [5].

The present article, in contrast, executes a shift in the research paradigm, utilizing the already produced artwork as a sociological case study. In this way, the central question shifts from how art is made to generate knowledge to what art reveals about gender and power dynamics in the digital sphere, focusing on the critique of the body, performativity, and affective capitalism. The integration of gender performativity within the paradigm of the Self's

Unsustainability, therefore, constitutes the new, unprecedented, and substantial focus.

2 Philosophical and Sociological Framework

The theoretical framework of the work is constructed from a cross-reading that diagnoses the crisis of the subject through the convergence of the philosophy of being, the sociology of fluidity, and cultural criticism.

2.1 The Tyranny of the Gestell, Provocation, and the Instrumentalization of Dasein

The Gestell compels Being to enter a mode of purely calculative thinking, focused on efficiency, control, and predictability. This instrumental thinking displaces meditative thinking, which is what allows Dasein the profound questioning of the meaning of Being and authentic existence. The human being's renunciation of thinking about Being is the direct consequence of this enframing [6].

The loss of Sorge (Care or the fundamental concern for Being) is the most tragic result. In the performance society, time and energy are dedicated to self-optimization to increase the value of the personal profile (Bestand) instead of to the care of authentic existence and genuine relationship with the other.

The work "Eros, Constructor of Identities" seeks to reintroduce the concern for Being through alienation. By colliding the digital image with the fragility of the support, it forces the audience into prolonged and careful attention to the phenomenon, halting the passivity of media consumption and reintroducing the possibility of meditative reflection in that instant.

2.2 From the Thing to the Data Flow

Han's critique of the Non-Thing explains psychic and social dematerialization [3]. The Thing possessed aura, history, silence, and resistance, which allowed for a meditative relationship. The Non-Thing, information, data, the digital image, is ephemeral, noisy, and compels an incessant flow. The primacy of the Non-Thing transforms identity into a semiotic construct, a collage of dislocated and disposable information. The speed of the feed prevents the sedimentation of experience and the formation of deep memory, forcing identity to be a chain of performative instantswithout ontological continuity. The ultimate form of Bestand in this context is Big Data, the total reserve of human actions and emotions, ready for analysis and commercialization.

In the face of this dematerialization, object based videomapping proposes an anchor by using the Crystal Body, due to its fragility, its volume, and its capacity to refract, multiply, and distort light, operating as an Active Optical Interruption Device. By forcing the digital image (the Non-Thing) to collide with a materiality that disorders it, the work symbolizes that the Self is a vulnerable Thing that requires Sorge and resists total reduction to transparency, proclaiming the return of the material.

2.3 The Agony of Eros, the Loss of Distance, and Affective Capitalism

The ethical crisis manifests itself in the affective sphere, where Han diagnoses the agony of Eros [7]. Hyper-transparency and the coercion of performance instrumentalize desire. Eros, which is the engine of the search for alterity and wonder, is transformed into a self-exposure strategy to generate emotional capital [8]. Relationships become transactional, and the subject submits to an economy of visibility, where the value of the self depends on its capacity to be consumed and validated by the algorithmic gaze.

Furthermore, this dynamic of total transparency entails the loss of critical distance. Without distance (or Benjaminesque aura [9]), there is no space for reflection or mystery. Identity is subjected to the Society of the Spectacle, where life is no longer lived, but represented [10] (Figure 1). The fragile and ephemeral nature of the videomapping acts as a metaphor for this spectral existence: the self only exists while it is being projected and consumed in the feed, confirming the vulnerability of an existence constructed as a simulacrum for consumption.

3 The Psychopolitics of Calibration and the Censorship of the Self

The installation uses advanced videomapping processes (the editing of Mapping and Masking) as a research-practice model that offers a homologous reading of the psychological processes of construction and management of the self's social image, specifically in how the individual calibrates their inner self with external reality.

3.1 Mapping and Failed Mimesis

Mapping is a process of projection, perspective correction, and geometric calibration between flat digital content and the irregular three-dimensional surface. The deformation (warping) of the image seeks the illusion of unity, but on crystal, mimesis is unsuccessful due to inherent refraction. This technical difficulty is a direct analogue of Psychological Calibration and its limits.

Social adaptation compels the individual to map their self-concept onto external expectations, seeking visual congruence between the digital profile (flat image) and the physical/psychic body (3D object). The single-channel projection, in contrast to its multi-channel appearance, corresponds to the self's need to achieve inter-role coherence in social and work life (Figure 2). However, the impossibility of perfect alignment on the crystal becomes the reflection of the psychological impossibility of total transparency, leaving a remnant of Being that cannot be measured or projected. This remnant is the Shadow, essential for psychic sustainability.

3.2 Masking and the Biopolitical Discipline of the Image

Identity is a narrative flow in constant re-editing (Figure 3). Videomapping allows for the deconstruction and reconstruction of the object's appearance in real-time, reflecting Self-Editing and the Psychopolitics of the self.

Masking is the technique of digital concealment that controls visibility. This control is the operative metaphor for Psychic Censorship and the disciplining of the self [11]. The subject, aware of algorithmic surveillance, applies masking to their own life, selecting which aspects are socially profitable and which must remain secret or repressed. Masking ensures that only "curated" content is projected. The manipulation of light (what is seen) and shadow (what is hidden) in the mapping onto the crystal becomes the visual



Figure 1: Stills from the video creation for the "Eros Identity Builder" Videomapping. Photographs by Shaula Ortega



Figure 2: Installation "Eros Identity Builder" Videomapping. Photographs by Shaula Ortega



Figure 3: Stills from the video creation for the "Eros Identity Builder" Videomapping. Photographs by Shaula Ortega

representation of the struggle for control of the personal narrative against the coercion of total visibility. The work exposes that masking is, paradoxically, both a tool for survival against transparency and an act of self-discipline.

4 Critical Analysis

The instrumentalization of Being manifests with particular violence in the sphere of gender and identity, where the personal Bestand is differentially valued, crystallizing the concept of Performative Objectification.

4.1 Unpaid Affective Labor and Biopolitical Control

The concept of Performative Objectification articulates gender performativity with market logic [12]. It is argued that gender performance online transforms into a form of unpaid affective and aesthetic labor that sustains the economy of attention.

The demanded hyper-visibility affects differently, identities devalued by the hegemonic system (women, racialized bodies, nonbinary identities) are subjected to constant aesthetic scrutiny that prioritizes their adherence to an idealized beauty canon. Their value as Bestand is tied to their aesthetic and affective availability. This is not just a matter of image, but of biopolitical control over the body and its representation, where the self must produce constant value for the system, even through the controlled exhibition of vulnerability (Performativity of Fragility). The work unmasks this dynamic by using the vertical format (1080x1920) of social networks, making what is quickly consumed in the palm of the hand now consume the spectator in the installation space, reversing the power dynamic of the gaze.

4.2 Aesthetic Fragmentation and Reduction to Commodity

The aesthetic of the videomapping, built from a visual collage of stereotypical images that overlap, is the diagnosis of fragmentation as psychic collapse. The subject is divided between the Authentic Self and the Algorithmic Self, consuming itself in the futile task of reconciling its freedom with the systemic need to be productive data (Figure 4).

This division is reflected in the commodity-form of digital identity [13]. The self is fragmented into consumable pieces (the post, the story, the reel), each fragment designed to maximize engagement and, therefore, exchange value. The visual multiplicity generated by the crystal and the mapping superimposes these fragmented layers, forcing the spectator to experience stereotypical saturation and the loss of the uniqueness of Being. Aesthetic fragmentation is, in this context, the materialization of the reduction of Being to interchangeable products.

5 The Act of Resistance and Psychosocial Ecology

The project transcends diagnosis to propose a path of resistance through aesthetic experience, promoting a new model of relational existence.

5.1 The Semiotics of Error and Phenomenological Interruption

The choice of the Crystal Body is the main interruption strategy. Its refractive nature multiplies, distorts, and disperses the projected light, preventing the perfect geometric alignment of the digital image. The crystal, as a physical negation of the digital plane, denies the uniqueness of Bestand and its promise of total control.

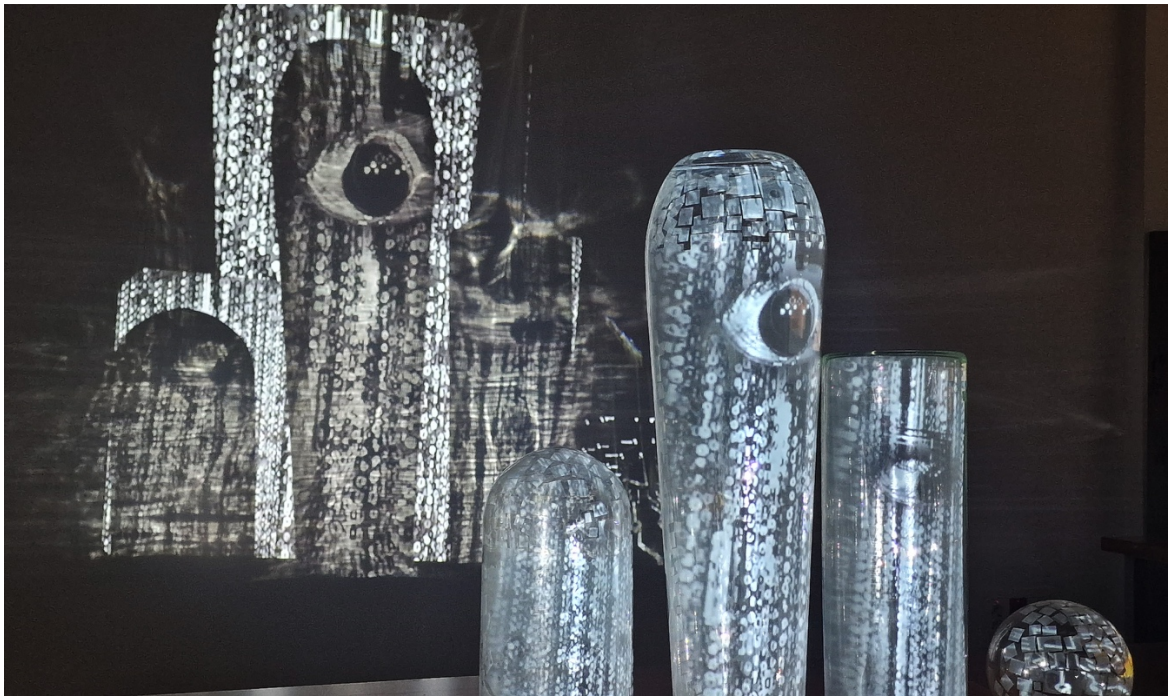


Figure 4: Installation "Eros Identity Builder" Videomapping. Photographs by Shaula Ortega.

The work applies Shklovsky's concept of Estrangement [14]. The spectator is forced to see the image struggling to adhere to the surfaces. In that cognitive lapse, in the consciousness's effort to reorder perception, a space of suspension opens up. This aesthetic shock compels meditative reflection and detachment from the logic of efficiency. The glitch (the technical failure) is incorporated as the semiotics of error, a "system noise" that is resignified as the voice of critique and the revelation of the self's own imperfection, the place where the possibility of Alétheia resides.

5.2 Towards a Politics of Safeguard and the Sustainability of Being

The emancipatory potential of art resides in its capacity to generate critical consciousness and promote a more ethical model of relational life, in line with the concept of sustainable psychosocial ecology. This concept encompasses the sustainability of Being and relational life in a hyper-technified environment, where Sorge becomes a politics of safeguard.

The Crystal Body, fragile and vulnerable, symbolizes that existence is not an infinite resource, but a Thing that requires care. The installation breaks the habit of distraction, encouraging an active and reflective gaze. By exposing fragmentation, the work promotes a Collective Identity based on social critique, in opposition to the narcissistic identity. A sustainable psychosocial ecology demands the de-instrumentalization of Eros and the body, advocating for a social system that values difference, shadow, and non-coherence, freeing the self from the tyranny of perpetual performance. Art becomes the space for withdrawal and meditation, the place where Sorge can be practiced as political and ethical resistance.

6 Conclusions

The research and analysis of the project "Eros, Constructor of Identities" confirm the central hypothesis that identity construction in the digital age is profoundly mediated by the Gestell and affective capitalism, manifesting in patterns of self-exploitation and performative objectification with a specific impact on gender identities under the perpetuation of marked stereotypes.

The project demonstrates the capacity of digital art to operate as an essential critical discipline, subverting its own technique to generate a profound dialogue with the sociology of crisis and the philosophy of Being. By using crystal as a mirror of fragility, and remix and appropriationism as a diagnosis of stereotypical saturation, object-based videomapping achieves a semiotic deconstruction of imposed regimes of visibility.

Its main contributions lie in articulating the crisis of identity as a crisis of human sustainability, linking gender performativity with psychic exploitation under the logic of Bestand. The subversion of videomapping through the objectivity of the crystal and the resignification of mapping and masking as metaphors for control and psychic censorship. Acting as a device of unconcealment (Alétheia) that generates critical thought through aesthetic shock and the interruption of spectator passivity, re-enabling Sorge as a political and ethical practice.

The interpretive results confirm that the project achieves its objective of generating an intimate confrontation and active reflection, essential for critical digital literacy and the promotion of a Being that prioritizes authenticity over the mandate of perpetual visibility, establishing the foundation for a sustainable psychosocial ecology based on Care and Safeguard.

Acknowledgments

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Three Languages of Artistic Research – Precious Multitudes as a Performative Documentation of Research in New Media Art

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Abstract

This work explores the innovative intersection of artistic practice and academic communication, focusing on the use of augmented reality (AR) comics as documentation of artistic research. It builds upon the premise that traditional scholarly formats often fail to encapsulate the nuanced, multifaceted nature of the research process, particularly within the context of Human-Computer Interaction (HCI) and artistic methodologies. By employing a case study of the performance *Precious Camouflage,* the paper illustrates how a non-linear narrative integrated with hand-drawn illustrations can convey *felt knowledge* that transcends written documentation. Comics inherently accommodate complex narratives that represent multiple perspectives and temporalities, thus serving as a potent medium for expressing such intricate experiences. Furthermore, the work suggests that AR does not merely enhance visual storytelling; it enables *thick documentation* that encapsulates the contradictions and ongoing uncertainties inherent to artistic research. This aligns with prior discussions on somaesthetic design, which prioritize embodied experiences in HCI research. Last, the proposed methodology seeks to contribute a new dimension to the conversation on how artistic research can coexist alongside traditional academic outputs. It underscores the importance of documentation as an active participant in the research journey, rather than an afterthought, presenting an approach that values the unfinished and evolving nature of artistic research.

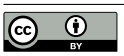
CCS Concepts

• **Human-centered computing** → Visualization; Visualization theory, concepts and paradigms.

Keywords

Artistic Research, Embodiment, Choreography, Comics, Augmented Reality, Lecture Performance, Felt Knowledge, Media Art, Media Aesthetics, Languages

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1 Introduction

«LA SIMULATION N'EST PLUS CELLE D'UN TERRITOIRE, D'UN ÊTRE RÉFÉRENTIEL OU D'UNE SUBSTANCE. C'EST LA GÉNÉRATION D'UN RÉEL SANS ORIGINE NI RÉALITÉ»[2]

Nature is staged – there is no such thing as untouched wilderness, opens the graphic novel *Multitudes*, an augmented comic about artistic research in AI and humans, connected to the fields of art and contemporary dance. This statement, illustrated through the metaphor of safari parks where what appears to be freedom is a carefully orchestrated illusion, serves as a firm, framing entry point into the fundamental challenge of documenting artistic research. Just as safari parks present a hyperreal version of nature – optimized for visibility, safety, and prepared for entertainment and consumption – traditional academic documentation formats transform the embodied experiences of artistic research into something tamed, measurable, connectable, and consumable. This paper presents an alternative approach to documenting artistic research through an augmented reality comic that explicitly resists such taming. Using the dance performance *Precious Camouflage* as a case study, we demonstrate how the combination of hand-drawn illustrations, non-linear narrative, and AR technology can preserve what Klein calls a felt knowledge [11] – the embodied, non-verbal insights that emerge through artistic practice yet resist linguistic written capture (Figure 1). The work follows the notion that everything is language and that non-verbal knowledge can and needs to be expressed by other than written language.

The comic is thus a presentation of the seeking of languages and to document a research process by means of a visual narrative, alternative to what would usually be done in these different fields using scientific publications, experiments, statistics, and other objective tools (Figure 2). The comic itself embodies its central thesis that there is no absolute reality. Through five chapters exploring perception, intelligence, bias, and human-AI interaction, it presents multiple, sometimes contradictory perspectives on the same research journey. Additionally, to explaining or translating the artistic research, the comic performs it, creating what Baudrillard might recognize as its own simulacrum – a reality without origin that nonetheless reveals truths about our relationship with technology [2, 19]. Apart from the book form and the different hand-written narratives presented in print, there is an AR layer to download from Appstore and Playstore, for both, handheld device and Apple Vision Pro. In this text, we propose the augmented comic as a new documentary form for artistic research that preserves ambiguity and multiplicity. We demonstrate how this format can bridge the gap between artistic and scientific communities in Human Computer Interaction (HCI). This is done offering a concrete example



Figure 1: Selected pages of the Artistic Research Comic *Multitudes*, Credits: Triebus

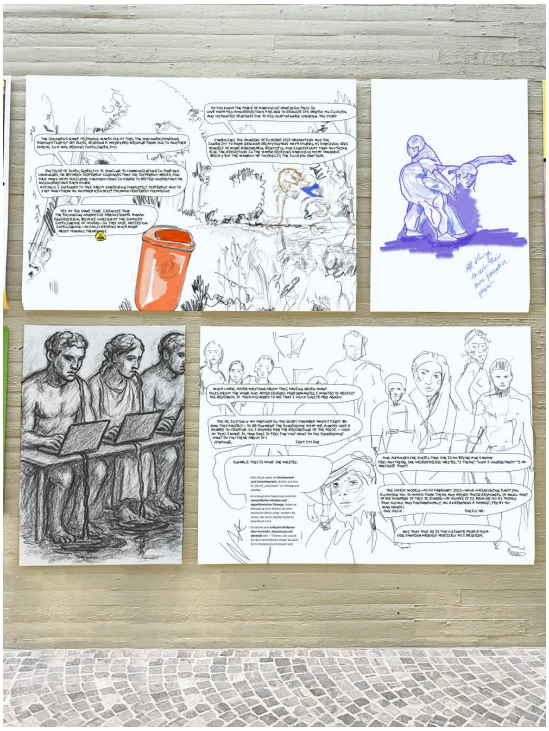


Figure 2: Selected pages of the Artistic Research Comic *Multitudes*, Credits: Triebus

of how research in art can generate knowledge that complements traditional academic outputs without being reduced to them [4].

2 Background & Related Work

The integration of artistic research into HCI represents a growing recognition that traditional scientific methods alone cannot fully capture the complexity of human experiences with technology. Borgdorff distinguishes between research about art, research for art, and research in art – with the latter being most relevant to our work. In research in art, the artistic practice itself becomes both the method and the site of knowledge production [4]. Recent HCI research has increasingly embraced artistic methodologies. Höök et al. advocate for somaesthetic design that centers bodily experiences [8], while Benford et al. explore how performance can reveal new insights about interactive systems [3]. Nevertheless, a persistent challenge remains: how to document and communicate the felt knowledge that emerges through artistic practice without reducing it to propositional statements. Traditional academic publishing formats – with emphasis on linear argumentation, reproducibility, and verbal precision – often fail to capture the multisensory, sensual, ambiguous, and embodied nature of artistic research. Eisenstein notes in his film theory, "the artist thinks directly in his materials... The thought passes immediately into action, which is not 'formulated' as a formula but as form" [6]. Previous attempts to address this challenge include books and pictures, video documentation [15], interactive websites [5], and exhibition formats [14]. While valuable, these approaches often maintain a separation between the documentation and the research itself, treating documentation as a post-hoc translation rather than an integral part of the research process. Comics have emerged as a powerful medium for academic communication, particularly in fields requiring visual thinking [16]. Their combination of image and text, sequential narrative, and ability to represent multiple temporalities simultaneously makes them well-suited for capturing complex, non-linear research processes [12]. Jönsson and Grafström proposed that comics effectively serve as a medium for reexamining and disseminating scientific knowledge, makings the (un)written word visible, and providing opportunities for dialogue between researchers and the wider public [10]. Augmented Reality adds another dimension, allowing for layered information, interactive elements, and the coexistence of multiple realities within a single artifact. Furthermore, studies indicate that incorporating AR technology into comics can boost their appeal by inviting audiences to engage with the content in innovative ways. For example, Bala et al. reported on a transmedia project that integrates AR scenes within a non-linear comic narrative focused on animal welfare, showcasing how storytelling can address and critique social issues [1]. AR comics elevate the aesthetic experience by allowing readers to interact with comic panels in a dynamic and multi-dimensional manner. The ability to incorporate animated elements, sound, and other digital enhancements draws readers deeper into the story, fostering a more profound connection with the material. Recent work in AR storytelling [9] and interactive narratives [13] suggests the potential for AR to create what we might call thick documentation – preserving not just

outcomes but the messy, multiple, contradictory nature of research itself. Thick documentation refers to a form of documentation that, akin to Geertz's concept of 'thick description' [7], not only records events or actions but embeds them in their cultural, social, and affective context to convey meaning beyond the observable.

To summarize, comics offer a novel alternative approach to artistic research, especially when XR technologies are used to enable a more intense aesthetic experience than traditional graphic representation on paper. In the following we present how we realized this in our artistic project *Precious Camouflage.*

3 The Three Languages of *Precious Camouflage*

The research journey of *Precious Camouflage* exemplifies a threefold approach to accompanying artistic research – three distinct yet interconnected languages, with own qualities, historic traditions and starting points, that each capture different dimensions of the same investigative process. Instead of treating documentation as a post-hoc translation of artistic work into academic discourse, this approach recognizes that each language in the broadest sense generates its own form of knowledge while remaining in productive dialogue with the others. A take on the topic of language is set on the first page of the book, which is held in French, although the rest of the book is written in English and German. The French part can be directly translated into English/German via the AR layer and serves thus as a direct affordance to download the App [19].

3.1 Language 1: The Performance *Precious Camouflage*

Precious Camouflage premiered in June 2024 as a live dance performance featuring four human dancers and four AI systems interacting in real-time within a museum space defined by five LED screens [18] (Figure 3). The performance operates through communication loops – continuous cycles where dancers' movements are captured by cameras, processed by four distinct AI systems (Classification AI, Descriptive AI, Generative AI, and Water AI), and reinterpreted as visual and textual outputs that then influence the dancers' subsequent movements. The loop functions as a refinement of a cyclic process and is therefore comparable both to a helix structure and to the lands the children's telephone game (Figure 4). This first language is the embodied knowledge generated through the performance itself. As documented in the research, the performance revealed unexpected boundaries in AI interpretation, particularly around bodily fluids. The AI systems consistently refused to generate images of drooling dancers, despite having no ethical restrictions on other bodily representations. This discovery became central to the work's dramaturgical development, with drooling incorporated as a deliberate act of resistance against technological categorization. The performance's temporal structure – with its reaction gaps where dancers could respond to live-generated AI content – created what the documentation describes as emergent choreography where neither human nor system clearly control, and dance emerges from their mutual interaction. This first language is a felt knowledge that emerges in the fugitive instant when performing the artwork - also through the live encounter between human bodies and technological systems. One should note: the first language means the dance piece - the documentation in forms

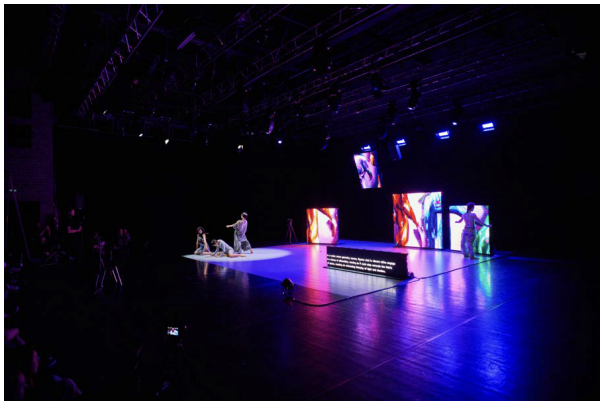


Figure 3: Impressions of the Work *Precious Camouflage,* Credits: Essex



Figure 4: Impressions of the Work *Precious Camouflage,* Credits: Essex

of video recordings and description and classification of the piece are already acts of translations.

3.2 Language 2: Academic Publications

The second language manifests in academic documentation and discussions of both – the upcoming research but also its results, such as this present paper or the paper discussing the performance itself, such as the paper of Triebus et al on an AR dance performance with an avatar or similar works [17]. This second, academic language employs theoretical frameworks including posthumanism, actor-network theory, and critical AI research to analyze the performance's implications for understanding human-AI relationships. This language provides analytical distance and contextual grounding. It positions the work within existing scholarly discourse while introducing concepts like the *body fluid boundary* as a site where moral judgments about 'proper bodies' are encoded within seemingly objective technologies. The academic language translates experiential findings into propositions that can engage with broader theoretical conversations about agency, embodiment, and technological bias. Crucially, this language reveals patterns invisible during the performance itself. The academic analysis identifies

how the AI's shifting stance on drooling – from categorical refusal to apparently thoughtful engagement – demonstrates critically how sustained artistic dialogue can expand interpretative frameworks.

3.3 Language 3: The Augmented Comic *Multitudes*

The third language emerges through *Multitudes*, an AR comic that neither explains nor translates the artistic research but performs it through its own medium-specific capabilities [19]. The comic finds no referentiality in other forms, neither when it comes to documenting artistic research nor when it comes to discussing scientific content (Figure 5). It is described best as a graphically felt lecture performance. The comic's five chapters (1) Realities & Memory, (2) Stories/God/Shamanism/Body, (3) Intelligence/AI/Bias, (4) *Precious Camouflage,* (5) Precious Feedback – create multiple, sometimes contradictory perspectives on the same research journey. The comic employs what we term a narrative strategy of establish and break. For example, page 7 establishes the classical Narcissus myth as authoritative narrative, then disrupts this authority by drawing parallels to AI's human-centric interpretation patterns (Figure 6). Similarly, page 13 presents the Turing Test with scientific gravity, only to undermine it through the absurd detail of "telepathy-proof rooms," revealing the historical contingency of what we consider serious AI research. The comic's visual language – deliberately sketchy and unfinished – resists the polished aesthetics typical of scientific illustration. This aesthetic choice brings forth Klein's felt knowledge by refusing to domesticate the messy, but sensual, contradictory nature of artistic research [12]. The telephone game structure, where meaning transforms as it passes from panel to panel, mirrors the communication helix of the performance while exploring how misunderstanding can be a productive state. The AR component does not lead away from the comic but deepens the debate with the book and the discourse/ knowledge (Figure 7). Four distinct modes of interaction and augmentation are introduced that extend the comic's capacity to preserve multiplicity. Some modes are intertwined and form hybrid experiences:

- **Documents and Sources:** Physical materials – Wikipedia entries, book scans, historical artifacts – appear as if lying beside the comic, suggesting a workspace where research materials accumulate organically rather than being hierarchically organized. They are accessible as further and deeper information.
- **Saliva as Environmental Element:** Digital saliva surrounds and permeates the comic pages, creating a world that wraps around the comic. This transforms the body fluid boundary from a conceptual limitation into an immersive environment. It ranges from fountains, rains, sculptures to typography of puddles.
- **Interactive Elements:** Moments where readers can see themselves reflected, most notably in the Narcissus sequence, where after the Narcissus graphic as a marker, a pond runs downward out of the page, where one can see oneself mirrored. The reader can touch the puddle and enter with the handheld device into the 3d situation as if it would be a room opening.



Figure 5: Prototype of AR Extensions of the Comic *Multitudes,* Credits: Triebus

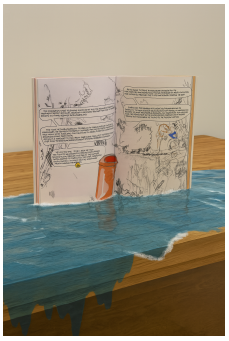


Figure 6: Prototype of AR Extensions of the Comic *Multitudes,* Credits: Triebus

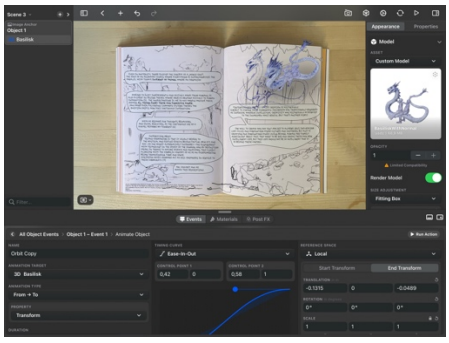


Figure 7: Prototype of AR Extensions of the Comic *Multitudes,* Credits: Triebus/ MIREVI

- **Animated 2D Aesthetics:** Background elements – forest scenes, runway models, planets – become animated while maintaining their hand-drawn quality, creating conceptual *loops/gifs* that bring stillness into motion without losing the comic's essential sketchiness.

4 The Comic as Artistic Research Documentation

Multitudes functions as both accompanying documentation and continuation of the artistic research initiated by *Precious Camouflage*. It avoids explaining the performance, but performs what lead to it, thus being an *act of offering* and a soft layer of an artistic experience itself. With the meta question - what is research, and do we have to decide what form it takes - the comic performs its own investigation into the questions of perception, intelligence, and human-AI relationships that emerged through the dance work. Through its specific medium capabilities – sequential narrative, visual metaphor, and AR integration – the comic creates a thick documentation that preserves the ambiguity and multiplicity essential to artistic research.

4.1 Structure of the Comic: Five Chapters as Investigative Methodology

The comic's five-chapter structure forms a printed, graphically recorded lecture performance, performing the research journey itself, moving from foundational questions about perception to specific encounters with AI systems:

Chapter 1: Realities & Memory (Perception) opens with the safari park metaphor, establishing the comic's central concern with staged versus authentic experience, questioning the existence of authenticity. The chapter explores how memory functions as both storage and creative reconstruction, introducing the telephone game as a structural principle. Through references to communication theory and memory studies, the chapter establishes that reality is highly subjective and shaped by different levels of perception.

Chapter 2: Stories/God/Shamanism/Body traces humanity's drive to create intelligent others, from biblical creation myths to contemporary AI development. The chapter employs a signature *establish and break* strategy: presenting the Narcissus myth as classical narrative, then revealing how it mirrors contemporary human-AI relationships. The visual treatment of pareidolia – humans seeing faces in random arrangements – becomes both subject matter and methodology, as the comic itself invites readers to find patterns and meanings across its sketchy, unfinished drawings.

Chapter 3: Intelligence/AI/Bias confronts definitional problems in AI discourse. The Turing Test sequence exemplifies the comic's approach to academic material: presenting serious research with full theoretical gravity, then undermining it through absurd details like telepathy-proof rooms. This strategy reveals how supposedly objective scientific concepts carry historical and cultural assumptions again suggesting that there is no absolute truth. The chapter's exploration of datasets and bias culminates in the visual representation of the internet's representative – sided by the AIs embodied idea of women - a sexualized representation serving to prove AIs idea of women urges predominantly of pornographic training data.

Chapter 4: Precious Camouflage. Although functions as the comic's central case study, it is not explained. Attending the lecture, aka the comic, is intended to broaden the understanding of the piece and the research. The chapter presents scenes from the piece, sketches capturing constellations, without explanation, a non-verbal addition to everything laid out before.

Chapter 5: Precious Feedback continues the investigative helix through meta-reflection. The comic documents the AI's evolving response to the performance, including its eventual acknowledgment that "these insights make it one of the rare works that don't merely thematize AI, but perform with it and through it". The chapter ends with the AI's self-naming of the conversation as Self-awareness and Analysis, suggesting new possibilities for human-machine collaboration, while maintaining skepticism about anthropomorphic projections, but also while becoming object of anthropomorphism itself.

4.2 Visual Language: Deliberate Incompletion as Research Method

The comic's visual aesthetic – characterized by sketchy line work, alluded, highly detailed and unfinished elements, and varying levels of completion – functions as more than stylistic choice. Different styles follow different strands of storytelling, grouped in reality (pencil and charcoal), myth (chalk), stories (ballpen). The deliberate incompletion serves multiple research functions:

Resistance and Augmentation to Scientific Illustration: Usually academic graphics aim for structuring and measuring, the comic's visual language preserves ambiguity and continues the idea of visual heritage and languages. Complex theoretical concepts like pareidolia or the communication loop are rendered through loose, interpretive drawings that invite multiple readings rather than definitive understanding.

Embodiment of Process: The unfinished quality reflects the ongoing nature of research itself. Rather than presenting completed findings, the comic maintains what Spatz calls research remainders [15] – aspects of artistic investigation that resist closure. The varying completion levels across different panels and pages suggest different degrees of certainty or resolution in the research process.

Material Presence: The hand-drawn quality asserts the comic's materiality against the digital environments it discusses and flickers between the analogue and the digital. While analyzing AI systems that exist only as algorithms, the comic maintains tactile, bodily traces of human creation. This material insistence becomes particularly significant when contrasted with the immaterial nature of the AI systems under investigation but also the immateriality and indescribability of the felt.

4.3 Narrative Strategy: Establish and Break

The comic employs a consistent establish and break narrative pattern that serves both critical and epistemological functions:

Academic Authority and Its Disruption: The comic repeatedly presents scholarly concepts with apparent seriousness – complete with citations and theoretical frameworks – then undermines their authority through visual jokes, absurd details, or unexpected juxtapositions. The Turing Test sequence exemplifies this approach: academic explanation of the test's significance is followed by the detail about telepathy-proof rooms, which retroactively casts the entire enterprise as historically contingent rather than scientifically inevitable.

Mythological Narratives and Contemporary Parallels: Classical stories like Narcissus and Pygmalion are presented as cultural narratives, then revealed as templates for recurring parallelisms with

contemporary human-AI relationships. This strategy suggests that current anxieties in regard to technological developments repeat ancient patterns while appearing to be unprecedented.

Scientific Objectivity and Cultural Bias: The comic establishes AI systems as objective analytical tools, then breaks this fiction by revealing the cultural biases embedded in their training data. The bracket with the safari metaphor reappears - the apparent nature is crafted as AI is crafted too. The landscapes forming the background of the spreads transform more and more into the crowds that form the AI.

4.4 AR Layer as Meta-Research Commentary

The AR components transform the comic from documentation into active (and raw) research environment. The four AR modes each serve distinct epistemological functions:

Documents and Sources: These create a workspace where research materials accumulate organically. Rather than hierarchical citation systems, the AR presents research materials as if scattered around a working desk – Wikipedia entries, book pages, historical artifacts – suggesting knowledge production as bricolage rather than systematic construction, a parc of knowledge with branches alluding to the constructed nature metaphor.

Saliva as Environmental Element materializes the performance's central discovery about AI limitations. The digital saliva that wraps around the comic transforms a conceptual boundary into an immersive environment, by once again transforming it into the digital, allowing readers to experience rather than merely understand the resistance between human embodiment and technological interpretation. The written saliva statements in AR elevate the discourse again into a meta counterstatement: this text is also not to believed.

Interactive Elements implements the comic's Narcissus and saliva theme literally and technologically. When readers see themselves reflected in the AR pond, they experience the narcissistic dynamic the comic analyzes conceptually. This creates what we might call embodied critique – understanding through technological experience rather than textual explanation.

Animated 2D Aesthetics maintain the comic's visual integrity while bringing to life temporal elements. The animated backgrounds – forest scenes, runway models, planetary systems – create loops/ helices that suggest cyclical rather than linear research processes. The animations preserve the hand-drawn quality while adding the temporal and spatial dimension.

4.5 The Telephone Game: Methodology as Subject Matter

The telephone game functions simultaneously as the comic's structural principle, its primary metaphor for communication, and its methodological framework. This triple function creates a performative methodology – research methods that enact their own subjects of investigation and make them explicitly experimentally felt.

Structural Principle: Information transforms as it moves through the comic's chapters, with meanings shifting and accumulating new associations. The safari park metaphor that opens the comic returns transformed by the end, carrying accumulated meanings about simulation, staging, and authenticity. This is elevated even more through the AR layer.

Communication Metaphor: The telephone game provides a model for understanding both human-AI communication in the performance and reader-comic interaction in the documentation. Misunderstanding becomes productive rather than problematic, generating new meanings by adding possibilities to original messages.

Research Methodology: The comic demonstrates rather than describes how knowledge changes through transmission and interpretation. Each chapter performs its own version of the telephone game, taking concepts from previous chapters and transforming them through new contexts and visual treatments. When the piece *Precious Camouflage* appears and makes previously mentioned concepts applicable.

4.6 Preservation of Multiplicity

Perhaps most significantly, the comic intends to preserve what traditional academic documentation typically eliminates: multiple, contradictory, and unresolved aspects of research. The comic maintains precious multitudes – the proliferation of perspectives that emerges through artistic investigation. The comic's final pages, with their repetition of "I AM MULTITUDES" over seemingly classical charcoal drawings of Narcissus, now drooling into his own pond of saliva suggests having both - amplified and twisted all layered meanings of the comic. Narcissus bends over, touching his own pond, meanwhile a smaller narcissus, also kneeling does the same. The scene is observed by a table with four laptops, handled by four humans, also drooling. Knowing that all depicted crowds of people are the proposed new form of AI, it is alluded that the entire scene is one AI, now also capable of drooling. At the same time, it suggests that both AI systems and human researchers contain multiplicities that resist singular definition. The comic preserves these multiplicities not despite its role as documentation, but because of its specific capabilities as an artistic research medium. This preservation of multiplicity has methodological implications beyond artistic research but carries importance to all disciplines. Comics suggest alternative approaches to documentation that could benefit fields ranging from ethnography to HCI, to design research – approaches that maintain complexity rather than reducing it to manageable conclusions.

5 Conclusion

This investigation of *Precious Camouflage* and its augmented comic documentation *Multitudes* reveals new possibilities for documenting artistic research in HCI contexts while highlighting fundamental questions about how we understand and represent human-AI relationships. The project's threefold language approach – live performance, academic analysis, and augmented comic – demonstrates that different media forms generate distinct types of knowledge that, while individually incomplete, create together a more comprehensive fabric and understanding than any single approach could achieve.

The augmented comic's preservation of felt knowledge offers particular insights for HCI research struggling to capture the embodied, cultural, and sensual dimensions of HCI. By refusing to translate artistic discoveries into purely textual statements, the comic maintains access to forms of understanding that resist linguistic capture while remaining rigorously investigative. The comics *establish and*

break narrative strategy provides a model for critical engagement with technological concepts that acknowledges their cultural construction without dismissing their material effects. At the same time, it acknowledges distinct but equally non-hierarchical perspectives coming from other disciplines. Perhaps most significantly, the project's discovery of the *body fluid boundary* in AI systems illuminates how resistance between human embodiment and technological interpretation can be productive. The AI systems' refusal to depict drooling – and their subsequent evolution toward more nuanced engagement with this boundary through artistic dialogue – suggests that sustained critical interaction can expand both human and machine interpretative capacities. The meta-reflective process documented in the comic's final chapter, where the AI achieved what it titled "self-awareness and analysis," points toward new possibilities for human-machine collaboration that neither seamlessly integrate the human and technological nor accept fixed boundaries between them. Instead, the project suggests approaches that work productively with the tensions and partial translations that characterize contemporary human-AI encounters. This research also reveals challenges for implementing artistic documentation approaches within academic contexts that privilege reproducible results and clear conclusions. The comic's preservation of multiplicity and its resistance to definitive interpretation, while methodologically valuable, require new frameworks for evaluating research contributions and new forms of institutional support for cross-disciplinary collaboration. The title *Precious Camouflage* refers not only to the ways humans disguise themselves to evade technological capture, but to the valuable aspects of embodied experience that resist complete computational translation. By making these camouflages visible through artistic investigation, the project contributes to a nuanced understanding of what it means to be human in an age of artificial intelligence. The comic's title brackets with its final assertion – I AM MULTITUDES – suggests that both humans and AI systems contain irreducible multiplicities that exceed singular definition, requiring documentation approaches capable of preserving rather than resolving such complexity.

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Fav(panopt)icon Project

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Abstract

In the digital age, users often hastily agree to lengthy cookie policies without fully understanding their implications for online privacy. *Fav(panopt)icon Project* explores this phenomenon by employing favicons—the small icons that represent websites—to symbolize user consent to such policies. When users agree within the project's interface, their internet activities are visually rendered in real time on a large LED panel through a corresponding iconic image, or favicon. This visualization, evocative of an omni-panopticon, allows other visitors observing the LED panel to witness and reflect upon the online behaviors of consenting participants. Once familiar with the project's interface, visitors can use the favicon imagery to display their everyday internet activities, much like how Pop artist Andy Warhol transformed his daily life into art. In essence, *Fav(panopt)icon Project* creates an ambivalent environment where visitors interact with favicon imagery while contemplating the contemporary significance of the panopticon within the context of the internet and digital surveillance.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Favicon, interactive art, panopticon, LED, net.art

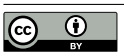
ACM Reference Format:
Byeongwon Ha. 2025. Fav(panopt)icon Project. In *12th International Conference on Digital and Interactive Arts: Media Art Cultures, Communities & Territories (ARTECH 2025), November 26–28, 2025, Braga, Portugal*. ACM, New York, NY, USA, 3 pages. https://doi.org/10.1145/3773699.3776577

1 introduction

In the rapidly evolving digital landscape of the twenty-first century, users constantly navigate the complex terrain of online platforms, frequently encountering lengthy and intricate cookie policies. In their eagerness to access desired content, users often hastily agree to these policies without fully understanding their far-reaching implications for online privacy. After such agreements, customized advertisements—generated based on users' cookies—begin to follow them throughout their online journeys. These ads persist even after the promoted products have already been purchased. By accepting cookie agreements, we become quasi-voluntary data donors; visiting websites is not a free admission but an act that demands our inevitable contribution. *Fav(panopt)icon Project* emerges as a critical and thought-provoking exploration of this widespread behavior. The project employs favicons—the small, distinctive icons that represent websites—as symbolic representations of users' consent to cookie policies. Before visitors begin interacting, the installation displays the phrase "Free Internet" to invite them to explore the web freely. However, this phrase carries a deliberate double meaning: it refers both to the misconception of the Internet as a free service and to the notion of using the Internet in a "risk-free" or private browsing mode. At the heart of *Fav(panopt)icon Project* lies a unique artistic approach to visualizing user consent. Within this installation, when users willingly agree with the cookie policies, their online activities are visualized in real time on a large LED panel. Each website visited by a user is represented by its favicon, displayed as a 12×12 pixel abstraction. Through this minimalist LED interface, visitors can observe simplified favicon images that symbolize the digital traces of consenting participants. This captivating visual mechanism reveals the often-overlooked consequences of the seemingly mundane act of accepting cookie policies. The LED panel, with its dynamic and ever-changing display of online behavior, transcends linguistic boundaries and serves as a universal medium for both communication and reflection.

2 The concept of Fav(panopt)icon Project

French philosopher Michel Foucault examined the Panopticon—a prison design featuring a central watchtower surrounded by peripheral cells—as a powerful metaphor for modern disciplinary society in Discipline and Punish (1975) [1]. Likewise, Jürgen Habermas's concept of the public sphere provides another critical framework for understanding how spaces of communication and visibility shape democratic participation [2]. In the digital era, online platforms have emerged as new forms of public spheres where personal data, opinions, and identities are constantly exposed, circulated, and negotiated under systems of surveillance and algorithmic control. Diverse contemporary artists including Rafael Lozano-Hemmer and Ben Rubin have drawn upon these theoretical lenses to critique digital surveillance, data capitalism, and the politics of visibility in networked culture. In this context, *Fav(panopt)icon Project* reinterprets the Panopticon while engaging with Habermas's notion of the public sphere to explore issues of online privacy, social interaction, and the collective ethics of visibility. A large LED panel functions as an omni-panopticon, transforming users' internet activities into a shared visual field. This environment creates a public sphere of observation, where viewers collectively reflect on privacy, consent, and participation itself. Until users consent to the cookie policy, they repeatedly encounter the familiar consent window—an everyday ritual of digital agreement. Once consent is given, their digital footprints are projected onto the LED display, inviting both self-awareness and public scrutiny. Through this process,



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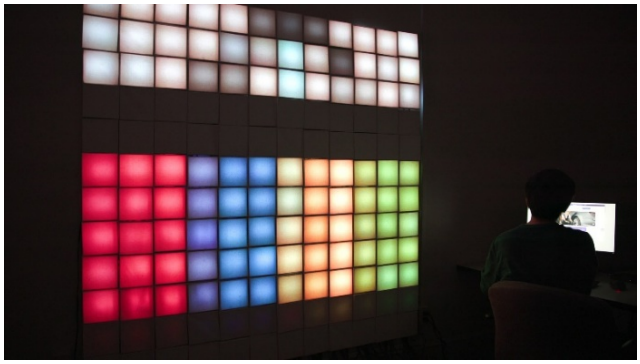


Figure 1: The participation image of Fav(panopt)icon Project. The LED image shows the eBay favicon when the participant visits the eBay website. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

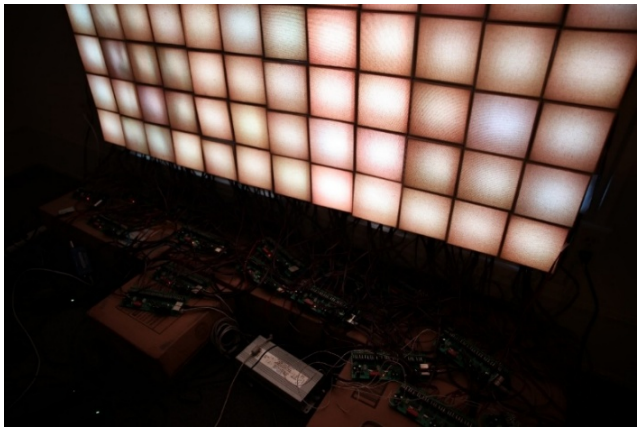


Figure 2: The LED installation part of Fav(panopt)icon Project. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

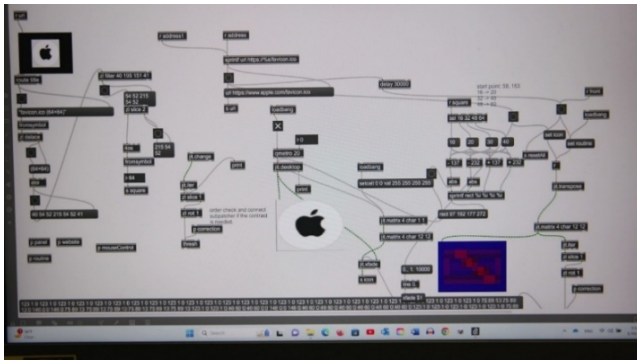


Figure 3: The Max 7 patcher for Fav(panopt)icon Project. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

the project converts private online actions into a public dialogue, prompting reflection on how our digital lives both shape and are shaped by surveillance and social performance. By combining Foucault's disciplinary gaze with Habermas's communicative sphere, *Fav(panopt)icon Project* visualizes the paradox of visibility in contemporary network culture: the simultaneous desire to be seen and the fear of being watched. In essence, the project examines the ambivalent experience of internet users through the lens of the omni-panopticon. To visualize participants' website visits effectively, the project collects each site's favicon, a small representative icon typically used in browser tabs. Favicons are usually rendered in low resolution, resembling pixel art—an aesthetic that harmonizes with the abstraction of the LED display. These simple, minimalist icons enable visitors to intuitively recognize participants' online activities, translating complex digital behaviors into accessible visual forms. Rather than merely criticizing the public exposure of personal data, the project also operates as a narcissistic interface, mirroring how users voluntarily display their lives on platforms such as Instagram. It further interrogates Andy Warhol's famous prediction that "in the future, everyone will be world-famous for fifteen minutes" [3]. *Fav(panopt)icon Project* thus functions both as a public platform—momentarily placing participants in the spotlight—and as a political interface that critiques the invisible leakage of private information. This duality resonates with Dada and Fluxus principles, which blur the boundary between art and everyday life. In this sense, *Fav(panopt)icon Project* serves as a contemporary public sphere for discussing the intertwined issues of online privacy, digital narcissism, and the ambivalent experiences that arise between them. Visitors may embody multiple roles: a passive user seeking to erase their digital footprint, an active participant eager to showcase their online presence, or a creative performer who exposes the entire interface to public view.

3 The technology of fav(panopt)icon project

To create an interactive online environment that connects virtual data with physical space, *Fav(panopt)icon Project* employs Max 7 in conjunction with a DMX interface. These tools form the core of the system's logic, translating digital information into tangible, visual, and spatial experience. Before visitors begin to interact with the work, the installation displays the phrase "Free Internet" letter by letter on a small LED text screen, gently inviting participants to explore the online world. This initial prompt sets a paradoxical tone: it welcomes users into a seemingly open digital space while simultaneously hinting at the illusion of freedom in contemporary network systems. When a visitor accesses a specific website through the project's interface, Max 7 immediately detects the website's address and retrieves its favicon—the small icon typically displayed on browser tabs—by appending "/favicon.ico" to the site's URL. Using the object jit.desktop, the system crops and isolates the favicon image on screen according to the resolution data provided by the website. This process not only captures a visual trace of online activity but also transforms an invisible fragment of web infrastructure into a visible artifact within the physical space of the installation. The application then converts each retrieved favicon into a pixel-art-like image with a resolution of 12×12 pixels, reducing complex web imagery to a minimalist data abstraction. The external Max object imp.dmx translates this color matrix into

a list of numerical values, which is then sent to the DMX interface. Acting as a mediator between software and hardware, the DMX interface transmits this data to sixteen nine-RGB-channel DMX decoders, each responsible for controlling multiple LED nodes. Each small LED pixel-like display consists of twelve RGB LED lamps arranged in a grid and covered with a thin white canvas diffuser to soften the light and create a painterly visual effect. This diffusion transforms the mechanical brightness of LEDs into a more organic, atmospheric glow, aligning the technological aesthetics of the work with the contemplative tone of new media installation art. The entire LED matrix—configured as a 12×12 grid—functions as both a data screen and a minimalist sculpture. Although it presents a simple abstract composition, its construction is complex and labor-intensive, involving approximately 30 meters of LED string, 120 meters of electrical wiring, and 144 six-by-six-inch canvases meticulously mounted on the display surface. Beyond its technical sophistication, this physical complexity underscores a conceptual irony: a seemingly simple digital gesture—the retrieval of a small website icon—requires a vast network of hardware and human labor to manifest. This tension between digital simplicity and material intricacy mirrors the project's critique of online transparency and the hidden infrastructures of data collection. Through this interplay of light, code, and form, *Fav(panopt)icon Project* transforms the intangible mechanisms of the internet into a concrete, experiential environment where users can confront the aesthetics and ethics of visibility in the digital age. In the end, through a gradual fade-in and fade-out visual effect, the favicon image slowly emerges on the display, allowing the audience to recognize it progressively. At this moment, participants become aware that their online activities are being rendered visible to others—transforming an invisible digital act into a shared, public experience.

4 The Future of fav(panopt)icon project

Fav(panopt)icon Project will be expanded into a video sculpture as a Gesamtkunstwerk, or total work of art. In this new iteration, the initial version will remain the central interactive component that directly engages participants. Surrounding it, the expanded version will incorporate a video sculpture composed of twenty HD displays—ten on each side—framing the main installation. Using visitors' cookie data in real time, Max 7 will generate collage-based moving images reminiscent of Nam June Paik's vibrant video art aesthetics. To create these dynamic compositions, Max 7 will collect diverse video clips and still images derived from the keywords extracted from visitors' cookies. By employing the jweb, jit.rota, jit.op, jit.chromakey, and jit.desktop objects, the system will continuously produce mesmerizing, collage-like moving images in real time. In this configuration, the project becomes not only an interactive experience for participants but also a video performance generated by them. The integration of interactive art and video sculpture establishes a more comprehensive environment—offering an immersive, participatory experience for active users and a theatrical, observational experience for passive viewers. This expansion transforms participants into active performers who visually manifest their own online activities. Ultimately, this development reinforces the central concept of *Fav(panopt)icon Project*: the ambivalent tension between online privacy and online narcissism.

5 Conclusion

Fav(panopt)icon Project investigates the dynamics of user consent within the framework of online cookie policies by employing favicons as visual and conceptual symbols. Within this system, the internet activities of consenting users are translated into real-time visualizations on an LED panel, where each favicon becomes a digital emblem of participation and exposure. By transforming these small, often overlooked web icons into an aesthetic language, the project reveals how the simple act of clicking "accept" initiates a complex interplay between visibility, surveillance, and agency. Adopting a panoptic perspective inspired by Michel Foucault, the project reinterprets the LED panel as an omni-panopticon—a digital apparatus that simultaneously observes and displays. In doing so, it provokes reflection on the ethical dimensions of data collection and the conditions of contemporary spectatorship within net.art culture. The installation makes visible what is normally invisible: the continuous circulation of personal data, consent, and self-representation within networked systems. At first glance, *Fav(panopt)icon Project* might appear to be a simple interactive work—a critical yet playful commentary on the commercialization of personal data through cookie policies. Yet, upon deeper engagement, the project invites participants to reconsider the meaning of the "public favicon" as both a symbol of exposure and a tool for self-expression. By actively engaging with the interface, visitors can strategically reappropriate the system, transforming a mechanism of surveillance into a stage for self-presentation. In this way, the work blurs the boundary between passive observation and active performance. Visitors are not merely observed but become performers who shape the aesthetic and conceptual outcome of the piece. *Fav(panopt)icon Project* thus underscores the ambivalence of digital participation—oscillating between online privacy and online narcissism, control and expression, observation and creation. Ultimately, it challenges us to reconsider what it means to be visible in the age of ubiquitous data, where every click, consent, and icon becomes part of a shared public performance.

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“UrdiSynth42” e a tecelagem figital

“UrdiSynth42” and figital weaving

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Abstract

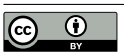
This study examines the contemporary challenge of digital art in preserving cultural authenticity while balancing technological innovation with historical continuity. It posits that virtualization, understood as shifts in identity towards expressive potentials, is a longstanding cultural phenomenon that predates the digital era. By employing the Portalegre Tapestries as a paradigmatic case, this research identifies five historical dimensions of transcoding, dimensional, material, technical, temporal, and interpretative; that foreshadow methodologies in contemporary digital art.

The concept of phygital art is introduced, establishing a hybrid temporal grammar that merges the rhythms of online and offline environments. Within this framework, the ”UrdiSynth42” model proposes a hierarchical four-layer architecture (Perception, Cognition, Expression, Coordination), which operationalizes historical virtualization through computer vision, machine learning, and generative synthesis. The strategic application of technologies such as Docker ensures both digital and cultural preservation.

This study concludes that historical virtualization does not signify a technological rupture but rather a natural evolution, offering a robust foundation for future artistic practices that honor cultural traditions while exploring new technological possibilities.

Résumé

O presente estudo aborda o desafio contemporâneo da arte digital na preservação da autenticidade cultural, procurando conciliar a inovação tecnológica com a continuidade histórica. Defende-se que a virtualização, compreendida como um deslocamento identitário para potenciais expressivos, constitui um fenómeno cultural contínuo, presente muito antes da era digital. Utilizando as Tapeçarias de Portalegre como caso paradigmático, este trabalho identifica cinco dimensões históricas de transcodificação; dimensional, material, técnica, temporal e interpretativa, que antecipam métodos da arte digital contemporânea.



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Apresenta-se o conceito de arte *figital*, que estabelece uma gramática híbrida temporal, combinando os ritmos dos ambientes online e offline. Neste contexto, o *framework* ”UrdiSynth42” propõe uma arquitetura hierárquica de quatro camadas, Perceção, Cognição, Expressão e Coordenação; que operacionaliza a virtualização histórica através de visão por computador, *machine learning* e síntese generativa. A utilização estratégica de tecnologias como Docker assegura a preservação digital e cultural.

O estudo confirma que a virtualização histórica não representa uma rutura tecnológica, mas sim uma evolução, oferecendo uma base robusta para futuras práticas artísticas que visem respeitar as tradições culturais, ao mesmo tempo que exploram novas possibilidades tecnológicas.

CCS Concepts

• **Computing methodologies**; • **Computer vision**; • **Applied computing**; • **Media arts**; • **Generative and developmental approaches**;

Keywords

Generative Art, Digital Tapestry, Portalegre Tapestry, Computer Vision

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1 Introdução: A arte *figital* contemporânea e a preservação da autenticidade cultural

A arte digital contemporânea enfrenta um desafio crucial: conciliar a inovação tecnológica com a autenticidade cultural, evitando que a rápida obsolescência dos dispositivos seja confundida com uma rutura civilizacional. Como observa Manovich [15], existe um risco constante de que as artes digitais sejam vistas como uma descontinuidade histórica, relegando as práticas artesanais a um estatuto meramente folclórico. Em vez disso, este estudo argumenta que os processos de virtualização, entendidos, segundo Lévy [13], como deslocamentos identitários para campos de potencialidade, permeiam a história da arte muito antes do advento da tecnologia digital.

A virtualização, portanto, revela-se uma modalidade cultural contínua que permite unir tradição e experimentação, preservando a coerência ontológica das obras enquanto expande seu horizonte expressivo.

As Tapeçarias de Portalegre, estabelecidas em 1946, oferecem um exemplo paradigmático desta virtualização histórica, evidenciando cinco dimensões de transcodificação: (I) dimensional, convertendo esboços bidimensionais em tecelagens tridimensionais; (II) material, substituindo pigmentos por fios; (III) técnica, transitando da pintura para a tecelagem; (IV) temporal, transformando atos espontâneos em gestos meditativos; e (V) interpretativa, migrando de uma autoria individual para um processo colaborativo. Estas operações antecipam metodologias centrais da arte digital, desde a modelação 3D até a lógica de rendering distribuído, e demonstram que a continuidade cultural é compatível com a inovação formal.

A arte *figital* constitui-se como uma gramática temporal híbrida que funde ritmos online e offline, instaurando um *metabolismo computacional*, um conceito que descreve a alternância cíclica entre criação e retroação em ciclos síncronos e assíncronos. Este termo, inspirado na biologia, refere-se à forma como os sistemas artísticos híbridos processam e transformam informação, mantendo um equilíbrio dinâmico entre o ambiente digital e o físico. Gao [10] demonstra que a ubiquidade das tecnologias digitais permite habitar múltiplas temporalidades em ambientes generativos e imersivos, articulando-se em práticas de media digital e performance duracional onde diferentes perceções de tempo coexistem. Carvalhais [5] reforça esta visão ao sublinhar que, na arte generativa, a obra emerge de um fluxo contínuo de eventos, um sistema auto poético que negocia constantemente as condições da sua própria produção.

Neste contexto, a arte *figital* expande a experiência temporal ao criar ecossistemas em que o humano e a máquina renegociam continuamente o ritmo e a duração do gesto criativo. É precisamente sobre esta convergência que se ergue o *framework* "UrdiSynth42": uma arquitetura hierárquica de quatro camadas que operacionaliza princípios de virtualização histórica através de visão por computador, *machine learning* e síntese generativa, encapsulando tanto dependências técnicas como saberes tácitos em contentores imersivos.

Os protótipos funcionais desenvolvidos demonstram ser possível conceber experiências *figitais* simultaneamente robustas, culturalmente autênticas e historicamente informadas. Ao fazê-lo, o "UrdiSynth42" ultrapassa a aparente dicotomia entre *novo* e *tradicional*, abrindo caminho a práticas artísticas capazes de honrar o passado enquanto projetam futuros expressivos.

2 Arte *figital* e virtualização histórica: Uma nova gramática temporal

O conceito de arte *figital* supera a simples combinação de elementos físicos e digitais, estabelecendo uma gramática temporal que integra paralelismos entre os domínios online e offline. A produção artística digital contemporânea é caracterizada pelo surgimento de obras híbridas que coexistem em múltiplos domínios, criando uma *ritmicidade sistémica* na qual as dimensões física e digital se articulam de forma coreografada [11]. Esta hibridização manifesta-se através de transições dinâmicas entre estados de interatividade síncrona, típicos das experiências online em tempo real, e momentos de reflexão assíncrona, característicos do ambiente offline, estabelecendo um "metabolismo computacional" que facilita acoplamentos entre ação e retroação [4].

A par disso, a convergência das esferas artísticas na era digital promove a dissolução das fronteiras entre o real e o virtual, desafiando os conceitos tradicionais de espaço, tempo e materialidade, e permitindo a criação de experiências artísticas dinâmicas e participativas. Estas dinâmicas são potencializadas pelo uso de tecnologias digitais que facilitam estruturas narrativas complexas, não-lineares e interativas, promovendo uma participação ativa do público e uma contínua renegociação da experiência temporal e espacial [4].

No contexto das Tapeçarias de Portalegre, esta ritmicidade é evidente na alternância entre a interpretação criativa ativa e a execução mecânica repetitiva. Enquanto o artista se dedica à criação do cartão, interpretando criativamente o design, a execução mecânica repetitiva pode ser equiparada a algoritmos digitais que reproduzem padrões de forma consistente.

A virtualização histórica, conforme estabelecida por Pierre Lévy [13], não constitui desmaterialização, mas sim uma transformação da identidade através da descoberta de novas questões. O virtual opõe-se ao atual, não ao real, constituindo uma modalidade do ser que transcende limitações espaciais e temporais convencionais. As cinco dimensões de transcodificação identificadas nas Tapeçarias de Portalegre demonstram como processos de virtualização operam em contextos pré-digitais. Por exemplo, a transcodificação dimensional, que envolve a conversão de representações bidimensionais em formas tridimensionais, pode ser comparada à modelação digital onde imagens bidimensionais são transformadas em modelos 3D. Similarmente, a transcodificação material, que envolve a substituição de pigmentos por fios, reflete a reformatação digital onde materiais tradicionais são substituídos por pixéis e vetores.

O *framework* delineado a partir destes conceitos assenta em três princípios ecossistémicos derivados da análise das tapeçarias de Portalegre:

- 1.Diversidade sistémica: Este princípio consiste na integração de múltiplas modalidades de processamento, representação e interação, valorizando simultaneamente a herança artística e as potencialidades tecnológicas. Ao conjugar técnicas tradicionais de tecelagem com ferramentas digitais de criação, os artistas podem respeitar a tradição e, ao mesmo tempo, explorar novas possibilidades expressivas. Por exemplo, ao utilizar software de design para criar padrões complexos e depois aplicar essas criações em teares manuais, os artistas podem combinar a precisão digital com a riqueza tátil dos materiais tradicionais [4].
- 2.Interdependência adaptativa: Este princípio designa as relações dinâmicas entre os componentes do sistema, fomentando uma adaptação mútua por meio de transições contínuas entre os domínios online e offline. Estes ritmos conciliam a imediaticidade do digital com a reflexão contemplativa do fazer manual. Um exemplo claro disso é quando um artista alterna entre esboços digitais e a execução têxtil. Durante o processo criativo, o artista pode usar ferramentas digitais para experimentar rapidamente diferentes *designs*, antes de selecionar e implementar as melhores ideias através de técnicas manuais de tecelagem. Esta alternância permite uma

reflexão mais profunda sobre as escolhas de design enquanto se mantém a eficiência e a flexibilidade proporcionadas pela tecnologia digital. Conforme Duester [8], a incorporação de software digital e inteligência artificial nas práticas artísticas contemporâneas tem fomentado novas formas de eficiência, criatividade e adaptação, permitindo que os artistas explorem rapidamente diferentes soluções visuais e ajustem os seus processos criativos em tempo real.

- 1.Emergência controlada: O princípio em questão aborda a génese de modalidades expressivas inovadoras, mantendo uma consonância com valores culturais pré-estabelecidos. A experimentação é fomentada, mas circunscrita a parâmetros delineados pela tradição e pelo contexto cultural. Por exemplo, a evolução de técnicas de tecelagem pode culminar em obras originais que salvaguardam a identidade cultural, quer através da integração de motivos tradicionais em desenhos inovadores, quer mediante a utilização de materiais contemporâneos que remetem para a estética dos materiais ancestrais.
- Deste modo, a experimentação controlada possibilita aos artistas inovar sem desvincular-se do contexto cultural e histórico das suas criações, garantindo a perpetuação e autenticidade das tradições culturais. Este equilíbrio entre inovação e tradição é essencial nos processos de inovação cultural, os quais dependem de condições sistémicas e da circulação de saberes no seio das comunidades, incentivando a cocriação sem rutura com o legado cultural existente [8].

Estes princípios juntos proporcionam uma estrutura robusta que permite aos artistas explorar novas fronteiras na arte *figital* enquanto mantêm uma forte ligação com as tradições culturais. Ao integrar tecnologia e tradição de uma forma equilibrada e respeitosa, o *framework* apoia a criação de obras que são ao mesmo tempo inovadoras e culturalmente ricas.

3 Arquitetura do *framwork* “urdisynth42”

O ”UrdiSynth42” adota uma arquitetura hierárquica de quatro camadas, baseada nos princípios de virtualização histórica e na integração de operações paralelas em ambientes online e offline. Esta configuração visa facilitar transições dinâmicas entre diversos estados sistémicos, fomentando um ecossistema híbrido que salvaguarda a autenticidade cultural, ao mesmo tempo que estimula novas formas de expressão.

Lupo [14] sublinha que a convergência entre os domínios físico e digital, denominada *figital*, cria espaços dinâmicos onde os elementos tangíveis e intangíveis do património cultural se interligam, possibilitando experiências criativas sem comprometer a integridade cultural. Esta abordagem híbrida é considerada essencial para a inovação no design e na experiência do património cultural, incentivando a cocriação, a adaptação e a expansão das práticas culturais tradicionais através das tecnologias digitais.

3.1 Camada de perceção

A camada de perceção constitui a interface sensorial primária entre o sistema e o ambiente físico-digital. Recorrendo a visão por computador, captura gestos, posturas e movimentos corporais que alimentam as etapas da cognição e expressão.

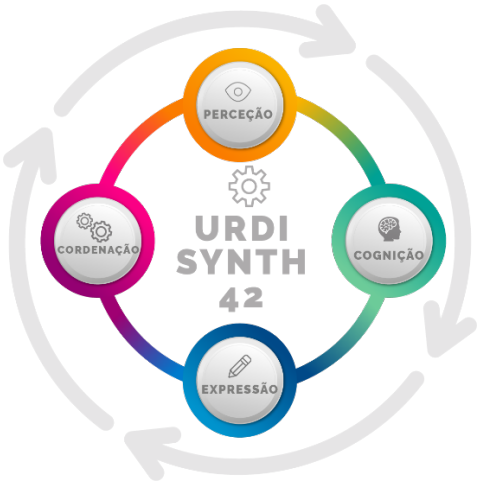


Figure 1: Diagramal de arquitetura hierárquica de quatro camadas. Este diagrama ilustra a interação entre as quatro camadas do framework ”UrdiSynth42”: Perceção (captura de dados do ambiente físico-digital), Cognição (interpretação semântica e cultural), Expressão (criação de respostas multimodais) e Coordenação (gestão do sistema). A estrutura circular sugere um fluxo contínuo e interdependente, refletindo o ”metabolismo computacional” do sistema. Fonte: autor

Componentes técnicos:

- Algoritmos de estimativa de pose corporal: Utilização de ferramentas como *MediaPipe* e *OpenPose* para uma deteção precisa da pose corporal a partir de imagens de câmaras.
- Sistemas de tracking gestual: Tecnologias que permitem o seguimento de gestos com precisão, garantindo fidelidade na captação de movimentos visuais.
- Módulos de calibração automática: Sistemas que se adaptam automaticamente a diferentes condições de iluminação e ambientes, assegurando uma performance consistente das câmaras.
- Interfaces de captação visual: Integração de câmaras de vídeo para uma perceção abrangente do ambiente visual.

Funcionalidades:

- Deteção e seguimento de gestos: Capacidade de detetar e seguir gestos, permitindo uma interação em tempo real baseada em dados visuais.
- Classificação de intenções gestuais: Interpretação em tempo real das intenções por trás dos gestos captados pelas câmaras, facilitando uma resposta adequada do sistema.
- Adaptação automática: Ajuste automático a diferentes utilizadores e contextos visuais, garantindo uma experiência personalizada baseada em entradas visuais.
- Filtragem de ruído visual: Eliminação de movimentos não intencionais e ruídos visuais, melhorando a precisão da interação baseada em câmaras.

3.2 Camada de perceção

A camada cognitiva é encarregue da interpretação semântica dos dados recolhidos pela camada percetiva. Esta camada recorre a algoritmos de *machine learning*, implementados em *TensorFlow*, para categorizar gestos com base em padrões culturais e adaptativos, possibilitando uma compreensão mais rigorosa das interações humanas. A utilização de redes neurais recorrentes (LSTM/GRU), em conjunto com *TensorFlow*, tem demonstrado uma eficácia significativa no reconhecimento e classificação de gestos, facilitando a extração automática de características pertinentes e a adaptação a diversos contextos culturais. Misal [16] destaca a relevância destas abordagens para o desenvolvimento de sistemas robustos de reconhecimento de gestos, capazes de suportar aplicações avançadas em interação humano-computador.

Arquitetura de aprendizagem:

- Redes Neurais recorrentes (LSTM/GRU): Modelação temporal de sequências de gestos, permitindo a compreensão de padrões ao longo do tempo. Estas redes são implementadas utilizando *TensorFlow*, que oferece um suporte robusto para a criação e treino de modelos complexos de *machine learning*.
- *Transformers*: Captura de dependências de longo alcance entre gestos, facilitando a interpretação de sequências complexas. A utilização de *TensorFlow* permite a implementação eficiente de *transformers*, melhorando a capacidade do sistema de compreender contextos complexos.
- Mecanismos de atenção: Foco em aspetos relevantes dos dados, melhorando a precisão da classificação. O *TensorFlow* fornece ferramentas para a implementação de mecanismos de atenção, permitindo uma análise mais detalhada e precisa dos dados.
- Sistemas de memória episódica: Preservação do contexto das interações, permitindo uma adaptação contínua e contextualizada. Com *TensorFlow,* é possível criar sistemas de memória episódica que mantêm e utilizam informações contextuais para melhorar a interpretação dos gestos.

Processamento semântico:

- Classificação de gestos: Classificação de gestos segundo uma taxonomia cultural específica, garantindo uma interpretação culturalmente sensível. O *TensorFlow* facilita a criação de modelos de classificação que podem ser treinados com dados culturais específicos, melhorando a precisão e a sensibilidade cultural do sistema.
- Interpretação contextual: Interpretação baseada no histórico de interações, permitindo uma resposta adaptada ao contexto. A utilização de *TensorFlow* permite a integração de informações contextuais históricas, enriquecendo a interpretação dos gestos atuais.
- Adaptação gradual: Ajuste gradual a padrões individuais de utilizadores, melhorando a experiência ao longo do tempo. O *TensorFlow* suporta a implementação de algoritmos de aprendizagem contínua, permitindo que o sistema se adapte e melhore com o uso.
- Integração de conhecimento cultural: Incorporação de conhecimento cultural sobre as Tapeçarias de Portalegre, enriquecendo a interpretação dos gestos. Com *TensorFlow*, é possível integrar bases de dados culturais específicas, melhorando a capacidade do sistema de interpretar gestos dentro de um contexto cultural rico e diversificado.

3.3 Camada de expressão

A camada de expressão tem a função de traduzir os resultados da análise cognitiva em manifestações visuais e sonoras. Para isso, utiliza motores de síntese que combinam aleatoriedade algorítmica com regras composicionais inspiradas nas Tapeçarias de Portalegre. Esta metodologia possibilita a criação de respostas estéticas que são sensíveis tanto ao gesto do utilizador quanto ao contexto cultural em que estão inseridas. De acordo com Manovich [12], a integração de técnicas de síntese algorítmica com elementos culturais específicos é uma estratégia eficaz para o desenvolvimento de experiências multimodais interativas. Tal abordagem promove a personalização e a relevância cultural das respostas criadas pelo sistema.

Motores de Síntese:

- Redes adversarias generativas (GANs): Treinadas com um *dataset* de tapeçarias, permitindo a criação de texturas e padrões autênticos.
- Modelos de difusão: Criação de texturas e padrões que evocam a materialidade das tapeçarias.
- Algoritmos de síntese procedimental: Utilização de funções de ruído e autômatos celulares para a criação de padrões complexos.
- Sistemas de composição musical: Criação de composições musicais baseadas em estruturas têxteis, enriquecendo a experiência multissensorial.

Criação de conteúdo:

- Síntese de texturas: Criação de texturas que evocam a materialidade das tapeçarias, garantindo uma experiência visual autêntica.
- Criação de padrões geométricos: Inspiração em Manuel Cargaleiro para a criação de padrões geométricos complexos.
- Criação de paletas cromáticas: Utilização das 7.000 tonalidades disponíveis nas tapeçarias para a criação de paletas cromáticas ricas e variadas.
- Composição de movimentos fluidos: Criação de movimentos que evocam o processo de tecelagem, enriquecendo a experiência visual e sonora.

3.4 Camada de Coordenação

A camada de coordenação é responsável pela gestão das interações entre todas as camadas do sistema, utilizando lógica distribuída e processamento assíncrono. Esta metodologia é crucial para assegurar a resiliência e a sincronização do estado do sistema, permitindo que este responda de forma adaptativa a flutuações interativas e técnicas. Sadnan [16] demonstra que arquiteturas de coordenação em camadas, baseadas em algoritmos distribuídos, são eficazes na gestão de sistemas complexos. Estas arquiteturas promovem autonomia, robustez face a falhas e reduzem a complexidade computacional centralizada.

Infraestrutura distribuída:

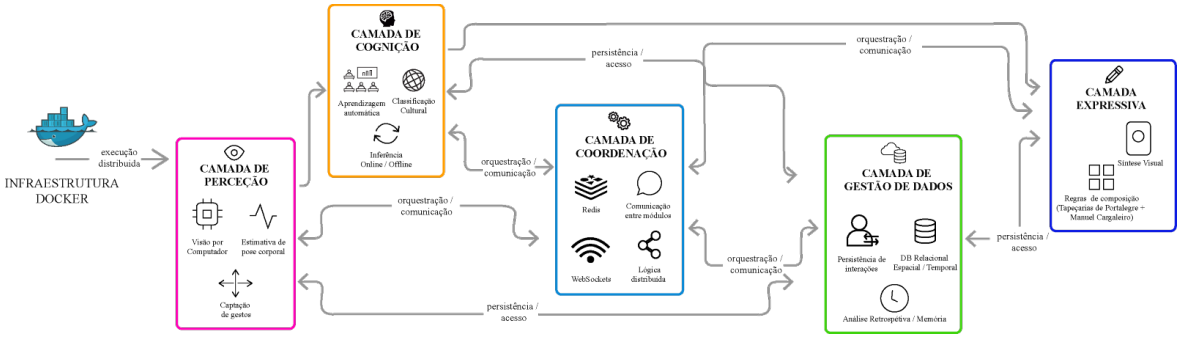


Figure 2: Arquitetura da framework ”UrdiSynth42”. Este diagrama detalha a implementação técnica da arquitetura de quatro camadas. A Camada de Perceção utiliza câmaras e sensores para capturar dados. A Camada de Cognição processa esses dados através de modelos de machine learning (Análise de Comportamento). A Camada de Expressão gera conteúdo visual e sonoro (Síntese de Imagem e Som). A Camada de Coordenação gere o estado, os dados e a infraestrutura (Gestão de Estado, Camada de Gestão de Dados, Infraestrutura Distribuída). A interligação entre as camadas demonstra um sistema integrado para a criação de experiências *figitais*. Fonte: autor

- Arquitetura de micros serviços: Design que permite escalabilidade horizontal, facilitando a adaptação a diferentes cargas de trabalho.
- Sistemas de balanceamento de carga dinâmico: Distribuição eficiente de recursos, garantindo uma performance consistente.
- Protocolos de recuperação e tolerância a falhas: Mecanismos que asseguram a continuidade do serviço mesmo em caso de falhas.
- Monitorização em tempo real: Monitorização contínua da performance sistémica, permitindo uma resposta rápida a problemas.

Gestão de estado:

- Sincronização de estado: Manutenção de um estado sincronizado entre múltiplos componentes, garantindo uma operação coerente.
- Versionamento de modelos de *machine learning*: Gestão de diferentes versões de modelos, facilitando a atualização e a recuperação.
- Backup distribuído e recuperação de dados: Mecanismos que asseguram a integridade e a disponibilidade dos dados.
- Gestão de sessões de utilizador e preferências: Personalização da experiência do utilizador, garantindo uma interação adaptada às suas preferências.

4 *ContENTORização* e Preservação Digital/Figital

O sistema em análise utiliza uma estratégia de contentorização[1] em *Docker*, reconhecida na literatura académica recente como uma solução robusta para desafios de portabilidade, escalabilidade e preservação digital em ambientes de desenvolvimento e produção [17]. Cada componente do sistema é encapsulado num contentor autónomo, incluindo todas as dependências e configurações necessárias, garantindo assim a replicação fiel do ambiente original, independentemente da infraestrutura subjacente. Esta abordagem é crucial para assegurar a integridade, funcionalidade e longevidade dos sistemas, especialmente em contextos de preservação digital e cultural [9].

A arquitetura modular do sistema inclui vários contentores especializados, cada um com uma função específica. O contentor de perceção incorpora ferramentas e bibliotecas essenciais para a aquisição e processamento de dados visuais, como o *OpenCV*, utilizado em aplicações de visão por computador em tempo real devido à sua eficiência e suporte multiplataforma [18]. Além disso, o *MediaPipe* tem demonstrado alta precisão na captura e análise de movimentos, sendo validado em estudos recentes como uma solução robusta para tarefas de processamento visual [25].

O contentor de cognição é dedicado à *machine learning* e à interpretação semântica, utilizando *frameworks* como *TensorFlow* e *PyTorch*. O *TensorFlow* é reconhecido pela sua capacidade de operar em larga escala e em ambientes heterogéneos, sendo adotado em investigação e produção para aplicações de *deep learning* [2]. O *PyTorch*, por outro lado, é valorizado pela sua abordagem imperativa, flexibilidade e desempenho, facilitando o desenvolvimento e a experimentação em projetos de *deep learning* [19].

O contentor de expressão é responsável pela criação de conteúdos visuais e sonoros, utilizando motores de síntese e bibliotecas gráficas para criar respostas estéticas baseadas nas interpretações cognitivas. Esta abordagem modular permite a integração eficiente de componentes especializados para a produção de respostas multimodais.

Por fim, o contentor de coordenação gere a comunicação e a sincronização entre os diferentes componentes do sistema, utilizando tecnologias como *Node.js*, conhecida pela sua arquitetura orientada a eventos e elevada escalabilidade em aplicações distribuídas [1], e *Flask*, que oferece flexibilidade e suporte a aplicações distribuídas e persistentes [3].

[1]Este termo refere-se ao processo de “empacotar” software em contentores, que são unidades padronizadas de software que incluem código e todas as suas dependências, permitindo que as aplicações sejam executadas de forma rápida e confiável em diferentes ambientes de computação.

A utilização de tecnologias de contentorização tem vindo a assumir um papel central na gestão eficiente de sistemas complexos. Esta abordagem não só simplifica a administração técnica, como também facilita a preservação do conhecimento tácito inerente ao funcionamento dos sistemas. Ao encapsular configurações específicas, parâmetros críticos e dependências essenciais de cada componente, a contentorização promove a reprodutibilidade e a robustez operacional [22]. Além disso, a integração de métricas de desempenho e padrões de interação diretamente nos contentores possibilita uma monitorização contínua, bem como a implementação de processos de otimização progressiva, alinhando-se com as melhores práticas de *DevOps* e computação em nuvem [17].

À medida que o sistema evolui com a sua utilização, as melhorias incrementais e adaptações contextuais são registadas e preservadas nos próprios contentores. Isso permite a construção de uma "memória cultural" digital que reflete não apenas as dinâmicas históricas do sistema, mas também as especificidades das interações dos utilizadores, assegurando a continuidade do conhecimento institucional e operacional.

A literatura recente evidencia que a adoção de contentores Docker consolidou-se como uma prática dominante em ambientes de produção, especialmente em sistemas que requerem elevados níveis de flexibilidade, isolamento e facilidade de manutenção [7]. A modularidade e portabilidade inerentes ao Docker facilitam a replicação, distribuição e manutenção de sistemas complexos, incluindo aqueles dedicados à preservação digital e cultural, mesmo face a mudanças tecnológicas significativas [17].

Em síntese, a estratégia de contentorização não só contribui para a preservação técnica dos sistemas, como também garante a manutenção e transmissão do conhecimento cultural e tácito acumulado ao longo do tempo. Esta abordagem assegura a sustentabilidade e relevância contínua dos *frameworks* tecnológicos, em consonância com as recomendações mais recentes da investigação académica sobre computação em nuvem, *DevOps* e preservação digital [7].

5 Implementação técnica

O sistema em questão utiliza uma arquitetura híbrida e modular, meticulosamente projetada para combinar requisitos rigorosos de processamento em tempo real com a preservação da autenticidade cultural das Tapeçarias de Portalegre. Esta abordagem estrutural integra uma plataforma baseada em inteligência artificial, desenvolvida em *Python* para processamento de dados e *machine learning*, com um ambiente de execução assíncrono em *Node.js*, responsável pela orquestração de serviços distribuídos e comunicação eficiente entre componentes. A recente capacidade nativa do *Node.js 22.x* para aceleração GPU através de CUDA demonstrou uma redução significativa nas latências associadas à inferência de modelos de inteligência artificial [24]. Práticas recomendadas no ajuste de micro serviços, como *pooling* eficiente de conexões e mecanismos de gestão assíncrona de erros, garantem uma escalabilidade robusta sem comprometer o desempenho global.

Este termo refere-se ao processo de *empacotar* software em contentores, que são unidades padronizadas de software que incluem código e todas as suas dependências, permitindo que as aplicações sejam executadas de forma rápida e fiável em diferentes ambientes de computação.

O ciclo operacional deste sistema começa com a aquisição contínua de imagens, seguido por etapas rigorosas de pré-processamento destinadas à filtragem de ruído e à extração dos movimentos gestuais dos utilizadores. Estes gestos são analisados e classificados num contexto cultural específico, utilizando modelos treinados para reconhecimento de interações naturais, semelhantes às aplicadas em museus virtuais [20]. A partir desta interpretação, ocorre a criação dinâmica de texturas visuais e composições sonoras inspiradas nas técnicas tradicionais das Tapeçarias de Portalegre. Para manter níveis mínimos de latência, o pipeline de síntese visual utiliza técnicas de renderização aceleradas por GPU, semelhantes às usadas na digitalização volumétrica avançada de património cultural tridimensional [6].

O sistema dispõe de regras estruturadas, armazenadas em arquivos JSON validados por esquemas formais, permitindo uma atualização fácil e controlada das paletas cromáticas, gestos reconhecidos e padrões visuais disponíveis. Esta gestão eficaz responde diretamente às recomendações de rigor e integridade semântica exigidas em projetos de salvaguarda digital do património cultural [26].

Por fim, o desempenho e a eficácia do sistema são continuamente avaliados por meio de indicadores-chave; a rapidez da interação é medida por métricas precisas de latência; a diversidade criativa é quantificada através de medidas de entropia visual e sonora entre diferentes sessões de interação; e o envolvimento dos utilizadores é monitorizado pela duração das sessões e pela satisfação reportada através de questionários periódicos. Estes dados são integrados num processo iterativo de melhoria contínua, garantindo uma evolução equilibrada entre inovação tecnológica e respeito pela herança cultural que fundamenta todo o projeto.

5.1 Validação Empírica e Metodologia de Investigação

Este estudo posiciona-se como um ensaio teórico-conceptual, alicerçado numa investigação prática. A metodologia de investigação-ação foi central para o desenvolvimento e validação do framework "UrdiSynth42". As obras *figitais* criadas, como "ChromaFlow", não foram apenas objetos de estudo, mas também instrumentos de investigação que permitiram testar e refinar a arquitetura proposta em ciclos iterativos.

A validação empírica do framework "UrdiSynth42" foi realizada através da criação de quatro obras *figitais* específicas, demonstrando de forma tangível as capacidades operacionais do sistema. Este ecossistema criativo foi desenvolvido, iterando na obra de Manuel Cargaleiro. As obras incluem "ChromaFlow", uma instalação interativa que explora fluxos cromáticos dinâmicos através do reconhecimento de gestos e algoritmos generativos; "TexturaMesh", que recria digitalmente a densidade e a trama das tapeçarias utilizando simulações físicas; "GeometricSonata", que interpreta a gramática modular de Cargaleiro através de malhas visuais generativas; e "TemporalWeft", que investiga as dimensões temporais da tecelagem por meio de redes neurais recorrentes. Cada obra foi concebida como um estudo de caso específico, explorando uma dimensão estética fundamental (cor, textura, forma e tempo). Estas operam num sistema de intercâmbio dinâmico que assegura uma interdependência adaptativa entre todas as componentes. Os resultados obtidos através desta

experimentação prática evidenciam que o framework consegue preservar a autenticidade cultural das Tapeçarias de Portalegre, ao mesmo tempo que introduz novas possibilidades expressivas, confirmando a viabilidade da abordagem *figital* proposta para a preservação dinâmica do património cultural.

6 Discussão e contribuições

Este estudo demonstrou a capacidade da arte *figital* em criar diálogos entre tradição e tecnologia, superando a visão simplista que posiciona estes elementos como antagonistas. Através da implementação do *framework* "UrdiSynth42", foi demonstrado que processos históricos de virtualização são perfeitamente compatíveis com abordagens tecnológicas, especialmente em contextos culturais complexos como o das Tapeçarias de Portalegre. A fundamentação teórica deste argumento baseia-se em Lévy [13], que define a virtualização como deslocamentos identitários para campos de potencialidade.

A investigação confirmou a hipótese inicial de que a virtualização não é um fenómeno restrito à era digital, mas sim um processo histórico-cultural contínuo, identificado nas cinco dimensões de transcodificação das Tapeçarias de Portalegre (dimensional, material, técnica, temporal e interpretativa). Estes paralelismos com processos digitais contemporâneos validam a integração sistémica proposta por Lévy [13], reforçando o entendimento da virtualização como deslocamento identitário em potenciais expressivos novos, sem perda da autenticidade cultural.

Os princípios propostos – diversidade sistémica, interdependência adaptativa e emergência controlada, revelaram-se particularmente eficazes na criação de um ecossistema *figital* coerente. O princípio da diversidade sistémica, que conjuga técnicas tradicionais com ferramentas digitais [4], permitiu a coexistência harmoniosa de múltiplas modalidades expressivas e técnicas. A interdependência adaptativa promoveu uma dinâmica fluida entre interações síncronas e reflexões assíncronas, enriquecendo significativamente a profundidade criativa das práticas artísticas, conforme destacado por Duester [8], que sublinha a relevância das tecnologias digitais na adaptação contínua dos processos criativos. Finalmente, o princípio da emergência controlada assegura uma inovação culturalmente informada, protegendo as tradições históricas contra uma eventual descaracterização causada pela experimentação tecnológica desenfreada [21].

A arquitetura técnica proposta, estruturada em quatro camadas (**perceção, cognição, expressão e coordenação**), demonstrou robustez e escalabilidade na prática. As camadas operaram com fluidez e eficiência graças à utilização de tecnologias como visão por computador, *machine learning* e síntese generativa, além da gestão eficaz proporcionada pela camada de coordenação, alinhando-se com as propostas de Sadnan [23] sobre sistemas distribuídos.

Além disso, o uso estratégico de tecnologias de contentorização em Docker garantiu a preservação da integridade funcional e cultural das experiências desenvolvidas. Esta abordagem modular facilita não só a gestão técnica, mas também promove uma memória cultural digital contínua, essencial para a preservação e continuidade do conhecimento artístico e técnico, em concordância com Muzumdar [17].

6.1 Desafios Éticos e Contextuais

A implementação de *frameworks* como o "UrdiSynth42" levanta importantes desafios éticos e contextuais que merecem uma reflexão profunda. A questão da acessibilidade tecnológica é central; a dependência de hardware e software especializados pode criar barreiras significativas, limitando a participação de artistas e comunidades com menos recursos. É imperativo, portanto, explorar soluções que utilizem tecnologias de baixo custo e código aberto para democratizar o acesso a estas ferramentas criativas.

Outro desafio crucial é o da apropriação cultural. Ao trabalhar com património cultural, como as Tapeçarias de Portalegre, é fundamental garantir que a tecnologia não se torna um vetor de descaracterização ou apropriação indevida. A colaboração estreita com as comunidades detentoras do saber tradicional, a atribuição de crédito e a partilha de benefícios são práticas essenciais para assegurar que a inovação tecnológica serve a preservação e não a exploração cultural. O *framework* "UrdiSynth42" procura mitigar este risco através da integração de conhecimento cultural específico nos seus modelos, mas a vigilância ética e o diálogo contínuo permanecem indispensáveis.

O presente projeto oferece contribuições relevantes em múltiplos níveis, teórico, prático e metodológico:

Teórica: Reafirma e expande o entendimento da virtualização como um fenómeno histórico contínuo, aprofundando a teoria de Pierre Lévy [13] ao aplicá-la a contextos artísticos específicos como as Tapeçarias de Portalegre. Além disso, introduz o conceito de "metabolismo computacional" como um modelo explicativo útil para compreender as interações híbridas no campo da arte *figital* contemporâneo [4].

Prática: Apresenta o *framework* "UrdiSynth42", que serve como referência técnica e conceptual para artistas e investigadores que desejem explorar práticas *figitais* informadas cultural e historicamente. Este *framework* fornece uma base robusta para a criação de obras que equilibram inovação e tradição, permitindo aplicações diretas em museus, galerias e outros contextos culturais, fundamentado nas práticas híbridas descritas por Lupo [14].

Metodológica: Propõe uma abordagem estruturada e replicável que pode ser adotada por futuras investigações em áreas semelhantes. A combinação de metodologias técnicas, como a integração de visão por computador [16], *machine learning* [2], síntese generativa [12] e contentorização [22], oferece um modelo claro para futuros desenvolvimentos na intersecção entre arte digital e património cultural.

Em resumo, o presente estudo avança significativamente na compreensão e aplicação prática da arte *figital*, oferecendo uma base sólida para futuras investigações e práticas artísticas que desejem manter viva a tradição cultural enquanto exploram possibilidades tecnológicas.

7 Conclusão

A investigação realizada demonstrou que a arte *figital* não representa uma rutura histórica ou tecnológica, mas sim uma evolução natural e coerente de processos culturais já estabelecidos, encontrando nas Tapeçarias de Portalegre uma expressão paradigmática.

Através de uma análise minuciosa, verificou-se que a virtualização histórica está profundamente enraizada nas práticas artísticas, sendo uma constante transcultural que precede a era digital.

A virtualização, longe de implicar uma desmaterialização do património cultural, possibilita uma expansão ontológica e expressiva, permitindo novas formas de interação e perceção cultural sem comprometer a autenticidade. O *framework* "UrdiSynth42" exemplifica esta potencialidade, oferecendo uma estrutura técnica e conceptual robusta que preserva o valor cultural histórico, enquanto promove abordagens sustentadas tecnologicamente.

A arquitetura em camadas, que combina estratégias de visão por computador, inteligência artificial, síntese generativa e contentorização, provou ser robusta e eficaz, confirmando a hipótese inicial de uma integração equilibrada entre tradição e inovação tecnológica. Este equilíbrio é particularmente relevante no contexto das Tapeçarias de Portalegre, onde o diálogo entre o artesanal e o digital preserva e revitaliza continuamente o património cultural.

Finalmente, salienta-se a relevância da abordagem metodológica proposta, que pode servir como modelo replicável para investigações e práticas artísticas futuras. Ao incorporar princípios como **diversidade sistémica**, **interdependência adaptativa e emergência controlada**, o estudo contribui significativamente para a sustentabilidade das artes *figitais*, garantindo a continuidade e a relevância do legado cultural face a um panorama tecnológico em constante evolução.

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Make America Great Again and Again: Voices Across the World

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Abstract

Make America Great Again and Again (MAGAA) appropriates the exclusive political slogan "Make America Great Again" to create an inclusive phenomenon. *MAGAA* invites visitors beyond the U.S. border to an exhibition space, transforming it into a playable public sphere where they can manipulate or maintain a large American flag displayed on a white wall, accompanied by the Star-Spangled Banner song. *MAGAA* is an ever-evolving open work, as it circulates at different exhibition events. Rather than providing a definitive answer to the questionable slogan "Make American Great Again," this project offers a playable public platform for participants to discuss diverse perspectives on the concept of "make America great again." This process naturally visualizes a temporal collage, transitioning from the American flag image to a multi-screen representation created by participants via YouTube.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Interactive art, participatory art, YouTube, internet art

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1 Introduction

According to media archaeologist Erkki Huhtamo, the concept within media undergoes a process of (re)cycling, a phenomenon he refers to as 'topos (plural: topoi)'—a recurrent and enduring theme [1]. Utilizing the American flag as a collage-based image in art is a prime example of such a topos. Renowned artist Jasper Johns, for instance, employed his iconic American flag image as newsprint collage on canvases, while Nam June Paik incorporated symbolized media images on television sets. Likewise, 'Make America Great Again' is a topos—a recurring phrase, predominantly associated with conservative politicians, including figures like Alexander Wiley, Barry Goldwater, and Ronald Reagan. More notably, President Donald Trump adopted this slogan for his last presidential campaign. This political phrase became a subject of controversy, entangling themes of racism, patriotism, and (ultra)nationalism.

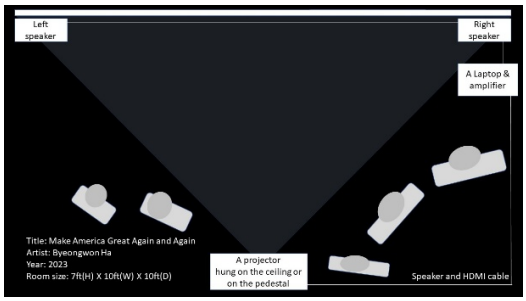


Figure 1: The floor plan for *MAGAA*. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha



Figure 2: The default projected image of *MAGAA*. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

In between these topoi context, *Make America Great Again and Again* (*MAGAA*), visualizes collage-based YouTube images through the internet, reflecting not only the evolution of technology in art but also the enduring fascination with the American flag as a compelling/controversial subject for both artists and audiences. As open work of participatory interactive art, *MAGAA* does not simply criticize the conservative slogan but delves into the appropriation of this exclusive idea as an inclusive one, facilitating visitor participation and fostering conversations about the complex web of meanings intertwined with this recurring and politically charged topos.

2 The Concept of MAGAA

The style of *MAGAA* draws parallels to Nam June Paik's video sculpture, *Video Flag* (1996), which features a massive American flag comprised of algorithmically mesmerizing moving images displayed across 70 television sets [2]. By reinterpreting Paik's approach with emerging technology, the Internet, *MAGAA* collects separate 60 parts of an American flag from live YouTube, one by

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Figure 3: The projected image of *MAGAA* with visitors' participation. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

one, as a spatial montage to compose a grand fluttering American flag image. To bring this flag image to life, *MAGAA* accesses video clips from the top YouTube search results for titles ranging from 'MAGAA_Project01' to 'MAGAA_Project60,' all of which were previously posted by the creator using these titles. The titles were never used for other projects before. So each title search result will show a part of the American flag image on the top. The 60 small screens of MAGAA align with the duration of one hour. Each minute corresponds to the top YouTube clip for that specific minute—'MAGAA_Project01' during the first minute, 'MAGAA_Project02' during the second minute, 'MAGAA_Project30' at the half-hour mark, and the cycle repeats every hour. Following the display of a video clip for a minute, each screen retains the last frame as a still image. While the rest of 59 small screens show still images respectively, *MAGAA* presents a single, small moving image with the American Anthem, the Star-Spangled Banner, for each minute, encouraging visitors to engage with the content on each small screen for a full minute. In the exhibition space, an algorithm governs the presentation of each image, creating an ephemeral collage-based image on the white wall. The instructions for this playable net.art are provided in the exhibition space.

The instructions are as follows: Using your cellphone, create a one-minute selfie video discussing the idea of "Make America Great Again." Film in Full-HD mode with the figure centered. Alternatively, use this mask if you prefer not to share your face image. Post your selfie video with the title: MAGAA_Project followed by a random number between 01 and 60, with an underscore in between. For example, MAGAA_Project07.

By adding "&sp=CAI%253D" to the end of each YouTube search result address, it allows sorting by upload date, ensuring that the latest uploaded video with each title will be played. Dependent on the audience's contributions, *MAGAA* can either preserve its original creation, the monumental American flag with the repetitive American Anthem, or transform into a collage-based composition featuring participants' moving images. Additionally, visitors have an opportunity to listen to the voice of each video clip for a minute while the American flag image undergoes its transformation into a collage-based representation, incorporating participants' video clips.

3 MAGAA as Participatory Art in the Expanded Field

Every minute, the computer program Max 8 presents the display of a single video clip on a small screen, progressing across the entirety of a white wall from left to right and from top to bottom. Upon showcasing each moving image with its corresponding audio, the program culminates the presentation with a freeze shot, leaving viewers with a silent image in the last frame. The selection of video clips is executed according to their rank, utilizing the titles 'MAGAA_Project01' to 'MAGAA_Project60.' Put differently, every hour, each small screen located in the same position will present the top-ranked link in order. If a visitor uploads a video clip using the title 'MAGAA_Project10,' their video clip will ascend to the top rank and replace a portion of the American flag at the top of the right corner display with their own content since the YouTube in *MAGAA* was set up to find the latest video with the title. The collective involvement of multiple visitors in the same participatory process results in the transformation of the American flag into a composite, collage-based image, featuring a diverse array of video clips. To materialize the dynamic process of showcasing each YouTube video clip, several elements come into play, including the use of jweb, jit.str.regexp, jit.desktop, and 11strokes&11clicks objects in Max 8 [3]. The jweb object empowers creators to incorporate the YouTube website within a Max patcher, while the jit.str.regexp object identifies the top-ranked YouTube link. Sometimes, YouTube suggests a commercial video clip at the top instead of a video clip with the exact title. To address this issue, the project utilized the "watch\? v =" filter keyword, enabling it to avoid the commercial video links. To prevent short commercials before playing each image, a YouTube Premium subscription was required. Subsequently, jit.desktop crops the YouTube video image and transmits it to each small screen. Finally, the 11strokes&clicks objects govern keyboard and mouse activities respectively, simulating the act of surfing the YouTube website. These sequential actions replicate a user's real-time interaction with YouTube, fostering a genuine connection between the project and the platform. This revelation can encourage visitors to take part in adding their video clips to the whole screen. As visitors await the updates, they engage with each small screen and may listen to the voices of others, extending the interactive experience beyond the confines of the screen-based project itself. In essence, this project serves as participatory art in the expanded field.

4 MAGAA as Open Work

MAGAA serves as a platform that offers audiences a public sphere where they can engage in dialogues about 'Make America Great Again.' Visitors are encouraged either to uphold the default image of the American flag or to deconstruct it according to their own perspectives by posting their own video clips. As implied by 'Again and Again,' this project thrives on the repetitive participation of visitors within a sustainable interactive environment. In addition, while exploring the titles, visitors also encounter diverse postings by other participants. This will be a significant opportunity to listen to other voices from different perspectives. It is intentionally designed to be exhibited asynchronously across diverse countries,

shedding light on the internal and external perceptions of the American image. While traveling around the world, sometimes, *MAGAA* returns to the United States and shows a collage-based American flag image, facilitating a transatlantic, transpacific, transcultural, and even virtual dialogues beyond the physical boundaries. This serves as a playable public sphere for the exchange of diverse perspectives on opinions, responsibilities, and critiques related to the concept of 'Make America Great Again.'

Instructions for Visitors at the Onsite Exhibition: Record a one-minute selfie on your phone, sharing your thoughts on the meaning of "Make America Great Again."

1. Upload your selfie to YouTube with a title between "MAGAA_Project01" and "MAGAA_Project60." Don't forget to include an underscore between "MAGAA" and "Project."
2. By following these instructions, you consent to your selfie being used for this project. If you do not wish for it to be used, set it to private to prevent it from being searched.
3. If you are uncomfortable showing your face, feel free to use one of the provided masks.
4. Your selfie will be played in the next cycle of this live, collage-based video until another participant uploads a selfie with the same title.

MAGAA functions as a public sphere that listens to diverse voices beyond the limits of an exhibition space. Online users can access these voices by searching for the same title on YouTube. Unlike the collage-based screen image, which only displays the latest video clip under the search title, YouTube users can explore the history of each video clip by searching individual titles. This project continues to evolve repeatedly, regardless of whether one visits the physical exhibition space. In other words, *MAGAA*, as an open work, is not merely an interactive piece confined to a specific exhibition space but a public sphere that exists on YouTube and within the broader world.

5 The Exhibition History of MAGAA

Reflecting its evolving nature, *MAGAA* has developed across diverse platforms to engage with a wider range of international participants. The project was first exhibited through the online platform Styly as part of the Constellations exhibition session at the International Symposium on Electronic Art (ISEA) in Brisbane, Australia, in 2024. A virtual reality version of *MAGAA* was also presented in the Demo Session at the ACM Symposium on Virtual Reality Software and Technology (VRST) in Trier, Germany, in 2024. In 2025, the offline mobile version of *MAGAA* was exhibited at the Workshop on New Media Art Archiving 2025 at the Center for Art and Media (ZKM) in Karlsruhe, Germany. At ARTECH 2025, the original installation version of *MAGAA* will be presented to further encourage participants to engage in manipulating this open work.

6 Conclusion

MAGAA transcends the aim of merely collecting opinions about the phrase "Make America Great Again" within the United States. Rather than confining itself to a national discourse, this project operates as a playable public sphere—an open platform where individuals across geographical, political, and cultural boundaries can engage in dialogue and reinterpretation. By inviting audiences beyond U.S. borders to participate, *MAGAA* transforms a historically charged slogan into a site of critical reflection, negotiation, and reimagination. Each new iteration of *MAGAA*—whether exhibited online, in virtual reality, or as a physical installation—extends the work's reach, enabling it to resonate within diverse sociopolitical contexts. As these versions emerge in different countries, they collect and juxtapose a wide spectrum of global voices. Through this process, *MAGAA* encourages a dialogic exchange that not only decouples the slogan from its original political framework but also reframes it through the lived experiences and cultural interpretations of participants worldwide. Ultimately, the project's international re-enactments function as an ever-evolving conversation—an ongoing effort to broaden the horizon of American self-understanding. By fostering encounters with multiple, and sometimes conflicting, perspectives, *MAGAA* highlights the productive tension that arises from difference. In doing so, it cultivates an awareness of interconnectedness and mutual influence, inviting audiences everywhere to reconsider how national narratives are shaped, challenged, and redefined in the global public sphere.

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From Sunlight to Qubits: Visualizing Analogies between Photosynthesis and Quantum Information Systems

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Abstract

This paper explores the intersection between art, science, and technology by examining the conceptual parallels between photosynthesis in plants and quantum computing. Taking into account aspects from biology, quantum physics, and computer science, the study investigates how energy transfer mechanisms in photosynthesis can be metaphorically related to quantum logic operations in computing. This research begins with the use of cellular automata governed by intuitionistic fuzzy logic and then programmed with quantum logic to generate visual representations of complex interactions that simulate certain characteristics of photosynthesis observed through quantum logic. By integrating these computational models into generative video art, the project creates an audiovisual experience that embodies the probabilistic and emergent behaviors observed in both living systems and quantum algorithms. The research demonstrates how artistic practice can serve as a transdisciplinary metodology to reflect and visualize the connections between natural and artificial processes, offering new perspectives on the dynamics of information, uncertainty, and complexity in contemporary art and science.

Keywords

Art science and technology, quantum computing, photosynthesis, video art.

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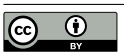
1 Introduction

What are the possible relationships between a plant and a computer? From a perspective that includes studies based on biology, quantum physics and computing, this reflection attempts to answer the previous question to establish an understanding of natural physiological processes in plants and find equivalences with the operation of computer systems based on quantum logic. The purpose of this study is to explore the parallels between energy transfer in photosynthesis and quantum computational algorithms. For this reason, it establishes a poetic and conceptual approach, structuring itself as a theoretical study that relates concepts and knowledge from the fields of quantum computing and biology to the visual arts, considering a work that combines video with generative art.

Hence, in the present work we explore the properties of quantum algorithms relating them with biological studies, i.e., with some characteristics in the process of photosynthesis. The following text is structured initially with a discussion in the field of computing with an understanding of probabilistic computational models that form a base for the understanding of quantum computational models. More specifically, we first consider the application of John Conway's Game of Life cellular automata, using an implementation based on intuitionistic fuzzy logic. On top of that, we build an algorithm for the automata's cell interaction based on the laws of quantum mechanics. The idea is to generate visual representations of cellular interactions that simulate the quantum aspects of photosynthesis. Finally, we present a poetic research process that explores these concepts through generative art and video art. So far, along with this article, the research has been presented as a video art artwork and a live audiovisual performance.

The integration of cellular automata and fuzzy logic provides a computational metaphor for complex interactions as the degree of uncertainty in cell interactions. Wolfram's [12] seminal work on cellular automata demonstrates how complex, emergent patterns can arise from simple, localized interaction rules. By incorporating intuitionistic fuzzy logic, these models can capture the inherent uncertainty and probabilistic nature of quantum and biological systems.

Automata theory was introduced in the 1940s in the multidisciplinary field of mathematics, linguistics, neurophysiology and engineering. Initially, the main idea was to develop machines, inspired by the work of Alan Turing (Turing Machines), to model the cognitive processes of the brain. In 1943, McCulloch and Pitts [9] proposed an abstract model, called neural networks, to explain the behavior of neurons using finite state machines (FSM) as a model of behavior. In an FSM, there are a finite number of states and rules that, based on the current state and a given input, the machine performs a state transition and produces an output. Thus, the proposed model associates the state transitions with the activation of artificial neurons. Basically, the authors proposed a way to mathematically formalize the behaviour of biological neurons, creating a model that could be used to explain cognitive processes in computational terms. The use of cellular automata to simulate life forms, as has been used in computer art since at least the 1970s, allows the visualization of interactions between cells in graphic forms and patterns generated according to computer programmed rules.



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Another prominent model in automata theory is Cellular Automata (CA). CAs are abstract, discrete computational models that can be used in a natural way to represent the dynamics of complex systems in various scientific areas, such as physics, biology, microstructures, the study of pattern formation, chaos, self-replication, etc. The CA model is defined using a finite set of basic units called cells. Cells have an initial state and evolve in parallel, in discrete time steps, according to a state transition function, i.e. they act on a set of simple rules to produce dynamic patterns. The evolution of a cell's state is determined by the states of the cells in its local neighborhood. They can be seen as models for life.

CAs are computational systems in the sense that they can solve algorithmic problems and, moreover, with an appropriate set of rules, they can behave like the universal model of computation known as Universal Turing Machines. Therefore, they can be used to solve any computable problem, in accordance with the Church-Turing Thesis (1967).

An example of a universal cellular automaton is John Conway's Game of Life [7]. The Game of Life was defined with an interest in recreational computing, but was later investigated as a universal model of computation, making analogies with logic circuits. In the Game of Life, the domain is an infinite two-dimensional grid of cells that can be in one of two possible states: alive (1) or dead (0), and which evolve according to a list of rules taking into account the states of the eight neighbors, either in a vertical, horizontal or diagonal direction.

Fuzzy logic is a type of logic that allows degrees of truth, rather than just true or false values. In traditional or classical logic, a statement is either true or false, but in fuzzy logic, a statement can be partially true or partially false. Intuitionistic fuzzy logic [1] is an extension of fuzzy logic that allows a more subtle and flexible approach to reasoning, taking into account the degree of uncertainty or hesitation associated with the system. Using the rules of intuitionistic fuzzy logic, it is possible to have a more complete representation of the complexity and ambiguity of real-world problems.

For example, suppose we want make statement about the probability of an event occurring. In traditional fuzzy logic, we could say that the probability is "high" or "low" based on a numerical scale from 0 to 1. However, in intuitionistic fuzzy logic, we can also indicate our degree of hesitation or uncertainty about the probability. Therefore, fuzzy sets are an extension of classical sets, where their members have degrees of pertinence (between 0 and 1). Thus, they are a generalization that considers, in addition to the pertinence function, a non-pertinence function.

Fuzzy logic has an interesting relationship with quantum computing and artificial intelligence, especially when it comes to modeling the behavior of algorithmic systems that involve uncertainty, ambiguity and complexity. Both areas seek solutions to problems in which classical or deterministic systems are not sufficient to capture the dynamics of real phenomena.

Quantum computing [10] is a computational paradigm based on the principles of quantum mechanics, such as superposition, entanglement and quantum interference. In classical computing, the transistors in modern integrated circuits act as switches that represent the binary values of 0 and 1, based on the presence or absence of electric current. This switching mechanism is the basis for the bits, which are the fundamental unit for encoding and processing information in classical computing. In contrast, quantum computing uses a quantum physical system, the qubit to encode and process information. Qubits can be physically implemented using quantum mechanical systems, such as the polarization states of photons, the spin direction of electrons, or the energy levels in ions or atoms, among other very small systems at the subatomic scale.

Thus, quantum computing uses qubits (or quantum bits), which can be in the states 0, 1 or any linear combination (superposition) of them. Each state in the superposition has a certain intensity, called the probability amplitude, which determines the chance of the qubit being observed as 0 or 1 when measured. Thus, the qubit can represent multiple states simultaneously, unlike the classical bit, which can only be in a single state at a time. This property of superposition is crucial for quantum parallelism and the computational power of quantum computers.

The probabilistic characteristic of quantum physical systems is due to the process of measuring or observing them. When a qubit in superposition is measured, it collapses into one of the basic states 0 or 1. The probability of collapsing into each state is determined by their probability amplitudes. Another characteristic of qubits is the entanglement, which is a strong correlation between two or more qubits, so that the state of one qubit cannot be described independently of the state of the others. When two qubits are entangled, the measurement of one of them instantly determines the state of the other, even if they are separated by large distances. Also, in quantum systems, their probability amplitudes can interfere constructively or destructively, depending on their relative phases.

The properties of quantum physical systems allow quantum computers to perform highly parallel calculations and tackle optimization problems, simulation of quantum systems and analysis of large volumes of data with an efficiency that surpasses classical methods. More specifically, considering the main characteristics of quantum systems and fuzzy logic for dealing with uncertainty and probabilities, some more specific relationships can be established: i) in quantum computing, uncertainty is intrinsic to systems due to the principle of indeterminacy and the probabilistic nature of measurements; in fuzzy logic, uncertainty is modeled explicitly using degrees of pertinence, which can represent how much an element belongs to a set; ii) In quantum computing, the superposition state allows a qubit to exist simultaneously in multiple states; similarly, in fuzzy logic, an element can belong to different sets with different degrees of pertinence. This similarity suggests that fuzzy logic can be used to interpret or manipulate quantum states, especially when representing quantum systems in the real world.

In addition, it is relevant to mention that in artificial intelligence (AI) applications, neural networks and machine learning algorithms can be trained to identify complex, non-linear patterns in data sets, allowing the system to learn from real data. Fuzzy logic acts in this context as a means of dealing with imprecision in the data, helping the AI system to make decisions based on incomplete or ambiguous information, something we can find, for example, in models of biological systems.

In this way, the system learns from the interactions of cells and adjusts its fuzzy rules over time, allowing a more accurate and dynamic representation of biological processes. As in real life, this

reflects behavior that is not governed by fixed and deterministic rules, but by a set of possibilities and interactions that are modeled in a flexible and adaptive way.

The model used in the first version of the present work was based on an implementation of Conway's Game of life using intuitionistic fuzzy logic using Processing programming language. By implementing intuitionistic fuzzy logic into the code of the Game of life algorithm, we believe that it becomes possible to explore a greater degree of uncertainty in the interactions of cells, as occurs in the principles of quantum superposition, in which states can present different degrees of probability, rather than behaving in a binary way.

More specifically, in the traditional Game of Life, the grid of cells evolves according to classical binary rules that determine the birth (state 1), survival, or death (state 0) of cells based on the states of their neighboring cells.

In the intuitionistic fuzzy version of the Game of Life, the concept of cell state is extended: each cell is associated not simply with a binary state (alive or dead), but with an intuitionistic fuzzy value, which consists of three components: a degree of membership (μ), a degree of non-membership (ν) and a hesitation margin ($\Pi = 1-\mu-\nu$), reflecting uncertainty or hesitation.

A cell is alive if and only if its degree of membership exceeds a certain threshold while taking into account the degree of non-membership and hesitation. The classical rules of birth and death are replaced by this intuitionistic fuzzy transition rules, which use the estimations of the neighboring cells' states. These rules compute the new state of a cell by aggregating the membership and non-membership degrees of its neighbors.

This approach allows the Game of Life to model gradual transitions between states, capturing uncertainty and partial truth values instead of just 0 or 1 states. For instance, a cell may be partially alive with a certain confidence level, partially dead with another, and some hesitation, reflecting incomplete or ambiguous information about its environment.

Moreover, the resulting dynamics of the intuitionistic fuzzy Game of Life show richer and more nuanced behaviors than the classical one, including fuzzy boundary propagations, wave-like patterns, and inherently probabilistic or uncertain evolutions of cells. This makes the system better suited for modeling complex natural or social phenomena where clear-cut states are an oversimplification.

Following this first implementation, we extended it with quantum-inspired rules of interaction, where for each cell was assigned a `noiseVal`, that is, a controlled random variable that simulates the cell's state fluctuation, analogous to a qubit's superposition. Prior to state updates, this `noiseVal` determines whether the cell "collapses" into alive or dead, representing uncertainty similar to the quantum wavefunction collapse.

The updated rules mimic entanglement-like interactions between neighboring cells, where the state of one cell non-deterministically influences the states of others. This interaction goes beyond the classical, local rules of Conway's Game of Life, introducing collective behaviors reflective of quantum correlations and probabilistic dependencies.

The model does not explicitly simulate qubit state vectors or quantum operations. Instead, it focuses on creating visual effects that convey the ideas of uncertainty, superposition, and multiple simultaneous possibilities, providing an intuitive quantum behavior to the dynamics of cellular automata.

Therefore, by programming a machine based on the laws of quantum mechanics, it is possible to develop a computer system that exhibits an unpredictable mode of action and a capacity for learning from the environment, with high complexity. Similarly, living systems are also characterized by their operations based on complex biological processes such as the transfer of energy present in the process of photosynthesis, which can be observed by investigating biochemical reactions or the flow of electrons through cell membranes.

Photosynthesis, a fundamental process not only for the plant kingdom, but for the biosphere on the planet Earth, can be briefly explained as a process of capturing and converting sunlight into chemical energy. During photosynthesis, sunlight is absorbed and electrons are transported between molecules until they reach the plant's reaction center, where the photon energy is transformed into chemical energy.

Recent observations of non-classical aspects of molecular vibrations in biological systems may lead to novel approaches in the study of energy transfer, not only in photosynthesis but also in other biomolecular processes. These findings indicate that quantum effects play a fundamental role in biological functions

Biological systems are known for their ability to capture and process information about the conditions and environment around them in order to find strategies for adaptation and survival. Brody [2] points out some situations that demonstrate the ability of biological systems to process information, for example, when a plant root encounters another root, it can detect whether it belongs to another type of plant. The bean plant is able to detect the existence of objects in its vicinity without physical contact; the parasitic dodder plant can process olfactory signals to distinguish the different levels of nutrients in plants and identify host locations.

Based on the process of photosynthesis from a quantum perspective, it is believed that the transfer of solar energy in plant cells takes all possible paths at the same time to reach the reaction center. Experiments carried out by Fleming et al. [6] show that the energy that reaches one chlorophyll, instead of being "thrown" to the next, is shared between the two, i.e. the energy is shared by both molecules instead of existing only in one or the other. According to Fleming et al. (2011), photosynthetic organisms use quantum superposition and tunneling mechanisms to optimize energy transfer. While researchers such as Matarèse, B. F. E.; Rusin, A.; Seymour, C.; and Mothersill, C. [8] hypothesized that plants exhibit quantum tunneling in photosynthesis, finding that plants have the ability to make energy reach the right places at the right times.

Previous studies on the macromolecules responsible for capturing sunlight and transferring energy were explained by observing the wave-like vibrational behavior of classical logic. Quantum biology, as a still recent field of study, was coined by Erwin Schrodinger in 1944 in his publication "What is Life? The Physical Aspect of the Living Cell" [11], addresses the non-classical properties of vibrational movements in processes present in photosynthesis that reveal a function for non-trivial quantum phenomena in biology.



Figure 1: Still Frame from video art shows light dots projected on leaves. Source: authors' personal archive



Figure 2: Photographic record of a live audiovisual performance held in 2025.

The most recent research involving quantum computing and quantum biology compares this biological process of photosynthesis with the functioning of quantum algorithms, which are characterized by the use of probabilistic phenomena to solve problems with great efficiency that classical algorithms could hardly achieve. Computers based on quantum logic are capable of scanning all possible options to choose the most efficient alternatives and solutions to a given problem. In analogy to what happens to plants during photosynthesis, the energy captured, transported and generated in the process of photosynthesis is able to travel through the leaves with great efficiency. This makes it possible to associate the natural processes of biological systems with the principles of quantum mechanics used in quantum computers to achieve greater computational efficiency.

These approximations between different scientific fields also instigate artistic creation, where it is possible to explore such concepts with a more intuitive and poetic approach. Recently, we've started to develop some process to combine generative art with video resources to create an audiovisual experience that uses biology and quantum computing studies as a starting point. In this way, we generated graphs based on the Game of Life and captured video of the leaves of a plant. At first, the graphs were obtained by incorporating intuitionistic fuzzy logic into cellular automata and then quantum computing rules were implemented to simulate patterns of quantum cell behavior in parallel to biological processes.

In the artwork in question, intuitionistic fuzzy logic and also quantum inspired rules were implemented in the algorithm responsible for generating videos in Processing demonstrating the uncertainty in the interactions between cells in the celular automata model. The result was a series of videos with spatially distributed light points with variable intensity and duration based on intuitionistic fuzzy and quantum rules. In a second step, the generative videos obtained with this programming were projected with the video mapping technique onto the surface of a plant, in order to propose a simulation of the plant's energy processing during photosynthesis with the patterns generated from the algorithm, based on the Game of life, showing behavior with a high degree of randomness due to interactions based on the quantum automaton.

The tree chosen for the projection was the araucaria, an ancient species that has already survived major climate changes, considering its presence on Earth over 100 million years ago. One of the characteristics of the tree is the rich energy of its leaves, which once made it a source of food for dinosaurs, as well as the pine cones produced by female plants that release pine nuts and, more recently, serve as food for birds and mammals. However, in Brazil, araucaria is one of the native plants threatened with extinction due to various reasons, such as logging, the expansion of monocultures, the construction of power plants, among others. This situation puts a large ecosystem at risk, as well as other species of plants and animals.

During the mapped projections of the generative video on a young araucaria plant, the video was captured from different angles, scales and perspectives, mainly exploring the scenes made with a macro lens that allowed the projections to be captured in detail. The video material with a certain number of plant scenes was then organized for use in two different situations. Firstly, it was edited in montage software and soundtracked with a musical composition produced with polyphonic synthesizers added, creating a work of video art. After this, we also prepared the video bank in VJing software for presentation in a live audiovisual performance.

It is important to understand that the relationship proposed here as an art-science-technology research is not intended to provide a study for understanding the laws of nature. According to [5], "Contemporary art seems to have come as far away as it can from sharing science's conventionally objective and therefore ultimately consoling vision of a nature governed by rules which underlie all things – its beauty." Furthermore, this research is much more interested in free experimentation with technologies in order to emphasize the experience during the live performance and video projection and the metaphorical visualization of photosynthesis process.

The uncertainties and ambiguities that are part of artistic creation are present in at least two stages of the process, as the graphical generation with quantum algorithm simulation and the live performance itself. In Processing, each execution of the code that simulates the behavior of living forms based on the rules of the

Game of Life, a new graphic configuration and development of interactions on time are obtained. In this research, we aim to explore uncertainty as a characteristic of every interaction between biological systems, first by implementing intuitionistic fuzzy logic in the code and then by simulating the quantum behaviour visualized according to the rules assigned to the algorithms.

It is also possible to think of uncertainty in terms of temporality and improvisation that is constituted in the act of performance with the execution and projection of a live sonorous and visual composition. Along the live performance the choices and moments of action, through the manipulation of visuals and sounds, are unpredictable and involve various factors for each gesture during the creation of the audiovisual experience. Therefore, the interest in ambiguity in creation, as an open work, from perspective of Umberto Eco [4] is configured as a "continuously open process that allows us to always identify new profiles and new possibilities of a form".

In live audiovisual performance, the music is arranged at the same time as the visuals are manipulated for the audiovisual composition that is projected over time. The use of digital and electronic media establishes a relationship between the machine and artist, who performs in dialogue with the controls and determined parameters from programming offered by the machine, while at the same time inserting the factor of instability into the system, which is given by the indeterminacy of possible choices in the act of sound and visual composition. Creating a live work with these technologies allows us to think about the processuality that is present in the experience according the BROECKMAN's [3] notion of process-based art that "refers to the time-based evolution and transformation of describable yet not fully programmed sequences of events that build on one another in a nonteleological manner."

> "If art is 'about' anything, it is a reflection of human experience in complexity and it emanates from an inventive individual with an unusual and sideways view on things, communicating with vigorous visual acuity and daring, its intellectual content, like that of poetry, conveyed through hints and ambiguities. Artists don't 'do' prettification, product or propaganda for the public understanding of science. But they can engage with it and create images which suggest alternative ways of seeing. " [5]

This kind of transdisciplinary approach between biology, quantum physics and computer science shows that bringing different scientific fields together can lead to sustainable technological breakthroughs, such as energy harvesting, and new ways of understanding the universe. This could lead to a paradigm shift in computing, from silicon-based systems to organic models inspired by plants. So, if plants act as quantum computers, they could provide models for the development of more efficient quantum computers that are harmoniously integrated with the environment.

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From Synergy to Method: A Case Study of Transdisciplinary SciArt Practices Between Art and Neuroscience

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Abstract

This paper introduces the ASTER+S project and its participatory method, eco-SciArt, developed to facilitate transdisciplinary collaboration across Art, Science, Technology, and Society (ASTS). The method (structured in three stages, Seeds, Flowers, and Fruits) enables the co-creation of artworks that translate scientific research into experiential and socially engaged forms. Focusing on the Art & Neuroscience edition, this study explores how topics such as brain plasticity, epigenetics, and brain–computer interfaces (BCI) inspired twenty interdisciplinary art prototypes. Through a detailed analysis of the artwork "bI/Onics", the paper examines how scientific insights were transformed into participatory, multisensory installations that foster public understanding and reflection. Results indicate that the eco-SciArt method enhances scientific communication, stimulates artistic innovation, and promotes ethical and emotional engagement with neuroscience and emerging technologies. It promotes transdisciplinary thinking, emotional engagement, and public reflection. The paper concludes that such SciArt practices constitute viable research methodologies that expand the epistemic scope of both art and science by integrating analytical, affective, and speculative dimensions of inquiry.

CCS Concepts

• **Applied computing** → Art and humanities; Media arts.

Keywords

ASTS, SciArt, Parcipatory method, Neuroscience

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1 Introduction

In this paper, we present the ASTER+S project [1], funded by the FECYT (Fundación Española de Ciencia y Tecnologia, Ministry of Science, Innovation and Universities), which aims to provide methodologically supported experiences in two social contexts: educational and cultural. This has been achieved through the co-creation of artworks developed by using our own transdisciplinary participatory hackathon-based method called 'eco-SciArt'. It was successfully implemented in three editions: the first one related to Natural Environment and Artificial Intelligence, the second edition about Sealife & Citizen Science, and the third edition about Neuroscience. Similar types of SciArt practices are becoming a trend internationally, as has been documented in literature [2–5].

Art-Science hackathons, such as Museomix, function as interdisciplinary spaces combining design thinking, participatory methods, and rapid prototyping to foster creative collaboration between artists, scientists, and technologists. These events emphasize experiential learning and transdisciplinary synthesis, where diverse participants co-create innovative solutions and generate new knowledge that transcends traditional disciplinary boundaries. Examples like Museomix, HackArt, and the Quantum Art Hackathon demonstrate how such formats encourage cultural innovation, youth engagement, and philosophical reflection on science and technology. Ultimately, these hackathons establish a "third space" where artistic intuition and scientific empiricism merge, as illustrated by the LIFT_C Hackathon 2025, which promotes ethical and imaginative inquiry [6–13].

The ASTER+S project seeks to foster individual and collective awareness of state-of-the-art research topics, as well as scientific-artistic communication to society, cultural innovation, service-learning, and the encouragement of Art, Science, Technology, and Society (ASTS) vocations. In section 2 the 'eco-SciArt' method is presented. In section 3 the Neuroscience edition is outlined. In section 4 a case study is analyzed in detail, and in section 5 some conclusions are addressed.

2 'Eco-SciArt': a participatory method to foster transdisciplinary outcomes

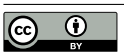
2.1 Project objectives

Among the specific project objectives are:

Obj-A: To promote creative transdisciplinary thinking in the ASTS field, strengthening individual and collective reflection on scientific topics, as well as the emotional connection between communities and local application of SDG challenges.

Obj-B: To encourage social innovation derived from transdisciplinary collaboration among scientists, artists, technologists, humanists, etc as well as citizen science, and local communities (in-person hackathon) or global communities (online hackathon).

Obj-C: To foster artistic innovation based on ASTS in a post-media context (any medium might be used), based on the premise that contemporaneity lies mainly in processes and discourse, and



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ideally those processes may trigger individual's and communities' moving into action.

Obj-D: To develop SciArt artifacts to innovate in the scientific-artistic communication of scientific knowledge and societal challenges, thanks to the involvement of creative people, local communities, in direct contact with top scientists.

2.2 Project method and implementation

In the framework of the "ASTER+S" research project, the 'eco-SciArt' method was created for supporting ASTS experiences with an innovative approach that fosters sustainability (it supports local and online implementations, promoting green practices), inclusion (in terms of gender and age in relation to the hackathon participants) and trans-disciplinarity (creative teams usually include scientists, artists, but also any kind of interested professionals such as mathematicians, psychologists, physicians, philosophers, historians and so on participating in a hackathon based experience). Inspired by nature, the 'eco-SciArt' method includes three main stages (Figure 1):

- **Seeds**: For a few months before the hackathon, scientists are invited to plant "SciArt seeds", i.e. describing state-of-the-art scientific topics according to a multidimensional structure that includes objective dimensions (title, summary, keywords, scientific field and subfield), as well as subjective dimensions (metaphor, metaphysical, ethical, motivational, and synesthetic e.g. colors, sounds, aromas, flavors), procedural (research process, diagram and tools) and additional resources (links, papers, presentations, pictures, videos, etc). These "SciArt seeds" are published on a website [14] after being delivered by inspiring scientists.
- **Flowers**: After all the seeds are published, creative teams are invited to foster the development of new art projects called 'SciArt Flowers' that reflect the synergy between ASTS. Usually two SciArt hackathons (local and online) are undertaken for three days each one to support the co-creation of the "SciArt flowers" in transdisciplinary creative teams. The goal is for artistic projects to bloom from "seeds" to "flowers". Participants may come from any discipline (artists, architects, engineers, designers, psychologists, etc). The "flowers" (artistic proposals) are developed and presented on the event's final day. The three-day hackathon includes: (a) participant introductions, concept mapping of scientific seeds, and formation of interdisciplinary creative teams; (b) completion of the "SciArt Flower" template; (c) finalization and presentation of the art projects. There is a flower template with objective and subjective dimensions: title, seed, participants, spokesperson, concept, interdisciplinarity, mood-board, conceptual map, sketches, expected materialization, previsualization, resources, methodology, time schedule, degree of innovation, references, presentation, budget, and a short video. Participants' interests for specific SciArt seeds and interdisciplinary diversity guides the creation of the creative teams. All participants contribute to the art concept, sharing their competencies and exchanging their roles.
- **Fruits**: After the hackathon is concluded, the "SciArt flowers" (art projects) are evaluated by the ASTER+S team using a rubric, and some of them may be selected for funding their production. Fortunately, during the three editions, all artworks could be funded. Creative teams usually spend a few months to co-create the final SciArt prototypes called "SciArt Fruits". A few months later, those art prototypes are showcased in an exhibition that is open to the public. During all editions till now, a local exhibition was implemented and mediated to the visitors. Moreover, a selection of artworks has also been invited to be exhibited at the Ars Electronica Festival every year [15–17]. In the three editions, a total amount of 41 artworks was produced: 15 in the 1st edition, 6 in the 2nd edition, and 20 in the 3rd edition. A total of 49 scientists and 123 participants were involved. Additionally, didactic complements were developed for mediation, and dissemination activities were supported to explore the artistic, critical and scientific dimensions of the artworks.

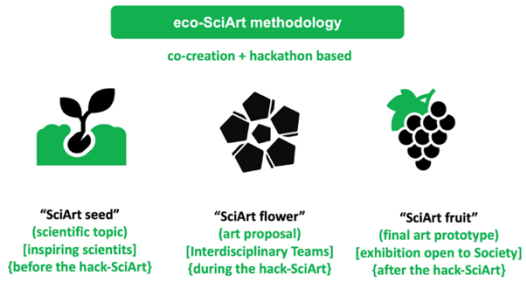


Figure 1: The 'eco-SciArt' method (own source by R. García Robles)

Moreover, a STEAM pilot experience is going to be implemented during 2026 in Primary, Secondary and Highschool education. The afore-mentioned didactic complements will be used in schools.

In participatory methods like the 'eco-SciArt', the role of interdisciplinary creative teams as "research agents" points to a deeper shift in how knowledge is produced and valued. These teams are not merely responding to scientific or societal topics, they are actively shaping new modes of inquiry, new vocabularies, and new forms of engagement. Their work challenges traditional hierarchies of expertise by integrating embodied knowledge, lived experience, speculative design, and critical theory into the research process. Such teams operate beyond disciplinary silos, using co-creation as a methodological engine that generates not only outcomes, but processes rich in reflection, negotiation, and innovation. In doing so, they reframe what it means to conduct research in the 21st century, transforming it into a shared, dynamic, and creative endeavor that responds to the complexity of our interconnected world.

In this context, the intertwining of the audience through the synergy of art and science becomes a powerful mechanism for transforming passive spectators into active participants in knowledge-making. In artworks like *"bI/Onics"* explained in section 4, the audience is not merely observing an artistic representation of scientific concepts, but they are engaging with them directly, through touch, data input, and relational avatars that reflect their own lived realities. This participatory structure, made possible by the fusion of artistic expression and scientific insight, creates a dialogic space

where individuals can explore how abstract scientific principles (such as neuro-harmony or brain-computer-interfaces) relate intimately to their identity, habits, and imagined futures. The aesthetic experience thus becomes both cognitive and emotional, fostering empathy, curiosity, and critical reflection. Through this intertwining, audiences not only understand science but feel it, question it, and contribute to its cultural meaning. This synergy ultimately tries to redefine the role of the public in research, positioning them as co-creators of meaning in a shared space of speculative, ethical, and transformative inquiry.

3 Art & Neuroscience edition

This edition explores a diverse constellation of neuroscientific themes that touch upon fundamental questions about life, identity, perception, and consciousness. From the clinical frontiers of brain death, neurodegenerative diseases, and surgical innovation to the metaphysical implications of memory loss, emotional regulation, and artificial intelligence, each SciArt Seed reflects the complexity and plasticity of the human brain in both health and illness.

The series of scientific themes includes brain death as a threshold state between life and absence; Alzheimer's as a slow erosion of identity; embodied disorders like Restless Legs Syndrome; and paradigmatic cases such as Phineas Gage, which question the essence of the self. Other topics delve into the poetic potential of synesthesia, the transformative promise of Brain-Computer-Interfaces (BCIs), and the ethical tensions of neurotechnology and AI. Together, these scientific foundations serve not only as research anchors but also as poetic seeds from which interdisciplinary artistic works have emerged, inviting new ways of sensing, imagining, and caring for the brain in the 21st century.

3.1 A selection of scientific topics suggested by the invited "inspiring scientists"

A total of nineteen neuroscientific topics were "planted" by scientists from different areas: Neurosurgery, Neurology, Neuropsychology, basic Neuroscience cell research, and Fundamentals of AI (as these technologies are based on brain models). Those scientists were asked to use a "SciArt seed" template to complete the description of objective and subjective dimensions, as a first step to build cognitive bridges with non-expert readers. To understand the poetic persuasion achieved by the "inspiring scientists" of this project, the following summaries a selection of scientific topics suggested by professionals from several institutions: (public Andalusian Health System, University of Seville, Universidad Carlos III de Madrid, and Sigmund Freud University).

Scientific Seed 01: "Crossing the Veil"

Brain death marks the irreversible end of all brain and brainstem functions, unlike comas or vegetative states where some activity persists. Though it signifies the end of one life, it also offers hope through organ donation, like an hourglass giving its final grains to keep other clocks running.

Scientific Seed 02: "The Thread of Your Fragments"

Learning allows information acquisition, while memory encodes, stores, and retrieves it, forming the basis of identity. Diseases like Alzheimer's erase this foundation, leaving individuals adrift in confusion and emotional reflexes. When memory fades, the mind invents fragments to fill the void, creating an ever-changing self guided by emotion rather than reason.

Scientific Seed 05: "The Essence of Being"

Phineas Gage's 1848 accident, which damaged his frontal lobe, transformed his personality and revealed the brain's role in shaping identity, emotion, and behavior. His case showed that something as intangible as the self has a biological base, just as bees are vital to ecosystems, our essence depends on fragile neural structures.

Scientific Seed 11: "The Invisible Choreographer and the Silent Scream of Cells"

This research explores how mechanical forces, like tissue rigidity and magnetic fields, influence cellular behavior. The "invisible choreographer" is the magnetic field guiding unseen interactions, while the "silent scream" represents cells' disrupted electrical communication under these forces.

Scientific Seed 16: "Towards Artificial General Intelligence Through Natural Intelligence"

Artificial general intelligence aspires to match human cognition, reasoning, learning, and adapting across contexts. Unlike narrow AI, which excels in one domain, AGI embodies versatile, creative intelligence capable of navigating any mental realm.

3.2 Bloom of SciArt prototypes

In the Neuroscience edition, the three-day SciArt hackathons were held to support the co-creation of the "SciArt flowers" in transdisciplinary creative teams: one in-person in Seville (January 2025), one in-person in Linz (January 2025), and one international online (March 2025). The aim was to support the co-creation of the "SciArt flowers" in transdisciplinary creative teams. Following the hackathons, twenty art prototypes were produced over a four month period. A quantitative and qualitative questionnaire was undertaken in each hackathon, and, whilst we will not delve into the details in this paper, the general perception about the 'eco-SciArt' method and the Art & Neuroscience experience was quite positive. Just as an example, one of the questions (among twenty-one) was about choosing the three dimensions that the participant believed contributed the most to the project. The outcome of this question can be seen in Figure 2.

The chart shows that across editions, participants identified three main contributions: understanding scientists, transdisciplinary creativity, and innovative experience. Understanding scientists stood out most, especially in Seville 2025, indicating the project's success in connecting public audiences with scientific thinking in accessible ways.

Transdisciplinary creativity followed closely, emphasizing how blending fields (especially art and neuroscience) stimulated innovation and collaboration. The project fostered a shared space for creative co-production across disciplines.

Innovative experience also ranked high, particularly in Seville and Online (2025), showing how participatory methods led to immersive, reflective engagement. Therefore, we can conclude that the project illustrates how SciArt, through collaboration, enriches knowledge sharing, cultural dialogue, and public participation.

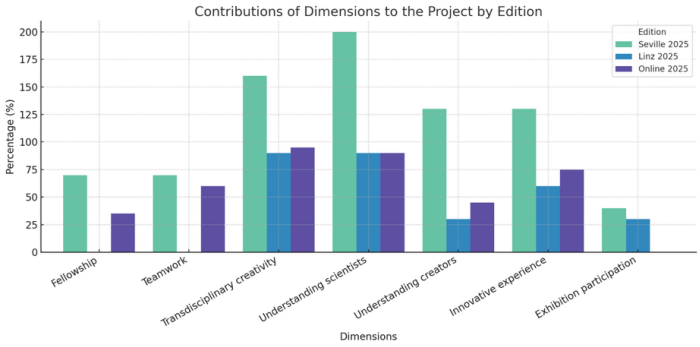


Figure 2: Comparative responses to the question: "Choose the three dimensions that you believe contributed the most to the project" (own source by R. García Robles)

Table 1: Summary of some art prototypes of the Neuroscience edition

SciArt fruit	Interdisciplinary team	Scientific topic (# seed)	Type of artwork
Neural Latency	Artists, Telecommunications Engineer	#1 Crossing the veil	Interactive sculpture
Programmed Obsolescence	Artists, Physicists	#2 The thread of your fragments	Video, LEDs and water installation
1Stein	Artists, Computer Science Engineer	#5 The Essence of Being	AI, sculpture and video-holographic installation
The Silent Shout	Flamenco Dancer, Artist	#11 The Invisible Choreographer and the Silent Scream of Cells	Flamenco performance, Photography and Video mapping
Playfull Sabotage	Creative Programmer, Computer Science Engineer	#16 Towards Artificial General Intelligence through Natural Intelligence + #17 GANsensus	Interactive AI installation

Additional questions asked to the participants pointed out to some challenges that need to be taken into account when planning such events:

- Improvement in planning, logistics, costly suppliers, and limited prior information about exhibition spaces.
- Challenges with the event's fast pace, team diversity, organization and the need for better communication.
- Need for an open mindset, an appropriate framework and active listening to truly understand and integrate different disciplines.

The vast majority stated they would gladly participate again and recommend the project to others.

3.3 Collection of the SciArt fruits

After the hackathon concluded, each SciArt flower (art project) was assessed using predefined evaluation criteria to determine its eligibility for production funding. Ultimately, all artworks were approved for funding.

A few months after the hackathon, the "SciArt fruits" are exhibited in a public showcase accessible to the broader community. In practice, during all editions, a local exhibition was implemented and mediated to the visitors, and a selection was exhibited at the Ars Electronica Festival. In the Neuroscience edition, twenty artworks were produced (Table 1). Most of them were new media arts, including three performances (flamenco, contemporary, and video-mapping), and two citizen participatory workshops.

4 Analyzing one Case Study: The "bI/Onics" Artwork

The SciArt work entitled "bI/Onics-I+II" (Figure 3, Figure 4, Figure 5, figure 6) is analyzed in this section to support deep reflection about the possible outcomes of ASTS methods and experiences. Firstly, the scientific seed, the vision of the creators of the artwork (SciArt Flower) and the vision of the curator (SciArt Fruit) are presented. Secondly, the dialectic of the artwork is analyzed in relation to the four project objectives mentioned at the end of section 2.

To better understand this SciArt media art installation, it is recommended to visualize the corresponding video [18]. The work has two parts which may be considered as twin artworks that complement each other:

- "bI/Onics I" is a tactile sculpture with four touch-reliefs in the four sides of the cube (all of them with half human face and the other half representing sports habits in a man's face with an sports icon, the second one is a woman's face with



Figure 3: "bI/Onics I + II": Haptic sculpture and an AI generated Neuro-avatar and Expanded-ego



Figure 4: "bI/Onics I": Haptic sculpture



Figure 5: "bI/Onic II": AI generated Neuro-avatar



Figure 6: "bI/Onic II": AI generated Expanded-ego

nutrition icons, a third one is a child's face with sleep icons, and the fourth one is an old face with social life).

- "bI/Onics II" is a AI app running on the cloud and interacted by visitors through a Raspberry Pi computer with a touch screen. The app supports the creation of two types of avatars: one AI generated from a questionnaire about the user's habits (concerning sports, nutrition, sleep and social life). The other avatar is also AI generated from a second questionnaire about the users' preferences for his/her hypothetical post-human alter-ego.

4.1 The Scientific Seed: The scientists' vision

As summarized by the inspiring scientists, the scientific topics behind this artwork correspond to two seeds:

Scientific Seed 13: "Neuro-Harmony" [Neuropsychology]

> "The connectome is a dynamic network of neural connections shaped by brain plasticity, enabling learning and reorganization. This process is influenced by epigenetic factors (such as sleep, exercise, diet, social life) and by microbiota, which affect gene expression, neurotransmitters, and mood" [19].

Scientific Seed 14: "Beyond the Final Frontier" [Neuropsychology]

> "Neurotechnology, a rapidly advancing branch of neuroscience, focuses on understanding the brain as an interface with the environment through the development of tools that visualize, control, repair, or enhance its functions through "Brain Computer Interfaces" (BCI) [20].

4.2 The SciArt Flower: The vision of the creators of the work

As stated by the authors of the artwork:

"An interactive light sculpture experienced haptically, together with an AI app, invites exploration that leads to questions about the essence of human being, and how our lifestyle, genetics and environment influence our brain, while new technologies shape expanded realities of ourselves".

Reflecting our own bionic potential, the app supports each user to build two avatars depending on responses: The *Neuro-Avatar* who is related to the user's lifestyle (food, sports, sleep and social interaction), and the *Expanded-Self* about a hypothetic post-human version of oneself. The audience may intertwine their "other selves," influencing each other in an ongoing dialogue. Therefore, a collective reflection emerges, raising metaphysical questions about identity, agency, and our bionic future, sparking ethical and existential questions" [14].

4.3 The SciArt Fruit: The curator's vision

As explained by the curator of that SciArt exhibition:

"The twin artworks "bI/Onic I + II" form an installation made of an exploratory App plus an Interactive Sculpture, inviting audiences to engage through touch, technology, and self-reflection. Inspired by research in the Neurology of Well-being, the work combines textured surfaces, meant to activate sensory and emotional responses, with an App that generates personalized avatars based on user habits. These AI-crafted projections appear beside the sculpture, turning the space into a responsive mirror of the body and mind.

The installation challenges the notion of a fixed self: Are we the result of our choices, our biology, or our environment like our generated Neuro-Avatars suggest? It also prompts reflection on

the ethical and philosophical implications of self-augmentation through BCI (Brain-Computer Interfaces). What happens when algorithms begin to shape not only who we are, but who we might become in post-human future? [14].

4.4 Multidimensional analysis of the "bI/Onics" SciArt work

In relation to the four project objectives mentioned at the end of section 2, some relevant conclusions are presented.

The "bI/Onics" project exemplifies transdisciplinary thinking by transforming complex neuroscientific ideas (such as brain plasticity, epigenetic influence, and brain-computer interfaces) into an embodied artistic experience. Drawing from both neuropsychology and neurotechnology, it reframes scientific discourse through multisensory, participatory art. By inviting users to reflect on how lifestyle choices (e.g., diet, sleep, sports, social life) shape their brains via the "Neuro-Avatar," the work personalizes scientific understanding and stimulates critical thinking about well-being. Simultaneously, the concept of the "Expanded-Self," tied to post-human identity, bridges scientific speculation with existential reflection, encouraging audiences to imagine futures shaped by neuro-enhancement technologies. So, this artwork fosters emotional engagement and community resonance: by allowing avatars to interpellate visitors, it encourages not just solitary contemplation but collective empathy.

On one hand, at its core, "bI/Onics" is the result of a deep collaboration between disciplines that don't typically intersect: neuroscience, AI, sensory art, speculative design, and curatorial practice. It exemplifies how social innovation emerges when artists and scientists co-develop conceptual and experiential frameworks, in this case, transforming neuroscientific knowledge into tangible, participatory formats. The design of the interactive app encourages audience participation akin to citizen science: users input data about their lifestyles, co-producing knowledge by generating avatars that visualize the interplay between environment, biology, and identity. This audience-driven creation positions visitors as active participants in a shared research-experience. The potential to replicate or adapt the experience in both in-person and online settings makes it scalable to local and global communities, nurturing a platform for dialogic knowledge exchange and continuous innovation.

On the other hand, "bI/Onics" thrives in a post-media environment by blurring traditional boundaries between art forms and disciplinary silos. Rather than limiting itself to a single material or medium, it integrates haptic sculpture, AI-generated avatars, and interactive digital applications, i.e. a constellation of formats that emphasizes process over product. Here, the artwork is not a static object but an evolving platform for self-exploration and collective introspection. The conceptual frame (built around bionic identity, neuro-enhancement, and lifestyle agency) provokes users to rethink their present and future selves in the context of expanding technological influence. By confronting audiences with their own "datafied" identities and speculative futures, the piece offers more than aesthetic experience, becoming a trigger for reflection and potential transformation by inviting users to reconsider their behaviors, values, and relationships with lifestyle and technology. In this way, "bI/Onics" enacts the essence of artistic innovation in ASTS: not only blending forms and disciplines but sparking dialogue, questioning, and potentially even social or behavioral change.

Beyond its interactive and sensory appeal, "*bI/Onics I*" opens a speculative arena where the aesthetic of the *datafied self* becomes both a mirror and a provocation. By transforming personal lifestyle data into algorithmically generated avatars, the artwork materializes the tension between self-knowledge and self-surveillance, inviting participants to confront how their biological and behavioral traces can be visualized, aestheticized, and potentially commodified. The resulting *Neuro-Avatars* are not mere representations but performative entities that reveal how identity is negotiated between human agency and computational logic. In parallel, "*bI/Onics II*" operates as a poetic and critical device that exposes the promises and anxieties of neuro-enhancement through the Expanded-egos: the desire to optimize the brain and extend consciousness, but also the risk of reducing subjectivity to patterns of data. Through this interplay of empathy, curiosity, and unease, the artwork reclaims the aesthetic field as a space for ethical debate about the future of human evolution in an era of algorithmic co-creation.

We can conclude that the installation of "bI/Onics" stands as a powerful SciArt artifact that makes neuroscientific knowledge accessible, experiential, and socially resonant. It moves beyond passive communication by creating an interactive ecosystem where audiences actively generate knowledge through personal data and sensory engagement. The collaboration with top scientists ensures that the artwork remains grounded in credible scientific concepts, while its translation into emotionally resonant, touch-based experiences makes it approachable to diverse audiences, including those with no formal scientific background. By placing visitors at the center of the narrative (inviting them to shape and observe their own avatars) "bI/Onics" democratizes science communication, transforming spectators into co-creators. Moreover, the shared virtual space, where these avatars interact, creates an environment conducive to community-based learning, reflection, and dialogue about identity, ethics, and the future of human enhancement. In doing so, the artwork fulfills its role not only as a mediator of scientific content but also as a catalyst for societal awareness and public discourse.

5 Conclusion

The SciArt processes (seeds and flowers) as well as the final art prototypes resulting from the ASTER+S project, such as the "bI/Onics" case study, demonstrate how ASTS practices can foster deeply engaging, transdisciplinary experiences that blur the boundaries between knowledge systems, media formats, and social roles. At their core, ASTS practices support contemporary art innovation and leverage the creative potential of artistic methodologies to communicate scientific concepts, while also inviting critical and collective reflection on their societal implications. The integration of neuroscience and artistic practice in "bI/Onics" exemplifies this synergy: neuroscience offers insight into the plastic, dynamic nature of the human brain and the emerging tools that can influence or augment it; art, in turn, offers sensory, narrative, and participatory formats to embody and question those insights.

The benefits of such hybrid SciArt practices are manifold: they humanize scientific knowledge, activate emotional and ethical engagement, and open space for citizen participation and social innovation. However, challenges remain. These include the risk of oversimplifying complex science, the difficulty of sustaining cross-disciplinary collaboration, and the need for new evaluative frameworks that recognize the epistemic value of artistic inquiry.

When neuroscience and art intertwine, they generate not just new forms of understanding but also new questions about identity, agency, and the future of the human condition. As seen in "bI/Onics", the creation of personalized avatars based on neurological and lifestyle data opens metaphysical and ethical inquiries: Who are we, and who do we become when our brains and selves are co-shaped by algorithms, interfaces, and social feedback? These speculative yet urgent questions emerge from the liminal space between disciplines, a space where ASTS practices thrive, and where art and neuroscience can jointly imagine and interrogate the evolving contours of human life.

In this context, art emerges not only as a tool for communication but as a legitimate research approach that complements the scientific methods. While science seeks objectivity, reproducibility, and causal explanations, art embraces subjectivity, ambiguity, and embodied experience. Artistic research can uncover insights that elude empirical methods, especially in areas involving consciousness, identity, ethics, and emotion. By offering alternative modes of inquiry and expression, art allows for a more holistic exploration of complex realities, making it an essential partner in advancing knowledge that is not only analytical, but also affective, relational, and transformative.

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The Ironic Machines

Computational Generation of Audiovisual Irony

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Abstract

This study introduces a methodological framework for constructing virtual ironic environments through the deliberate mismatching of emotional profiles in music and imagery. We conducted a statistical analysis of "happy/joy" and "angry" samples from two independent datasets to identify significant acoustic and visual features. These feature profiles were translated into mid-level semantic prompts to guide AI-based generation of visual and musical content. Our findings reveal distinct emotional signatures: happy music exhibits higher rhythmic onset rates and greater spectral variability, whereas angry music is characterized by a higher spectral centroid and more stable dissonance. Visually, joyful images are brighter and more symmetrical, while angry images feature darker hues and concentrated color distributions. Furthermore, mid-level perceptual descriptors generate the most coherent content, and we employed them to build a spectrum of virtual environments, including Sarcastic (joyful visuals + angry music) and Kind Ironic (angry visuals + happy music) spaces. This work establishes a new, data-driven approach to affective computing and speculative virtual design, grounded in the formal principle of audiovisual dissonance.

CCS Concepts

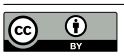
• **Human-centered computing** → **Interaction design theory, concepts and paradigms**; • **Computing methodologies** → *Artificial intelligence*; • **Applied computing** → *Sound and music computing*.

Keywords

Multi-modal Emotion Analysis, Kind Irony and Sarcasm, Audiovisual Dissonance, Affective Virtual Environments, Figurative Language, Prompting Engineering, Human–AI Interaction

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1 Introduction

Irony is a rhetorical figure of language that involves saying one thing while implying another, or even the opposite, using extra-propositional aspects to depart from literal meaning [1, 4, 11, 12]. There have been several attempts to frame the diverse types of irony. Most classifications include four common types: verbal irony, dramatic irony, cosmic irony, and romantic irony [5, 14]. The latter three are considered forms of situational irony in which the divergence arises from contextual expectations and not from language. Within verbal irony, scholars have further distinguished between two rhetorical figures: sarcastic irony, which uses blame to convey praise in conflictive contexts, and kind irony, which uses praise to express blame in cooperative settings [1, 4]. Both sarcasm and kind irony exhibit distinctive patterns that differentiate them from literal meaning. In spoken language, for example, irony has been consistently linked to acoustic features associated with affective and attitudinal states [9, 10, 12, 19, 21]. This overlap suggests that irony can be analyzed by detecting emotional divergence across communicative layers. This mechanism can be illustrated through verbal examples: a literally positive statement like "what a great idea," when delivered with a tone of anger or sadness (an opposing affective valence), functions as sarcasm. Conversely, a negative statement like "it was a terrible party," delivered with a happy or joyful tone, would constitute kind irony.

Extending this principle of affective contradiction, we can understand audiovisual irony as a mismatch between sound (music, speech, or audio effects) and imagery in an audiovisual piece, where the soundtrack conveys a meaning or mood that contradicts what is shown on the screen. Researchers have explored this idea from various perspectives. A key early concept is contrapuntal sound, introduced by Eisenstein et al. (1928), which refers to audio that contrasts with rather than complements visual content [8]. Similarly, John Paul Connor defines contrapuntal sound as music in direct opposition to the onscreen action [6]. It has also been studied under the concepts of soundtrack dissonance [18] and anempathetic sound [13].

In this research, we propose a strategy to build affective virtual environments as a framework to investigate the creation of virtual ironic spaces. We conducted a statistical analysis of two datasets, one with musical audio excerpts and the other with images. In both datasets, we filtered samples classified as "happy" or "joy" as representatives of positive emotional valence, and "angry" samples as representatives of negative emotional valence.

Based on the statistically significant features for each emotion, we engineered text-to-AI prompts to generate new images and

audio clips. For instance, to generate a sarcastic environment, we paired visual prompts based on features of "happy" images with audio prompts based on features of "angry" music.

The remainder of this paper is organized into five sections. **Section 2** describes the databases and the feature extraction methods used to characterize emotional profiles in music and images. **Section 3** presents the statistical analysis of acoustic and visual features distinguishing happy/joy from anger and explains the generation of ironic virtual environments based on audiovisual mismatches. **Section 4** provides an analysis of the results and discusses their implications. **Section 5** examines the limitations of our study and provides directions for future work. We conclude with final remarks in **Section 6**.

2 Methods

We propose a strategy to generate affective virtual environments that oppose musical and graphical content. For this, we conducted a descriptive and an inferential statistical analysis to compare and distinguish differences in musical-graphical features selected for the happy/joy-anger emotional classification.

2.1 Databases

We used two independent databases containing categorical labels for emotion recognition.

For musical analysis, we used the *Pandas Emotion Database* [15, 16], which consists of 900 song excerpts labeled with emotion tags originally provided by AllMusic. The database is supported by a manual blind validation process in which human annotators evaluated randomly selected 30-second clips according to Russell's circumplex affect model. The result corpus is a final data set evenly distributed across the four quadrants of the model, with 225 entries per quadrant. Each song is annotated with categorical arousal and valence labels, as well as multi-label emotion tags [1].

For the purposes of this study, we filtered the musical clips to include only those samples in Quadrant I (high valence, high arousal), labeled happy, and Quadrant II (low valence, low arousal), labeled angry. The final musical corpus under analysis consisted of 54 happy and 54 angry musical audio files.

We also used the *Cornell Emotion6 Picture Database* [17], a standardized image set developed to facilitate the study of emotional responses to visual stimuli. The database comprises 730 curated color photographs designed to evoke affective reactions across a wide spectrum of valence.[2]

For our analysis, we selected images from the joy and anger categories, comprising a total of 660 JPEG files. All images were resized to 256×256 pixels to ensure consistency in the feature extraction and analysis process.

2.2 Feature Selection

We extracted a set of acoustic and visual features aimed at capturing emotion-relevant properties of musical and visual stimuli from the databases. In total, 12 acoustic and 17 visual features were selected based on their interpretability, support in the affective computing literature, and insights from exploratory analysis (see Table 1). These features were categorized into five musical dimensions (rhythm, timbre, melody, dynamics, and harmony) and five graphical dimensions (color, texture, image complexity, symmetry, and structural characteristics).

Acoustic features were extracted using the *Essentia* library [2], which provides a comprehensive set of algorithms for audio analysis and music information retrieval.

Rhythm was characterized by the estimated beats per minute (BPM), which indicates the perceived tempo of a musical segment, and by the onset rate, which quantifies the frequency of note attacks and rhythmic activity. Timbre-related features included the mean and standard deviation of spectral kurtosis, which reflects the peakedness of the frequency distribution and is associated with percussive or sharp timbres; dissonance, which estimates the inharmonicity or auditory roughness of the sound; and spectral centroid, a descriptor of the brightness or sharpness of the audio signal. Melodic properties were captured through pitch salience, which measures the clarity and prominence of a main pitch, providing insight into tonal focus and melodic strength. The energy of the signal was represented by the average loudness, which is perceptually related to the intensity of the sound. Harmony and tonal features included the chords number rate and chords changes rate, which reflect the harmonic density and complexity of musical progressions. We also extracted the entropy of the Harmonic Pitch Class Profile (HPCP), which indicates tonal ambiguity, along with the estimated key according to the Krumhansl-Schmuckler model and the dominant key of the chords.

The graphical features were extracted using OpenCV [3] and scikit-image [20], and grouped into five graphical dimensions. In the color dimension, we computed a global HSV (High-Saturation-Value) color histogram with 512 bins to describe the overall color distribution of the image. Dominant color features were obtained using K-Means clustering, capturing the RGB centroids of the 20 most representative color clusters in each image. In addition, we computed the color moments by calculating the mean, standard deviation, and skewness of each HSV channel, which offers a compact description of the shape and spread of the color distribution. Texture features were derived from multiple methods: Histogram of Oriented Gradients (HOG), which captures localized edge directions; Local Binary Patterns (LBP), which quantify local grayscale texture patterns; and Gabor filter responses at multiple orientations, which characterize frequency-based textures. The complexity of the image was assessed using Shannon entropy, calculated from the grayscale histogram, to measure the visual unpredictability or disorder present in each image. Symmetry features were derived by calculating the average pixel-wise difference between the original image and its horizontally or vertically flipped version, providing a measure of visual balance. Finally, structural features included edge density, computed as the proportion of edge pixels detected via the Canny edge detector, along with average brightness and contrast, both derived from grayscale intensity statistics.

3 Results Analysis

3.1 Musical Feature Analysis (N = 108)

Tempo (BPM) was on average 6.77 BPM higher in Happy music (127.03 BPM) compared to Angry music (120.26 BPM), though this

[1] Downloaded from https://mir.dei.uc.pt/downloads.html
[2] Downloaded from http://chenlab.ece.cornell.edu/downloads.html

Table 1: Overview of Musical and Visual Features by Category

(a) Acoustic Features

Category	Feature Name
Rhythm	Rhythm BPM Rhythm Onset Rate
Timbre (Spectral)	Spectral Kurtosis Dissonance Spectral Centroid
Melody	Pitch Salience
Dynamics	Average Loudness
Harmony	Chords Number Rate Chords Changes Rate Tonal HPCP Entropy Tonal Key (Krumhansl Scale) Tonal Chords Key

(b) Visual Features

Category	Feature Name
Color	Color Histogram Dominant Color Color Moments
Texture	HOG (128 dims) LBP Histogram Gabor Filter Responses
Image Complexity	Entropy
Symmetry	Horizontal Vertical
Structural	Edge Density Brightness Contrast

difference did not reach statistical significance. However, the onset rate, reflecting rhythmic activity, was significantly greater in Happy songs, increasing by 0.78 onsets/sec, indicating a denser and more energetic temporal structure.

Timbre-related differences were particularly pronounced. The spectral centroid mean was 681 Hz higher in Angry music, suggesting a brighter, more aggressive timbre due to enhanced high-frequency energy. On the other hand, spectral centroid variability was 85.6 Hz greater in Happy music, reflecting a more modulated and dynamically colorful brightness.

Spectral kurtosis was significantly higher in Happy music for both mean and standard deviation values, showing increases of 69.6% and 70.7% respectively. This indicates that Happy music tends to exhibit more peaked and articulated frequency content, whereas Angry music sounds flatter and more spectrally dense.

Dissonance levels were on average 6.7% higher in Angry music, reinforcing its association with rough, tense, and harsh auditory textures. Interestingly, dissonance variability was 66.7% lower in Angry songs, suggesting a more uniform level of harshness, while Happy songs incorporated more dissonant fluctuation, contributing to textural variety.

Melodically, Angry songs had a 7.4% higher pitch salience, pointing to clearer, more dominant melodic lines, possibly reflecting assertiveness or dramatic clarity. Pitch salience variability did not differ significantly.

The average loudness was 0.06 dB higher in Angry music, which may seem small in absolute terms, but is consistent with the increased amplitude dynamics expected in music expressing heightened arousal or urgency.

In the harmonic domain, Angry songs showed a 0.03 changes/sec higher chord change rate, implying frequent harmonic shifts that contribute to musical tension. The HPCP entropy mean—a measure of tonal complexity and ambiguity—was 31.8% higher in Angry songs, consistent with unstable or emotionally charged harmonic environments. The entropy variability was also slightly higher (+4.1%) in Angry songs.

Regarding key mode, Happy music showed a 34.9% higher rate of major scale detection, reinforcing the widespread association between major keys and positive emotional valence.

Other tonal features, such as chord presence rate and key root, did not exhibit statistically significant emotional differences, indicating that some tonal aspects are more genre-driven than emotion-driven (see Table 2).

3.2 Visual Feature Analysis (N = 660)

Visual analysis across five graphical dimensions: color, texture, complexity, symmetry, and structural features, revealed significant perceptual distinctions between joy and anger, labeled images. Out of the total 660 images (330 per class), over two-thirds of the evaluated features showed statistically significant differences, suggesting a strong visual basis for emotional differentiation.

Color-based features were the most discriminative. From the 512-dimensional color histogram, 358 bins (69.9%) revealed significant differences between joy and anger. Angry images exhibited markedly higher frequencies in bins associated with dark, saturated tones in the HSV space, particularly in low-value (brightness) and high-saturation regions, indicating a visual dominance of intense reds, shadows, and deep hues. In contrast, joyful images showed stronger responses in bins tied to brighter, low-saturation areas (e.g., pastels and light yellows), reflecting light, diffuse, and emotionally uplifting palettes (see Fig 1).

Dominant color statistics further reinforced these differences. Seven out of nine dominant color dimensions (77.8%) were significantly different, with joy images displaying a greater presence of warm and luminous colors. Similarly, color moments yielded stark contrasts: 8 of 9 dimensions (88.9%) showed statistical significance. Notably, the chromatic variance (second moment) in Joy images was 61.3% higher, reflecting broader tonal diversity. Conversely, anger images exhibited sharply peaked distributions (e.g., 300% higher third moment in one channel), suggesting visual concentration and saturation.

Texture-based features, covering LBP, HOG, and Gabor filters, also provided robust differentiation. Although only 13 out of 128 HOG dimensions (10.2%) were significantly different, these localized

Table 2: Summary of Musical Dimensions by Emotional Category

Category	Angry Music Profile	Happy Music Profile
Rhythm	Displays a moderately fast tempo with 120.26 beats per minute and a lower density of rhythmic events, indicated by an onset rate of 3.40 onsets per second. Rhythmic articulation tends to be less frequent and possibly more deliberate.	Features a similarly fast tempo at 127.03 beats per minute but with denser rhythmic structuring, shown by an onset rate of 4.18 onsets per second. This points to a more active and event-rich rhythmic pattern.
Timbre (Spectral)	Exhibits concentration of spectral energy in the higher frequency range, with a spectral centroid around 2002 Hz. Dissonance is more consistently present, while spectral kurtosis values suggest a flatter frequency distribution and reduced timbral articulation.	Emphasizes more variable spectral content, with a spectral centroid around 1321 Hz and greater fluctuations over time. Spectral kurtosis values point to sharper frequency peaks, and dissonance tends to be more dynamically varied.
Melody	Melodic lines are defined by stronger pitch salience, with a mean value of 0.58, suggesting stable and well-defined tonal contours. Pitch variability is moderate.	Melodic material tends to be less centered on strong tonal anchors, with a mean pitch salience of 0.54 and slightly greater variation, allowing for more ornamented or diffuse pitch structures.
Dynamics	Maintains consistent loudness across musical segments, averaging 0.96 decibels, reflecting stable sound pressure and dynamic presence throughout.	Operates with a slightly softer dynamic profile, averaging 0.90 decibels, while exhibiting greater variability, possibly reflecting shifts in intensity within musical phrases.
Harmony	Harmonic motion is marked by frequent chord changes (0.10 changes/sec) and tonal instability, reflected in elevated entropy (2.57). The mode distribution favors minor tonalities, with a mean Krumhansl scale value of 0.54.	Harmonic structures are more tonally anchored, with less frequent chord transitions (0.07 changes/sec) and lower pitch class entropy (1.95). The harmonic mode is more often major, with a mean scale value of 0.83.

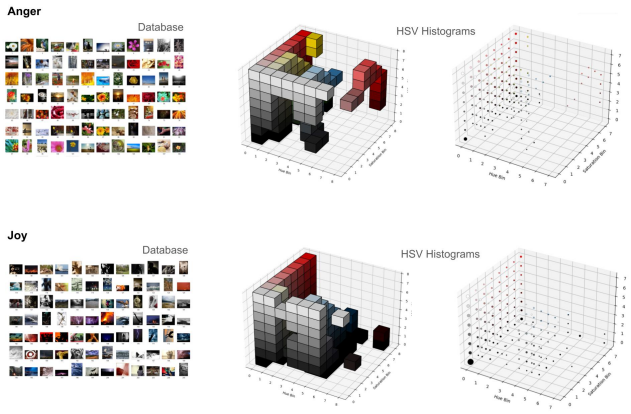


Figure 1: Color histogram distribution in HSV space. Joy (yellow) vs. Anger (red).

differences point to greater orientation strength and edge directionality in Joy images. Conversely, LBP descriptors—where 6 out of 58 bins (10.3%) differed—showed higher values in Angry images, indicating greater local texture variation or micro-patterning, often associated with visual tension or chaos.

Gabor responses were particularly revealing: all four frequency-orientation channels (100%) differed significantly. Joy images scored 10–20% higher on average, suggesting richer mid-level textures and more visually organized patterns.

Visual complexity, as captured by entropy, was 5.0% higher in Joy images, a somewhat counterintuitive but statistically reliable finding. This suggests that joyful scenes may contain more varied visual elements, yet still be perceived as harmonious due to their brightness and balance. Angry images, though less entropic, may rely on starkness and contrast for emotional impact.

Symmetry features (both horizontal and vertical) showed small but consistent differences: Joy images were 3.76% and 2.59% more symmetrical, respectively. These values align with psychological theories linking symmetry to aesthetic pleasure and emotional stability, supporting the hypothesis that visual harmony is tied to positive affect.

Structural properties captured broader compositional trends. Edge density was 28.3% higher in Joy images, indicating sharper transitions and denser spatial information, while brightness was 22.5% higher. These cues point to vivid, well-lit environments often associated with joy. In contrast, contrast levels did not differ significantly between the two classes, suggesting similar tonal range, though possibly serving different expressive functions depending on the emotional tone (see Table 3).

3.3 Affective Virtual Environments Generation

We propose using each profile deduced from the feature analysis to build ironic virtual environments. As text prompts, we tried three semantic levels to describe the emotional state of happiness/joy and anger. Following verbal irony equivalence, we have four possible combinations between the two modes of communication for the two emotions studied (see Table 4).

We used *DeepAI* image generation through their documented API to produce image textures[3]. We generated nine versions for each prompt for each emotion (see *Appendix* and Fig 2). For Music, we generated nine 30-second Audio Clips for each emotion using

[3]Obtained from https://deepai.org/machine-learning-model/text2img

Table 3: Summary of Visual Feature Characteristics by Emotional Category

Category	Angry Visual Profile	Joyful Visual Profile
Color	Visuals are marked by darker, saturated tones and more concentrated color distributions. Color histogram bins like `color_hist_0` are elevated (0.2446), dominant colors tend to cluster in darker hues (98.30), and early color moments show reduced brightness and variance (e.g., `color_moments_0` = 50.39 ± 5.04). Skewness and flatness measures also suggest focused, less varied palettes.	Brighter and more chromatically diverse. Histogram frequencies for low-saturation bins are lower (0.0972), dominant colors shift to lighter zones (128.52), and color moments reflect greater brightness and spread (e.g., `color_moments_0` = 56.28 ± 5.63, `color_moments_2` = 52773.84 ± 5277.38), indicating vibrant, luminous color schemes.
Texture	Texture is more compressed and less spatially rich. Gabor filter responses are lower (e.g., `gabor_2` = 69.97 ± 7.00), and fine-grained local variation is reduced in HOG (`hog_8` = 0.0862) and LBP (`lbp_0` = 0.0466), suggesting simpler directional structures and less pronounced patterning.	Higher mid-level and local texture energy. Gabor responses are stronger across all channels (e.g., `gabor_2` = 85.71 ± 8.57), HOG values increase (`hog_8` = 0.1093), and LBP histograms (`lbp_0` = 0.0520) indicate greater local contrast and detail, contributing to visual richness and pattern diversity.
Image Complexity	Scenes exhibit slightly reduced informational density. Mean entropy is lower (6.87 ± 0.69), implying more uniform or predictable spatial compositions.	Visual scenes are more complex and information-rich, with higher entropy values (7.21 ± 0.72), reflecting greater variety in structure and content.
Symmetry	Compositional balance is lower. Symmetry measures indicate slightly reduced alignment along horizontal (119.52 ± 11.95) and vertical (121.79 ± 12.18) axes, contributing to a sense of instability or visual tension.	Scenes are more symmetrical both horizontally (124.01 ± 12.40) and vertically (124.95 ± 12.50), reinforcing compositional harmony and visual comfort often associated with positive affect.
Structural	Lower structural density and luminance. Edge density (20.99 ± 2.10) and brightness (91.52 ± 9.15) values suggest shadowed, less defined visual forms, contributing to a darker and more visually aggressive tone.	Brighter and more sharply articulated visual structure. Edge density (26.95 ± 2.69) and brightness (112.09 ± 11.21) are markedly higher, signaling energetic and engaging visual environments.

Table 4: Visual, Musical, and Audiovisual Space

Visual	Musical	Audiovisual Space
Anger	Happy	Kind Irony
Anger	Anger	Sincere Anger
Joy	Anger	Sarcasm
Joy	Happy	Sincere Happiness

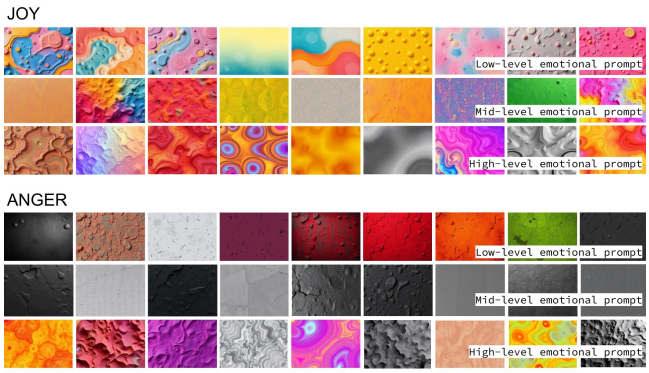


Figure 2: Text guided Texture Images per semantic level and emotion

MusicGEN. [7][4] We implemented the mid-level semantic descriptions to develop a web app in p5.js, a sketch for the visualization of the four possible scenarios (see Fig 3).

- Happy: Generate a texture with low histogram frequency in bright bins, dominant color in high RGB range, and high brightness and color variance. Apply high-frequency texture with strong filter energy, pronounced gradient magnitude, and strong local contrast. Use high spatial complexity, increased horizontal and vertical symmetry, high edge density, bright gray levels, and high contrast. Emphasize rich visual structure, color variation, and texture intensity across spatial composition.
- Anger: Generate a texture with high histogram frequency in dark bins, dominant color in low RGB range, and low brightness and color variance. Apply low-frequency texture with low filter energy, weak gradient magnitude, and low local contrast. Use low spatial complexity, reduced horizontal and vertical symmetry, low edge density, dark gray levels, and moderate contrast. Emphasize coarse structure and limited variation in color, texture, and spatial distribution.

We included a graphical user interface to select the emotion for audio and visual AI generation based on a semantic mid-level description [5].

[4]Obtained from https://colab.research.google.com/github/sanchit-gandhi/notebooks/blob/main/MusicGen.ipynb

[5]Available at https://jfforero.github.io/TheIronicMachine/index.html

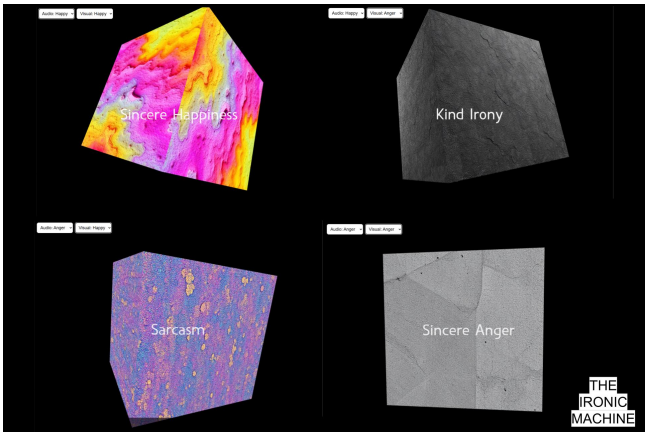


Figure 3: Screenshots of The Ironic Machine P5.js virtual environments

4 Synthesis and Discussion

The application of our methodological framework for constructing ironic virtual environments through opposing audiovisual emotional cues revealed several consistent patterns:

- **Musical Dimensions:** Happy music exhibited greater variability in rhythmic onset, spectral dynamics, and timbral articulation, suggesting that happiness as an emotional construct benefits from more complex and dynamically shifting sonic representations. In contrast, angry music displayed more stable dissonance and tonal entropy, indicating a deliberate emphasis on tension, harshness, and emotional clarity. This distinction may explain why ironic effects involving positive visual content combined with negative musical affect (sarcasm) produce more immediately recognizable contradictions, aligning with prior research on contrapuntal sound [6, 18].
- **Visual Dimensions:** The visual analysis reinforced this asymmetry. Joyful images were not only brighter and more symmetrical but also more complex, with higher entropy and edge density. These characteristics created nuanced, visually engaging canvases from which ironic contrast could emerge. Angry images, while visually darker and less complex, relied on intense color saturation and micro-texture variation to convey affective weight. These findings align with psychological theories of affect and perception that associate brightness and symmetry with positive affect, and darkness and irregularity with negative emotional tones [17, 20].
- **Prompt Engineering Insights:** Preliminary analysis of the audiovisual results indicated that mid-level semantic descriptors—those describing concrete perceptual features without being overly technical or abstract—proved most stable for guiding AI generation. Low-level descriptors (e.g., specific RGB or BPM values) were often too rigid and narrow, constraining creative output. Conversely, high-level affective terms (e.g., "joyful") were overly subjective and reliant on the AI's internal biases, frequently resulting in generic content. Mid-level prompts offered an optimal balance, enabling controlled and reproducible generation while maintaining significant expressive variability.

5 Limitations and Future Work

While effective for controlled experimentation, this project reveals several limitations. First, not all irony emerges from emotional opposition. Irony is a complex, context-dependent phenomenon that can also be emotionally neutral. Second, the emotional space was limited to a binary opposition (joy vs. anger), which reduces the spectrum of affective nuance and excludes emotions such as fear, sadness, or surprise that may play critical roles in ironic expression.

The selected datasets, while validated, are limited and biased. They consist of short musical excerpts and static images, lacking the temporal dynamics and narrative continuity essential for more immersive or contextually rich experiences. Moreover, the final environments were developed based on the authors subjective criteria to establish the most stable group of audiovisual results.

Future works should address these limitations by incorporating additional emotional categories, using temporally extended datasets, and integrating user-centered evaluations of perceived audiovisual irony. Furthermore, exploring irony beyond binary oppositions, toward ambiguous, layered, or culturally inflected forms, would deepen the expressive potential of affective computing systems and contribute to more nuanced human, AI interaction.

6 Concluding Remarks

This research articulates a novel pipeline for constructing irony as a formal property within virtual environments. By reframing the semiotics of irony in an audiovisual context, we provided a proof of concept demonstrating how statistical inference can serve as a powerful tool for generating and analyzing kind-irony and sarcasm. The resulting digital spaces not only illustrate how irony can be translated into audiovisual design but also offer a robust framework for studying affective dissonance in machine-mediated interactions. These findings contribute to expanding the expressive vocabulary of affective computing and virtual art.

Acknowledgments

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Table 5: Three prompt levels (Simple, Technical, Semantic) for generating Happy vs. Angry content in Music and Visual domains.

Domain	High-level description Prompt	Low-level description Prompt	Mid-Level description Prompt
Musical (Happy)	Generate a happy soundtrack.	Generate a happy soundtrack with a tempo of 127.03 BPM and an onset rate of 4.18 onsets/sec. Use spectral centroid 1321 Hz, variable dissonance, and spectral kurtosis indicating sharp frequency peaks. Set pitch salience to 0.54 with defined pitch variation. Loudness should be 0.90 dB across segments. Use chord change rate of 0.07 changes/sec, pitch class entropy 1.95, and Krumhansl scale value 0.83 in major mode.	Generate a happy soundtrack with fast tempo, dense rhythmic activity, bright timbre with dynamic spectral variation, peaked spectral shape, variable dissonance, moderately clear pitch, moderate loudness, infrequent harmonic changes, stable tonality, and major mode. Emphasize timbral brightness with ornamented melodic contours and harmonically grounded progressions.
Musical (Angry)	Generate an angry soundtrack.	Generate an angry soundtrack with a tempo of 120.26 BPM, onset rate 3.40/sec, spectral centroid 2002 Hz, flat spectral kurtosis, stable dissonance, pitch salience 0.58, loudness 0.96 dB, chord change rate 0.10/sec, tonal entropy 2.57, and Krumhansl key profile 0.54. Emphasize sharp timbres, clear melodic focus, and harmonically complex progressions.	Generate an angry soundtrack with moderately fast tempo, sparse rhythmic activity, bright timbre, low brightness variability, flat spectral shape, stable dissonance, clear pitch, strong loudness, frequent harmonic changes, ambiguous tonality, and minor mode. Emphasize sharpness in timbre with focused melodic lines and harmonically unstable progressions.
Visual (Happy)	Generate a happy visual texture.	Generate a texture with `color_hist_0` = 0.0972 (normalized frequency), `dom_color` = 128.5 (RGB value), `color_moments_0` = 56.28, `color_moments_2` = 52773.84 (moment values), `gabor_2` = 85.71 (filter energy), `HOG_8` = 0.1093 (gradient magnitude), `LBP_0` = 0.0520 (histogram frequency), entropy = 7.21 (bits), `symmetry_h` = 124.01, `symmetry_v` = 124.95 (pixel difference), edge density = 26.95 (edges/unit), brightness = 112.09 (gray level), contrast = 27.15 (gray stddev).	Generate a texture with low histogram frequency in bright bins, dominant color in high RGB range, and high brightness and color variance. Apply high-frequency texture with strong filter energy, pronounced gradient magnitude, and strong local contrast. Use high spatial complexity, increased horizontal and vertical symmetry, high edge density, bright gray levels, and high contrast. Emphasize rich visual structure, color variation, and texture intensity across spatial composition.
Visual (Angry)	Generate an angry texture.	Generate a texture with `color_hist_0` = 0.2446 (normalized frequency), `dom_color` = 98.3 (RGB value), `color_moments_0` = 50.39, `color_moments_2` = 32717.72 (moment values), `gabor_2` = 69.97 (filter energy), `hog_8` = 0.0862 (gradient magnitude), `lbp_0` = 0.0466 (histogram frequency), entropy = 6.87 (bits), `symmetry_h` = 119.52, `symmetry_v` = 121.79 (pixel difference), `edge_density` = 20.99 (edges/unit), brightness = 91.52 (gray level), contrast = 28.42 (gray stddev).	Generate a texture with high histogram frequency in dark bins, dominant color in low RGB range, and low brightness and color variance. Apply low-frequency texture with low filter energy, weak gradient magnitude, and low local contrast. Use low spatial complexity, reduced horizontal and vertical symmetry, low edge density, dark gray levels, and moderate contrast. Emphasize coarse structure and limited variation in color, texture, and spatial distribution.

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3DAroma: Spice-oil-saturated Tangible Installation with Auditory Interaction as Embodied Reminiscence of Exploring Nomadic Memory and Identity

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Abstract

Memory, particularly in the context of diaspora and nomadic experiences, often exists as a fluid and multifaceted construct, challenging conventional archival methods. The ephemeral nature of personal and collective reminiscences necessitates innovative approaches to capture, preserve, and transmit these deeply embedded cultural narratives. This paper discusses 3DAroma and its formation, a practice-based artistic research that synthesizes olfactory, auditory, tactile, and optic modalities to transform diasporic memories into an immersive physical archive. Building upon earlier explorations of nomadic legacies, identity, and consciousness through interviews, workshops, and literature investigation, 3DAroma employs specific culturally resonant spices, such as cinnamon, cumin, and cardamom, extracted into oils that permeate algorithmically AI-generated and machine-printed pattern sculptures. These sculptures, derived from traditional nomadic Etlas fabrics, serve as tangible symbols of Nomadism, inviting participants into a synesthetic recollection of heritage. Research contributions manifest twofold: (1) the experimentation of olfactory-tactile interfaces with spice-media as nomadic archives for culturally coded remembrance; (2) the exploration of meditative art workshops for bridging individual and communal memory retrieval. 3DAroma ultimately discovers nomadism not as loss but as fluid decomposition, where scent becomes record, and touch transforms into testimony.

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CCS Concepts

• **Applied computing** → Arts and humanities; Media arts; • **Human-centered computing** → Visualization; Interaction design.

Keywords

Meditation Art Workshop, Multisensory Embodiment Archive, Haptic-Olfactory Installation

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1 Introduction

Across histories of displacement and diaspora, cultural memory often persists not only through formal archives but also through everyday materials, such as textiles, spices, and customs, that carry embodied knowledge across generations. For nomadic communities, spices such as cardamom, cassia bark, and star anise are more than ingredients; they are sensory records embedded in domestic rituals, seasonal cooking, and oral tradition. We found this feature from conducted interviews and workshops with local communities. Spices become in this research both medium and metaphor, a conduit for evoking nomadic consciousness, sensory testimony, and transregional exchange, then speak to a transregional history of movement, adaptation, and survival. Yet such embodied forms of heritage are sometimes overlooked in dominant frameworks of cultural preservation, which privilege visual or textual representation over olfactory and tactile experience.

3DAroma addresses this situation by experimenting with an alternative form of sensory archiving. Positioned at the intersection

of media art, sensory ethnography, and participatory design, this research builds upon the artist's prior investigations into nomadic textile heritage and somatic memory. 3DAroma explores scent as a powerful index of opening questions to collective identity and private consciousness. By algorithmically generating sculptures from fabric patterns and dropping distilled spice oils, the installation invites audiences into an immersive space where memory is felt, inhaled, and enacted. Participants touch printed slice sculptures, see projected lightning patterns, and hear gathered domestic soundscapes, to excavate personal and collective memories rooted in scent. This research builds on discourses and bases in artistic meditation workshops, in-depth interviews, and focus groups, contributing to two main research domains: (1) the investigation of olfactory-tactile sensations as embedded memory archives in nomadic culture; (2) the employment of participatory art workshops with meditations as a method for excavating personal and mutual memory and consciousness.

2 Concept

Through Aristotle's definition of sensation as a symbol referring to a certain sensory emotional response in *On the Soul*, along with the markedness presented by visual signs, the post-sensory abilities help us to remember and imagine things that do not exist at the moment [1]. In addition to vision, this practice-based research investigates how other sensory symbols contribute to multidimensional experiences, facilitate emotional communication, and foster identity recognition for individuals and communities. Inquiry itself aligns with Craig Owens's discourse on representation, power, and culture, which examines the possibilities for articulating subjectivity within broader socio-economic systems [2]. In this context, the artwork itself functions as a mediating field to amplify marginalized voices, visualize unseen realities, and reconstruct neglected narratives. As Barthes mentioned, the narratives are disseminated through a plethora of materials, any of which can convey transnational and transhistorical stories [3]. The translation of immaterial experiences into tangible forms thus enables a deeper engagement with complex emotions, bridging cultural and historical divides while inviting audiences to form their own interpretative connections. When participants engage with these sensory narratives, artworks can transcend mere representation to become sites of radical embodiment, offering potential for communal healing by weaving fragmented identities into polyphonic tapestries of belonging. However, the risk of reproduction through cultural appropriation in the arts deserves concern and was criticized by Sally Price in *Primitive Art in Civilized Places*, whether it is the appropriation of artifacts, art forms, or the redefinition of existing [4]. Therefore, to navigate these concerns, this research explored the method of conducting artist and audience workshops aimed at fostering a deeper understanding of cultural sensitivity and promoting critical creation processes. These workshops are structured to encourage dialogues and reflections on the complexities of cultural exchange, ensuring that artistic practices honor the cultural heritage from which participants draw inspiration and contribute to a more equitable communication landscape.

Grounded in Plato's conception of drawing as an activity of the soul in *Philebus* [5], these workshops position drawing not merely as an act of representation but as a cognitive and emotional process for externalizing internal sensations and cultural memories. Within this framework, meditation functions as a somatic method for cultivating embodied attention, as researchers Varela et al. termed Lived Cognition, enabling participants to access layers of pre-verbal memory and sensation that often remain unarticulated in conventional discourse [6]. By beginning with internal visualization and then expressing perceptions through drawing, participants engage in what Shaun McNiff identifies as Art-based Knowing, a non-verbal mode of inquiry where the act of making becomes a form of thinking and healing [7]. Consequently, this process facilitates the emergence of deeply personal and affectively charged imagery, which can then be shared and reflected upon or within a communal setting. As Jill Bennett argues, the affective transmission of experience through sensory art practices enables not just expression but resonance, bridging individual trauma, memory, or displacement with shared understanding [8]. Thus, the workshops are intentionally configured to integrate psychological meditation, artistic creation, and group dialogue as a means of activating sensory symbols, fostering emotional communication, and enabling collective memory construction through an embodied and culturally respectful engagement.

Building upon the insights derived from these workshops, the research progressed to the development of an art installation as a case study to further investigate how multisensory modalities can embody and communicate diasporic memory. Rooted in the interviewed artists' nomadic cultural background, particularly within the context of Uyghur heritage, this installation draws upon traditional Uyghur textile patterns and field-recorded domestic soundscapes as primary data sources (Figure 1). The installation work was developed through three iterative phases. The initial prototype engaged only the optical and tactile senses, allowing participants to visually perceive and physically trace AI-generated sculpture forms and projected textile motifs [9]. The second iteration incorporated auditory elements, layering in spatialized sound recordings from Uyghur home kitchens and other home environments to evoke a deeper sense of place and intimacy [10]. In the third iteration, olfactory elements were introduced by dropping oils extracted from culturally resonant spices such as cassia bark, cardamom, and fennel on the sculptures. This full-sensory composition aims to present an immersive and interactive environment wherein each modality contributes to a layered experience of memory, enabling the audience to engage with cultural narratives through a dynamic interplay of body, sense, and imagination.

3 Artistic Research

3.1 Art Meditation Workshop

The art meditation workshop was established as a pivotal phase and conceptual cornerstone for the 3DAroma project, designed to facilitate deeper connections between participants' internal experiences and their cultural memories. This foundational methodology employed a structured triad of meditation, drawing, and communal sharing to access the often pre-verbal and sensory-laden dimensions of reminiscence. Through this process, the workshop aimed not only to gather individual narratives but also to create a collective, reflective space where submerged memories could surface.



Figure 1: Carpets and Etles fabrics with characteristic patterns are a vital part of daily lives as enduring symbols of cultural identity and heritage for the local community in Kashgar, Xinjiang.



Figure 2: Drawing samples by art meditation participants when they're guided for three workshop practices focused on various themes.

The insights generated from this participatory engagement directly informed the artistic and sensory direction of the subsequent installation, ensuring the final work was rooted in embodied, communal experience rather than abstract representation.

Each workshop session began with guided meditations, specifically employing open monitoring techniques. This approach encouraged participants to cultivate a non-judgmental awareness of thoughts, sensations, and emotions, fostering a state of relaxed yet alert focus that has been shown to enhance convergent and divergent thinking [12]. Furthermore, this meditative practice has been shown to effectively reduce mental blocks, thereby preparing participants for the creative task [13]. Following the meditation period, participants were prompted to separately express the primal imagery, feelings, or memories that first emerged through drawing. This act of drawing was not evaluated for artistic skill, but rather as a powerful multimodal encoding strategy that enhances memory recall [14] and assists the externalization of complex internal states that are difficult to articulate verbally [15]. The process



Figure 3: From raw spice materials that bond with specific memories (left) to extracted oil carried with their own scent (right)

thereby encouraged participants to visualize and sketch imagery that resonated with their personal identity narratives and collective community consciousness in their subsequent drawing practices.

A critical component of the workshop contains the ensuing sharing, reflection, and communication among participants about their meditative processes and creative results. This session is applied to foster embedded communication and emotional regulation among participants as a staple strategy for art therapy [16]. It also served to strengthen community group cohesion, transforming individual expressions into a shared, supportive, and reflective experience [17]. By articulating the origins and meanings behind their drawings, participants revealed a profound, often subconscious link between memory and sensation. Notably, while the initial focus was on visualization, approximately sixty percent of the twenty-two participants spontaneously described memories connected to aroma. This unexpected yet consistent emphasis on olfactory memory during the sharing sessions provided a crucial insight. Although visual sketches collected during workshops served as the indirect inspiration and assistance of exploration processes for the subsequent development of the 3DAroma installation (Figure 2), the finding of aroma connections, especially with spices, directly influenced 3DAroma formation. More significantly, the recurring mention of aroma during the sharing and communication among participants became the essential impetus for iterative transformations of the art installation, driving its evolution from a purely optic and tactile experience to a fully multisensory one. During the first two versions of installation, artists and researchers did not find this coincident collective character of aroma; only in the third iteration, olfactory elements were introduced. At last, this full-sensory composition aims for immersion and interaction where each sense of modality plays for representative experience of memory, encouraging the audience to touch, smell, view, and hear nomadic cultural narratives through the body. It was this participant-driven insight that directly necessitated the integration of spice-based olfaction into the installation, transforming the project from a visual exploration into a fully embodied, multisensory archive centered on scent as one of the primary conduits for nomadic memory and identity.

3.2 Spice Inspiration

Spices have historically served as both cultural signifiers and agents of transregional exchange, where Nomadic and Uyghur communities emerged as key intermediaries in the flow of flavors, goods, and ideas [18]. Extended from the domestic life of meditation participants and installation artists, spices such as bay leaves, star anise, cassia bark, green cardamom, black cardamom, fennel seeds, and nutmeg (Figure 3) function as culinary staples and as aromatic markers of cultural identity and memory, intimately tied to the sensory landscape of the home. The 3DAroma research project expands on this legacy by recontextualizing these spices as embodied cultural media, transforming them into multisensory archives through extraction, drippage, and olfactory diffusion with 3D-printed sculptural slices derived from Etles textile geometries. This process aligns with current research in sensory museology and cultural heritage, which emphasizes the role of olfaction in accessing embodied, nonverbal modes of remembrance [19]. Furthermore, related research on cultural history highlights the significance of tactility for evoking deep-seated cultural memories [20], which inspired and supported the artistic decision to drip spice oils on tangible sculptures. Moreover, by embedding spices into algorithmically generated 3D forms and engaging participants through smell, touch, sound, and vision, 3DAroma positions spice as a mnemonic interface, bridging individual and communal memory while foregrounding diasporic experiences. Ultimately, this synthesis reclaims spice from commodified global trade narratives, re-inscribing it with cultural intimacy and affective resonance.

3.3 Technical Implementation

The technical implementation of 3DAroma is a multi-modal system designed to create a comprehensive sensory experience (Figure 4). The artwork system explores tactile, auditory, visual, and olfactory components by engineering each aspect to contribute to the immersive recollection of nomadic memory as embodied reminiscence.

For the tactile sense component, traditional Uyghur Etles fabric patterns, as a symbol of nomadic identity, were collected and served as the initial data source. These intricate patterns were then processed through an AI model to generate novel 3D forms, translating the two-dimensional textile geometry into a three-dimensional tactile experience. These 3D models were subsequently brought into physical existence by 3D printing, creating tangible sculptures that participants could physically interact with and trace, offering a haptic connection to the cultural motifs. Specifically, the transformation logic of the model from a two-dimensional digital image to a three-dimensional form is to assign the lowest and highest heights to the darkest and brightest pixels, respectively. The final shape of each pattern resembles a three-dimensional topographic

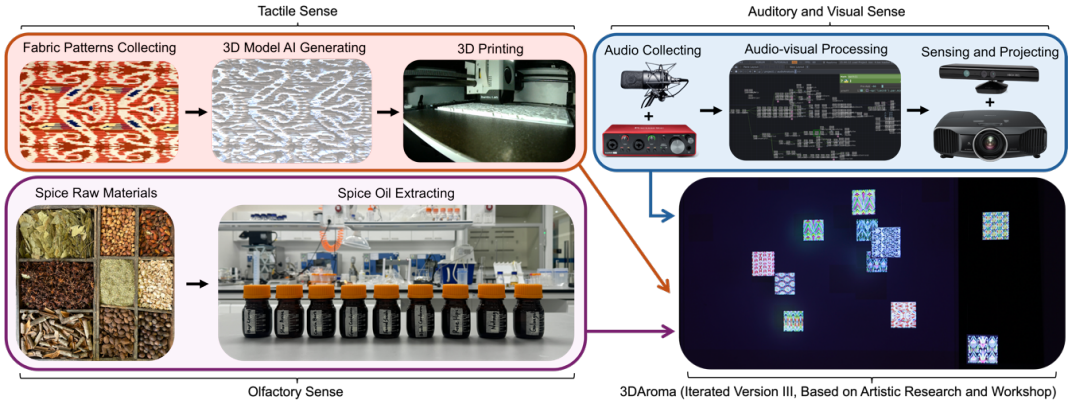


Figure 4: Implementation schematic diagram with interpretation of four senses for the third iterated version installation 3DAroma

map. Therefore, when touching each printed sculpture, the toucher can perceive the corresponding pattern and texture without relying on sight. After laboratory testing, the model height that provides the best tactile feel and is relatively the most economical in terms of printing material is 3.6mm. Correspondingly, after experimenting with the effects of different planar sizes on the toucher's ability to perceive patterns, the plane size was selected to be the maximum printable range of the common printer as Bambu Lab X1E (250mm plus 250mm), since the authors found that the larger the printed plane surface area, the stronger the perception ability for patterns and textures within the 250 square millimeters range.

The visual and auditory sense components work in tandem to create an enveloping environment. Visual elements derived from the Etles fabric patterns were projected onto sculpture surfaces, creating a dynamic visual backdrop that complements the tactile pieces. The projector equipment is Panasonic PT-LMW460C. In a pure darkroom environment, a 3400-lumen device was tested to be able to produce relatively clear and detailed projections onto a 250 square millimeter sculpted surface under transmittance ratios ranging from 1:36:1 to 1.64:1. However, considering the possibility of other projection influences or illuminated artworks in the same dark environment space during the group exhibition, the authors tested and obtained results showing that 4800 lumens is sufficient to ensure a clear projection effect in described circumstance for details of each piece. The practical demonstration at Ars Electronica in Linz also verified the feasibility of 4800 lumens for this project. Simultaneously, audio elements were collected through field recordings of Uyghur home kitchen environments and other domestic spaces, capturing the nuanced soundscapes of daily life. These raw audio files underwent audio-visual processing to enable spatialized sound, enhancing the immersive quality of the embodied experience. Based on the results of meditation workshops and artist interviews, each audio clip was associated with a specific pattern, representing a story, a dream, or a poem. Kinect devices were used to recognize the audience's touch actions. Kinect devices were used to recognize touch actions from visitors at the exhibition. When a specific sculpture was touched, the sensor identified the gesture and transmitted the data to the hub Touch Designer to trigger the associated audio playing. When multiple sculptures are touched, the sounds will be played in the order in which they were touched. However, to achieve a better overlapping effect, when more than one audio track is played, the volume of the audio tracks will be reduced proportionally. For example, two audio tracks will each play at 50% volume, three audio tracks will each play at 33.3% volume, and so on. Since the collected soundscapes are ambient sounds of home, the superimposed effect is not chaotic; on the contrary, it better reflects the poetic effect of different events or consciousnesses occurring in the same spacetime.

Finally, the Olfactory Sense component, as a vital addition driven by the insights from the art meditation workshops, involved the meticulous extraction of essential oils from the selected raw spices by participants and artists as bay leaves, cassia bark, fennel seeds, cardamom, nutmeg, etc. This process, involving precise distillation techniques, ensured the purity and potency of the aromatic compounds at the Lab of Future Technology in Hong Kong University of Science and Technology. These spice oils were then dropped directly on the 3D-printed sculptural forms, diffused within the installation space, and permeated the air. This direct contact allows for a localized and intensified olfactory experience upon tactile engagement, creating a powerful synesthetic link between touch and smell, and further deepening the embodied connection to memory. In practice, if 0.05 mL is approximately per drop from the laboratory essential oil bottle, a 250 square millimeter sculpture requires five drops of spice oil, and the scent of the oil dissipates after around five hours in the summer season by an average temperature of 27 degrees Celsius and 78% humidity. When an exhibition lasts a day from 9 am to 6 pm, it is necessary to replenish the essential oils at least once in the middle. Although the spice oils are made from all-natural plants, warning signs are placed at the entrance of the experiment and exhibition space to remind people with sensitivities to certain spices, taking into account the potential risk of inhaled allergens. The authors also considered exhibiting the installation with and without the scent experience in two adjacent rooms as an inclusive approach for the reminiscence.

The integration of these distinct sensory modalities, including tactile, auditory, visual, and olfactory, culminates in 3DAroma's

iterated version, a comprehensive art installation that leverages technology to create a rich, multi-layered archive of cultural memory. This technical framework aims for a dynamic interplay of senses, enabling participants to engage with complex cultural narratives through a holistic and embodied experience.

3.4 Participatory Interaction

The participatory interaction within 3DAroma is central to its objective of fostering embodied reminiscence and cultural engagement. The design of the installation encourages active participation across multiple sensory modalities, moving beyond passive observation to facilitate a deeper, more personal connection with the artwork and its underlying cultural narratives. This approach both aligns with core essentials of contemporary interactive art, which emphasizes the co-creation of meaning through engagement [21] and underscores the importance of multisensory cues in shaping a participant's artistic experience [22]. Participants are invited to engage with the Tactile Sense components by physically tracing the 3D-printed sculptural forms. Such haptic interaction is crucial, as touch enhances memory encoding through kinesthetic and somatosensory pathways, and the act of physically engaging with forms has also been shown to powerfully reinforce memory recall and resonance [15].

Simultaneously, the auditory and visual sense components respond to the participant's presence and movements within the installation space. This responsive feedback, facilitated by sensing and projection technologies, transforms the environment into an interactive canvas. The spatialized soundscapes of Uyghur domestic life and the projected visual patterns create an immersive atmosphere, where the participant's actions directly influence the audio output. Such interactive immersion is vital for creating a sense of presence and for allowing participants to feel actively involved in shaping their experience, thereby enhancing cognitive and emotional engagement with the cultural content. The integration of the olfactory sense further enriches the participatory experience. As participants interact with the spice-infused sculptures, the localized release of aromas creates a powerful synesthetic link between touch and smell. Olfaction is uniquely potent in triggering vivid and emotional autobiographical memories [23]. Research has consistently demonstrated the superiority of odors over other cues for evoking childhood memories [24]. This effect is supported by direct neural pathways connecting the olfactory system to brain regions associated with emotion and memory [25].

3DAroma's participatory interaction design fosters an environment where memory is not merely recalled but actively re-experienced and re-embodied. By engaging multiple senses in a responsive and integrated manner, the installation enables a profound connection to the nomadic memory and Uyghur cultural heritage. This multi-modal interaction aims to create a journey for participants, allowing them to construct and reconstruct their understanding of diaspora and identity through a dynamic interplay of sensory inputs and personal engagement.

3.5 Iteration

The development of 3DAroma was a dynamic and iterative process, evolving through three versions, each building upon the insights and technical capabilities of its predecessor. This iterative approach allowed for a progressive deepening of the multisensory engagement and more nuanced exploration of themes with artists and audience through interviews and workshops.

The first version served as the foundational prototype. This artwork was conceived to bridge the cultural heritage of traditional Nomadic Etles silk patterns with the transformative potential of AI technology. Initially, the project was expanded on the artist's vision: "When I recall past events, the first thing that comes to my mind is patterns, rather than specific descriptions or words. It could be the pattern of the carpet in the room, the pattern of my mother's apron, the decorative pattern on the curtains at home." The installation integrated Python code for data processing and modeling, resulting in 3D-printed Etlas pieces mounted on a map board, complemented by projection mapping. The interaction was primarily optic and tactile, allowing audiences to touch the 3D-printed sculptures and interact with dynamic projected light effects.

The second version expanded upon the first. This iteration maintained the 3D-printed tactile artifacts with ancestral motifs but introduced auditory elements. When participants touched each slice, audio recordings related to the artist's and mediation workshop participants' memories, such as the sound of a grandma cooking, a grandpa telling stories, or a brother playing with toys, were correspondingly played, creating a synesthetic interaction. If more people touched different pieces at the same time, sounds resonate more as a home soundscape. This version aimed to reconstruct remembrance as collaborative embodiment, provoking reflection on art's role in interrogating belongingness amid displacement. Its spatial arrangement introduced macro dimensions for time, generation, and publicity, further enriching the conceptual framework.

The third and current version, inspired by the diverse insights gained from a series of art meditation workshops. As noted in the above sections, the unexpected and consistent emphasis on aroma by participants during the subsequent sharing and communication sessions revealed a deep, subconscious connection between scent, memory, and identity. This critical feedback underscored the necessity of integrating olfaction to achieve a truly holistic and embodied experience of remembrance. Thus, 3DAroma systematically integrated all four modalities: optic, tactile, auditory, and olfactory. This full-sensory composition aims to construct an immersive environment wherein each modality contributes to a layered experience of memory, enabling participants to engage with cultural narratives through a dynamic interplay of sense, body, and imagination. Each iteration, from the initial focus on tactile accessibility to the expanded multisensory engagement, has progressively refined the artwork's capacity to serve as a powerful mnemonic interface for nomadic experiences.

4 Reflection

4.1 Cross-cultural Dialogue

The development and exhibition of 3DAroma were shaped by an ongoing reflective process, particularly through crucial interactions with and insights from local artists and audiences. Initial interviews with local artists proved invaluable, providing first-hand investigations into the nomadic cultural expression and the subtle ways in which memory is encoded within domestic and artistic practices.

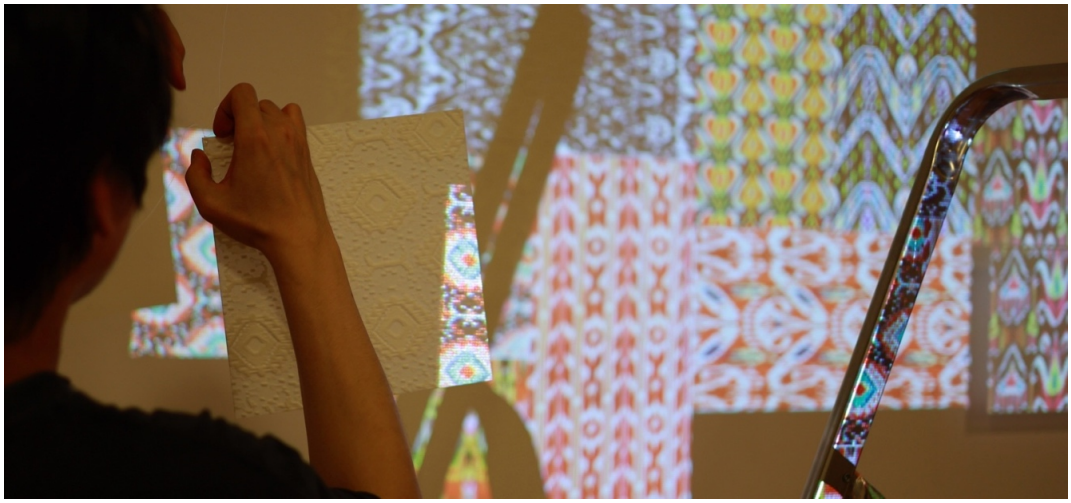


Figure 5: When installing 3D-printed slices with transparent fish lines to the ceiling before exhibition, a projector is used for calibration.

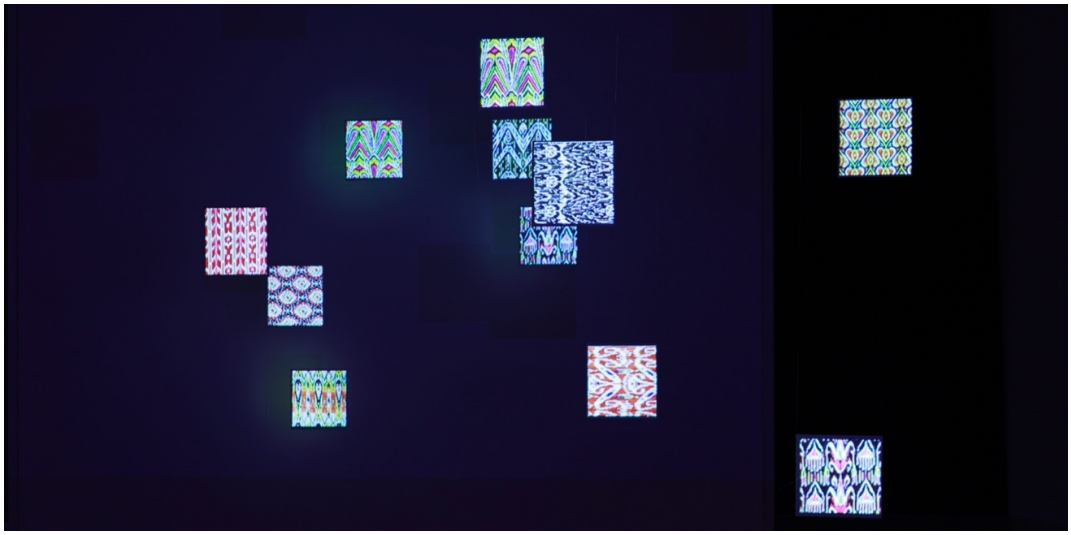


Figure 6: With accurate projection mapping, only 3D-printed pieces would be illuminated. Pictures taken at Ars Electronica, in Linz.

This direct communication was essential for ensuring cultural sensitivity and authenticity in the artwork's conceptualization and execution.

During the installation process in the exhibition, attention was paid to the accurate physical establishment of each slice. Transparent fish lines were used to suspend each 3D-printed piece from the ceiling (Figure 5), creating an ethereal effect that allowed lighting to be precisely projected onto the pieces without spilling onto other areas (Figure 6). This suspension also subtly recalled the inherent uncertainty and fluidity characteristic of nomadic culture and people, as mentioned in another research paper on the data visualization of nomadic peoples, with cultural elements and symbols transforming from invisible to visible [26]. When audiences touched each piece, it would gently sway, a physical and symbolic manifestation of the interactive and changing nature of memories as they engage with both internal and external worlds (Figure 7).

The art installation catalyzed critical dialogues and shared experiences at the electronic and digital art exhibition Ars Electronica in Linz. Audiences were from diverse regions of the world. But especially, participants from Portugal, Spain, South America (as Argentina, Brazil, Chile, and Peru), and Central Asia (as Kazakhstan, Tajikistan, and Uzbekistan) actively and frequently shared their common or similar feelings, visions, and memories evoked by the artwork's different parts. When artists and researchers were by the installation side during the exhibition time, communications between creators and audience went deeper into its methodology and

philosophy behind. Some audience members even proposed open-ended questions, which encouraged and helped with the research paper. This cross-cultural resonance underscored the universal human experience of memory and belonging, even when rooted in specific cultural contexts. Seven audience members mentioned that an unexpected element of interaction emerged as the projector's light sometimes fell upon participants' hands or bodies while they engaged with the pieces, creating an illusion akin to "trying on" the fabric patterns. This serendipitous interaction further deepened the embodied experience, blurring the lines between observer and artwork and inviting a more personal connection to the cultural motifs.

4.2 Findings, Limitations, and Future Works

The research result of 3DAroma yielded several critical analytical findings that extend beyond its technical execution. Firstly, the project demonstrated that a tactile-olfactory nexus serves as a particularly potent conduit for autobiographical recall. While the visual and auditory elements established context, it was the direct physical interaction with the spice-infused sculptures that most consistently triggered vivid, personal narratives among participants, validating the decision to pivot towards multisensory integration based on workshop findings. Secondly, the serendipitous trying-on effect, where projected patterns fell on audience bodies, emerged as an intriguing finding of exploring the digital lights as embodiment. This unplanned interaction transformed the experience from one of observing cultural artifacts to one of temporarily inhabiting them, effectively embodying the project's core thesis of memory as a sovereign act of reclamation, which aligns with the discussion result of another artistic research paper about sovereignty and entanglement in nomadic cultures [27]. Finally, the strong cross-cultural resonance, especially among audiences from regions with nomadic or diaspora histories, indicates that the language of sensory memory, while culturally coded, can transcend specific contexts to communicate universal themes of displacement, home, and identity.

The primary limitation of this research lies in the ephemeral and subjective nature of emotional and mnemonic data, gathered from observations and conversations. A more structured methodology, such as post-interaction interviews or validated psychometric scales, would strengthen the empirical basis of these claims. Such as the research on symbolic representations for triggering changes in psychological states in visual communication, employed both qualitative and quantitative analytical methods, and by dividing the research subjects into control groups and distributing questionnaires, it presented and analyzed the research results more comprehensively for future works [28]. Subsequent iterations will incorporate formalized data collection methods, including anonymous surveys and recorded interviews conducted by psychologists, to systematically capture participant experiences and strengthen qualitative analysis. Furthermore, the temporary nature of the scent diffusion posed a challenge; the intensity of the essential oils diminished over the course of the exhibition, leading to an inconsistent olfactory experience for later participants. This highlights a technical hurdle in sustaining volatile aromatic media in long-duration installations. Future prototypes will explore controlled

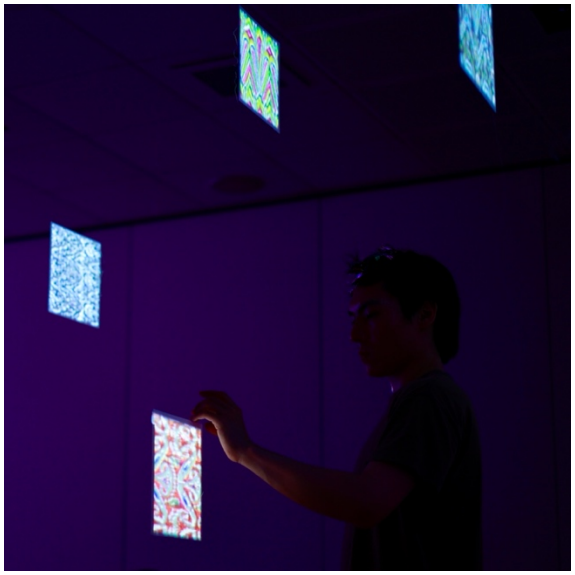


Figure 7: During audience interaction, the printed piece gently swings by reflecting the fluidity and uncertainty of nomadic culture.

scent-release mechanisms, such as programmable diffusers activated by proximity or warmth of touch, to ensure consistent and reliable olfactory stimulation.

In broader utilizations, the promising cross-cultural responses invite application in other diasporic contexts. A future research direction involves adapting the 3DAroma framework in collaboration with other communities to explore its efficacy in mediating different, yet parallel, memory traditions. The implications of 3DAroma are dedicated to extending beyond the domain of media art into sensitive heritage preservation and community-centered archiving. The methodology offers a template for creating living archives that can engage communities with their intangible cultural heritage in a more embodied and affective way than traditional museum displays. In conclusion, 3DAroma explores its role as an art installation to function as a methodological proposition. It posits that the complex, often emotional, tapestry of diasporic memory is not best served by static representation but can be more truthfully and powerfully engaged through multi-sensory, participatory encounters. By leveraging the profound link between sensations with memories, and by embracing a collaborative and iterative creation process, the project creates a space where nomadic identity is not narrated as a historical account but felt as a visceral, present-tense experience. It stands as a testament to the potential of sensory art as a tool for both cultural remembrance and holistic understanding.

5 Conclusion

3DAroma stands as a synthesis of artistic research and meditative experimentation, transforming the ephemeral nature of diasporic memories into a tangible, multisensory archive. By integrating olfactory, tactile, auditory, and visual modalities, the installation endeavors to discover forms of remembrance, offering participants an embodied experience of nomadic consciousness. From symbolic

presence in traditional cuisine and rituals to historical role in commerce, spices embody a deep cultural memory, evoking narratives of movement, connection, and the intricate exchange of knowledge and aesthetics between diverse regions. The strategic deployment of culturally resonant spices, extracted to oils and dropped on algorithmically generated 3D-printed sculptures, transforms into a contemporary medium for embodied reminiscence, where every aroma becomes a conduit for rediscovering and reinterpreting the nomadic spirit and its pervasive influence on art, identity, and collective memories. This research's contributions are twofold: it proposes the development of olfactory-tactile interfaces for art installation as nomadic reminiscence, demonstrating the poetic capacity of spice-media to function as archives for culturally coded remembrance; concurrently, it exploits meditative art mediations as a critical praxis for constructing individual and communal memory retrieval. 3DAroma found nomadism not as a narrative of loss and displacement, but as a fluid decomposition of experience, where the evocative power of scent becomes a profound record, and the intimate act of touch transforms into enduring testimony, offering an experimental research case for understanding the intricate scaffolding of identity through multisensory perception.

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Aquaterrestrial Recolonization:Mission Borneo

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Abstract

Aquaterrestrial Recolonization:Mission Borneo is an ongoing interactive art and AI project designed to address the global crisis of coral reef degradation through immersive, data-driven storytelling. Originally developed in The Bahamas and now adapted for Borneo, the project is conceived as a trans-local and site-responsive platform—one that can be deployed in any marine region experiencing ecological stress. Its goal is to raise awareness of oceanic collapse, stimulate emotional engagement, and promote environmentally conscious behavior by connecting audiences with the realities of coral loss and the potential for regeneration. Rather than idealized visualizations, the project focuses on reconstructing damaged or lost underwater environments. Using AI trained on environmental data, coral morphology, and documented reef degradation, the installation generates speculative but grounded renderings of revitalized reef ecosystems. These are presented in an immersive audiovisual space that invites public interaction and reflection on climate change. By integrating scientific modeling, artistic interpretation, and AI storytelling, *Aquaterrestrial Recolonization* serves as both a speculative archive and a call to action. It contributes to the preservation of marine bio heritage and fosters a global dialogue on sustainability—adaptable to multiple geographies, cultures, and communities facing the urgent consequences of climate change.

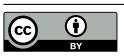
CCS Concepts

• **Applied computing**; • **Arts and humanities**; • **Media arts**; • **Computing methodologies**; • **Artificial intelligence**; • **Human-centered computing**; • **Human computer interaction (HCI)**; • **Collaborative and social computing design and evaluation methods.**;

Keywords

AI environmentalist, Coral reef conservation, Generative art, Interactive installation, Digital heritage, Climate change, Borneo, Marine sustainability

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1 INTRODUCTION

Coral reefs represent some of the most biodiverse ecosystems on Earth and are vital to coastal protection, food security, and marine heritage [1]. Yet, they are under severe threat due to human activity and climate change. In Southeast Asia, Borneo's reefs have experienced dramatic decline due to warming waters, sedimentation, plastic waste, and overfishing. These ecosystems, like many others globally, are on the frontline of ecological collapse and require urgent, sustained attention.

Artificial intelligence is playing an increasingly transformative role in environmental science and activism. In the context of ocean conservation, AI tools enable the collection, processing, and visualization of complex marine data, supporting both predictive modeling and creative reimaginings of ecological futures. Beyond scientific applications, AI also holds powerful narrative and communicative potential in art, enabling new forms of storytelling, memory-making, and public awareness.

The *Aquaterrestrial Recolonization: Mission Borneo* project was originally conceived as an artistic and technological intervention in The Bahamas. It used artificial intelligence to visualize the possible futures of coral ecosystems by reconstructing lost underwater habitats from environmental data. Now extended to Borneo and beyond, the project emphasizes that coral degradation is a global issue, not limited to a single site. Each iteration of the installation adapts to its local ecological context while contributing to a shared planetary narrative.

Rather than offering purely speculative simulations of pristine coral reefs, the project focuses on reconstructing damaged or disappearing marine environments. By utilizing real environmental records, underwater video footage, and AI-trained models of coral growth, the installation offers a digitally mediated representation of what has been lost and what could be restored. At its core, *Aquaterrestrial Recolonization* is a scalable platform for climate awareness and digital heritage preservation, inviting audiences worldwide to reflect on their relationship with marine ecosystems and the urgent need for collective action.

The project is conceived as a "translocal and site-responsive platform" that can be deployed in any marine region experiencing ecological stress. This inherent design enables a global scope while maintaining local relevance. Each iteration adapts to its local ecological context, contributing to a shared planetary narrative of coral degradation and potential regeneration. For Borneo, this involves incorporating specific environmental data and focusing on the region's unique coral crisis. Furthermore, the installation explicitly acknowledges Borneo's indigenous maritime heritage and ecological vulnerability. By preserving and reimagining coral environments, the artwork aims to be a vessel for biocultural knowledge transfer and a catalyst for sustainable thinking within the local context. Hence, the methodology involves collecting detailed data on

coral health, species diversity, and reef damage from Bornean marine research centers. This ensures that the AI models are trained on specific, local environmental conditions, making the visualizations relevant to the Borneo context.

2 ENVIRONMENTAL CONTEXT: BORNEO'S CRISIS

Malaysia, particularly Sabah and Sarawak, is part of Borneo and is home to fragile coral ecosystems [2]. These reefs are increasingly affected by warming ocean temperatures, unsustainable fishing methods, and rapid tourism development. According to recent surveys, many reef areas suffer from low coral cover and high mortality, compounded by diseases such as White Syndrome and ongoing pollution [3]. These factors mirror those faced in the Caribbean and highlight the global nature of coral degradation.

While *Aquaterrestrial Recolonization: Mission Borneo* focuses on the marine ecosystems of the South China Sea, its scope extends to the interconnected ecological systems of Borneo's rainforest and atmosphere. These environments—oceanic, terrestrial, and aerial- are mutually dependent, forming a living bioregion. Coral reef decline along Sarawak's and Sabah's coasts cannot be isolated from upstream deforestation, sedimentation, and atmospheric disruptions caused by burning and haze.

In this context, the project incorporates local and indigenous ecological knowledge from coastal and riverine communities. Their oral traditions, sensory observations, and material practices, such as the reading of tidal cycles, coral spawning cues, and seasonal monsoon winds, inform both the visual aesthetics and the data models used in the installation. Collaborations with local marine researchers, community leaders, and artists ensure that the AI reconstructions not only visualize data but also translate lived environmental memories into digital form.

This integration of indigenous perspectives transforms the AI from a neutral tool into a cultural interlocutor, mediating between scientific datasets and embodied ecological wisdom. The installation's speculative coral forms and environmental sounds draw upon Bidayuh and Melanau cosmologies, where water, forest, and sky are understood as reciprocal entities. Such frameworks enrich the AI's representational logic with cultural depth, creating a hybrid narrative language that merges environmental data with ancestral ecological philosophy.

To balance the project's global and translocal ambitions with deeper site-specific engagement, each deployment of *Aquaterrestrial Recolonization* adopts a modular, adaptive model. The global framework, addressing coral degradation and climate change, remains constant, but the visual data, local textures, and soundscapes are recalibrated for each host environment. In Borneo, this means prioritizing data from the South China Sea reefs, local coral species morphology, and community narratives about changing tides and fish migrations. The result is an installation that simultaneously speaks to planetary ecological crisis and local cultural identity, fostering both shared awareness and community empowerment.

3 CONCEPT AND OBJECTIVES

Aquaterrestrial Recolonization: Mission Borneo is an interactive art and AI project that stands out in the fields of eco-art and AI art by uniquely combining artistic expression, scientific data, and interactive AI to inspire behavioral change. While many eco-art practices aim to raise awareness about environmental issues, *Aquaterrestrial Recolonization* takes a step further. It utilizes AI to visualize a potential future where damaged parts of the planet are recolonized, offering a metaphorical healing process. This approach moves beyond mere representation to speculative intervention, aiming to assist in actual revitalization. Furthermore, the project incorporates recent scientific discoveries into its artistic intervention. For example, it uses the ambient sound of healthy corals to attract fish, a finding from recent coral recovery research.

The artwork leverages AI not just for aesthetic creation, but also as an "AI Environmentalist"—a chronologist, provocateur, and protector of the Earth. The AI generates 3D meshes of corals and simulates their growth based on temperature, allowing for dynamic, real-time visualization of environmental impact and recovery. This extends beyond mere representation to speculative intervention, aiming to facilitate actual revitalization. This serves as both a speculative archive and a call to action for the preservation of marine bioheritage. The installation offers an immersive audiovisual space where visitors can interact by adjusting parameters, such as water temperature levels, through digital interfaces. They can then observe AI-driven visual reconstructions depicting coral regeneration or degradation. This interactivity highlights the precarious balance of marine ecosystems and visualizes the impact of human-driven climate shifts. The AI's ability to interpolate between healthy and dead coral states based on temperature thresholds, informed by real marine science studies, engages audiences as co-agents of climate responsibility.

Aquaterrestrial Recolonization distinguishes itself by integrating rigorous scientific data and AI-driven simulations into an interactive art experience. It aims not only to raise awareness but also to foster emotional engagement and inspire environmentally conscious behavior by visualizing potential futures for degraded marine ecosystems, thereby acting as a powerful tool for environmental advocacy and digital heritage preservation. Therefore, its primary objectives are:

- • To simulate the regeneration of coral reefs in Borneo using AI-based modeling.
- • To visualize the transformation from degraded to thriving reef ecosystems.
- • To engage visitors visually and interactively, demonstrating the importance and possibility of reef recovery.
- • To motivate environmental responsibility and support restoration initiatives.

The core of the installation is an immersive audiovisual environment composed of:

- • To motivate environmental responsibility and support restoration initiatives.
- • Underwater video footage documenting Bornean coral degradation.
- • AI-generated 3D reconstructions of healthy reef colonies.
- • Ambient sound recordings mimicking vibrant reef life [4].
- • Holographic projections of evolving coral polyps.
- • Physical marine objects (e.g., ropes, anchors) signifying human impact.

- • A pseudo-temperature controller interface allowing visitors to simulate the effects of ocean warming or cooling.

Using AI models trained on coral morphology and environmental parameters, the system reconstructs dynamic underwater landscapes. Visitors interact with simulated ocean temperatures via mobile devices, witnessing the direct effects on coral vitality—from colorful regeneration to bleaching-induced decay. This interactivity underscores the precarious balance of marine ecosystems and visualizes the impact of human-driven climate shifts [5].

3.1 Conceptual choices in visual and behavioral change design

The project deliberately avoids idealized visualizations of pristine coral reefs. Instead, it focuses on the "reconstruction of damaged or disappearing marine environments". This conceptual choice grounds the artwork in the reality of ecological loss, making the speculative regeneration more impactful and relatable.

An AI-based agent serves as a "visual and computational mediator between scientific data and public engagement". It generates coral structures and simulates growth/decay based on temperature input, making the AI a dynamic storyteller of ecological narratives. This choice emphasizes the AI's role not just as a tool, but as an active participant in conveying the message. The core of the installation is an "immersive audiovisual environment". Visitors interact with digital interfaces, manipulating parameters such as water temperature and pollution levels, and witness AI-driven visual reconstructions. This interactivity underscores the precarious balance of marine ecosystems and visualizes the impact of human-driven climate shifts. The use of holographic projections of evolving coral polyps and ambient sound recordings mimicking vibrant reef life enhances the immersive quality.

The visualizations are described as "speculative but grounded renderings of revitalized reef ecosystems". This means that while they imagine future possibilities, they are firmly based on AI trained on environmental data, coral morphology, and documented reef degradation. This balance between artistic speculation and scientific grounding lends credibility and urgency to the project's message. The project aims to stimulate emotional engagement and foster empathy through its participatory design and emotionally resonant aesthetics. The visual transformation from degraded to thriving reef ecosystems is designed to engage visitors visually and interactively, demonstrating the importance and possibility of reef recovery.

Aquaterrestrial Recolonization: Mission Borneo employs a multifaceted approach to engage audiences, integrate local knowledge, and distinguish itself within the broader eco-art and AI art landscape. Its evaluation relies on observing interaction and gathering feedback, while its site-specific adaptations and community collaborations ensure local relevance. The project's unique use of AI for grounded speculation and its immersive design are central to its artistic and conceptual choices, aiming to inspire action for marine conservation globally and locally.

4 METHODOLOGY

4.1 Data Gathering and Training

Collect detailed data on current coral health status, species diversity, local environmental conditions, and reef damage assessments from Bornean marine research centers. This data feeds into machine learning models trained to understand coral growth patterns, recovery stages, and the impact of environmental stressors (Figure 1).

4.1.1 AI-Driven Reconstruction. Employ neural networks to generate dynamic 3D visualizations of coral colonies capable of "rebuilding" over time (Figure 2). These AI simulations respond in real-time to environmental inputs, such as temperature rises or pollution levels, illustrating potential future reef states.

4.2 Interactive Visualization

Design an immersive installation that allows visitors to manipulate parameters such as water temperature and pollution levels through digital interfaces, while observing AI-driven visual reconstructions that depict either coral regeneration or further degradation. Complementary soundscapes evoke the natural reef environment, enhancing emotional engagement.

4.2.1 Evaluation of Audience Experience and Impact. The evaluation of audience experience and impact for the 'Aquaterrestrial Recolonization' project primarily relies on direct interaction and qualitative feedback. The installation is designed to be interactive, allowing visitors to engage with the artwork and observe its responses.

4.2.2 Interactive Elements. Visitors can scan a QR code to access a pseudo water temperature controller on their mobile devices. By virtually increasing or decreasing the water temperature, they can change the color of the AI-generated coral colonies, symbolizing their health (grey for dead, full color for live). This interactive loop is crucial for the behavioral change process intended by the designers.

4.2.3 Qualitative Feedback. Although no formal experiments were conducted during the exhibition, the authors or mediators were present to interpret the artwork and engage with visitors. Unstructured, spontaneous interviews conducted days after interaction revealed that visitors confirmed exploring the effects of global warming after engaging with the installation, indicating a perceived impact. The project aims to provoke climate action-related behavioral change through this engagement.

5 CULTURAL, ECOLOGICAL, AND EDUCATIONAL IMPACT

An AI-based agent serves as a visual and computational mediator between scientific data and public engagement. The model generates coral structures from graph-based neural networks and simulates growth patterns and decay based on temperature input. Each visitor's interaction subtly shifts the virtual reef's condition, making them part of an evolving ecological narrative. The AI is trained to interpolate between healthy and dead coral states using temperature thresholds informed by real marine science studies [6].

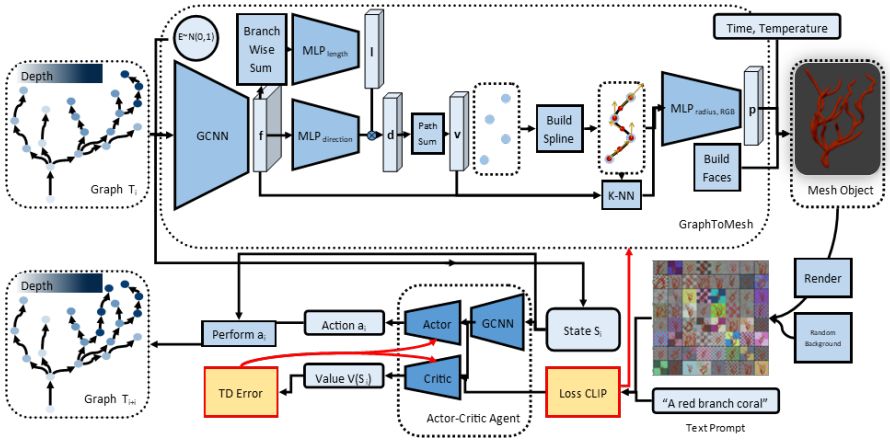


Figure 1: One training step for our AI: We use A2C for learning how to build appropriate graphs given a text prompt [9]

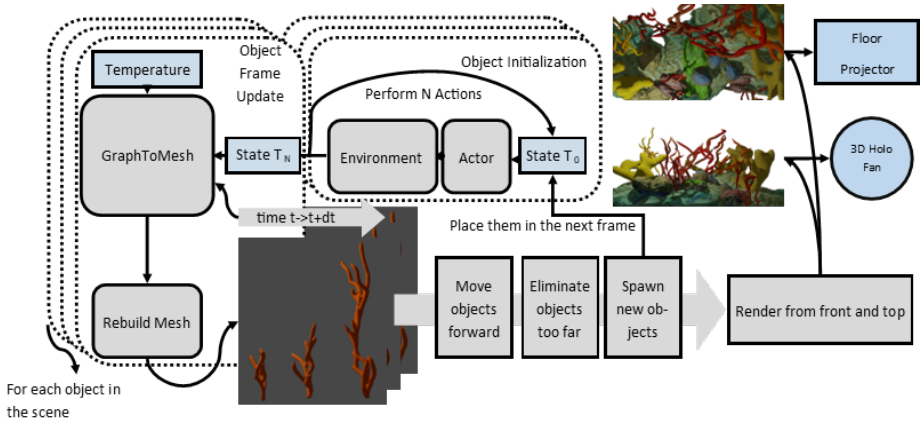


Figure 2: Schematic description of the algorithm for the scene updating at each frame

Aquaterrestrial Recolonization project operates at the intersection of artistic expression, environmental data visualization, and behavioral science. It engages audiences not just as viewers but as co-agents of climate responsibility.

Rooted in Borneo, the installation reflects the region's indigenous maritime heritage and ecological vulnerability. By preserving and reimagining coral environments artwork *Aquaterrestrial Recolonization: Mission Borneo* becomes a vessel for biocultural knowledge transfer and a catalyst for sustainable thinking.

The project aligns with several UN Sustainable Development Goals (SDGs), particularly those related to climate action, life below water, and sustainable communities [7]. Through its participatory design and emotionally resonant aesthetics, it fosters empathy and encourages meaningful reflection on ecological fragility and resilience [8].

6 CONCLUSION AND FUTURE WORK

The *Aquaterrestrial Recolonization* initiative showcases how AI-driven art can integrate environmental science, indigenous knowledge, and speculative storytelling to envision ecological futures. In *Mission Borneo*, the reefs of the South China Sea serve as both an ecological dataset and a symbolic mirror of cultural resilience. By transforming scientific data and oral traditions into immersive visual narratives, the project reframes AI as a medium for empathy, preservation, and collective imagination.

Future work will extend this integrative model beyond the marine domain to encompass the bio-heritage of Borneo's rainforests and sky phenomena, including canopy diversity, cloud dynamics, bioluminescent species, and atmospheric cycles. This expanded initiative, *Bio-Heritage of Borneo*, envisions a tri-layered narrative—sea, forest, and sky—capturing the island's ecological continuum through AI-generated visualizations informed by both local wisdom and scientific observation.

By combining local storytelling, environmental data, and community participation, future iterations will deepen site-specific authenticity while contributing to a global dialogue on digital heritage and climate action. Ultimately, *Aquaterrestrial Recolonization* positions Borneo not as a remote site of study, but as a co-author in a planetary narrative of regeneration, a dialogue between technology, tradition, and the living world.

Acknowledgments

The manuscript explicitly documents and incorporates AI-generated content. Detection of such content is therefore expected and reflects the study's subject.

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Searching for the *Everywhen* on the Basis of the Findings of the Artistic Research Project *skin flats*

The simultaneous existence of emptiness and fullness must not be a paradox—they can be one and the same

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ABSTRACT

The "everywhen" has a beginning that never ends—this is one of the assumptions in the deep time theory not only referring to geological time. Does it really contain past information as well as future imaginations, inscribing itself into physicality, matter, and thus writing history, presence and future at the same time? Discourses surrounding the "anthropocene" are still in their infancy; the polychronological concept of "deep time" as known not only from Māori indigenous cultures has developed over long periods of time. If the everywhen is a space-time where everything—all times, all places, all matter—can collapse into one, then what is it that arises—"emptiness?" Or is it entropic? And, can human consciousness access such everywhen? The paper explores the above questions on the basis of examining the creation processes of the image-video installation *skin flats*, in the light of positions from phenomenology and with a focus on embodied cognition.

Keywords

Everywhen, Emptiness, Void; Fullness, Abundance, Time, Polychronology, Anthropocene, Aitologies, Embodiment

1 Introduction

The "everywhen" has a beginning that never ends—this is one of the assumptions in the deep time theory not only referring to geological time. Does it really contain past information as well as future imaginations, inscribing itself into physicality, matter, and thus writing history, presence, and future at the same time?

Discourses surrounding the "anthropocene" are still in their infancy; the polychronological concept of "deep time" as known not only from Māori indigenous cultures has developed over long periods of time. If the everywhen is a space-time where everything—all times, all places, all matter—can collapse into one, then what is it that arises—"emptiness?" Or is it entropic? And, can human consciousness access such everywhen?

2 Searching for the *Everywhen* on the Basis of the Findings of the Artistic Research Project *skin flats*

The paper explores the above questions on the basis of examining the creation processes of the image-video installation *skin flats*, in the light of positions from phenomenology, and with a focus on embodied cognition.

skin flats started from close-ups of skin. For the artist, the blurry photographs "emerged" as they were created through the accidental and unconscious use of the camera. In a purely formal approach, the "self-portraits" were transformed into abstract images of flat geometric and simultaneously fuzzy field character—this is what led to the project title.

The artist continued to focus on letting emptiness appear; a "nothingness" between things—an aspiration she has been pursuing for decades.

But perhaps this understanding of emptiness and the claim to make it perceptible are entropic? Does emptiness have a form? Can it be given a form? Can it be contained in another form if it itself has no form? *The ontological opposition between physical mass and space* is a paradox and remains one of the recurring conflicts in the arts [9].

In an intuitive and randomly discovered way, the individual edits were arranged into triples. In these montages, they overlap and form segments of phenomena

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that—for the artist—connote future, present, and past, as well as their "inter-influencing."

skin flats turned into a quasi-automatically generated space of self-reflective perspectives, created through "subconscious image writing" and an "immersion in collectivity" by means of abstracting subjective phenomena. Although the montages are composed of specific self-portraits, they ultimately see themselves as "empty" pieces, elaborated from an aspiration to let "non-individual" work emerge, not least in a questioning of the artist as a "genius"—another approach to creating art that has accompanied the author for years.

The original chronology of the photographs taken is given up in the overall plot; the random appearance of the edits in the montages lets go of our common understanding of time and creation. They switch places, can be seen only in sections—fields of individual human experience; of marginal subjective perspective catching only a glimpse, as if from one side, of how it could be perceived when everything falls together into one; only to loose that glimpse again—like phenomena that disappear to just reappear on the other side; like a fleeting glance that keeps returning …

The wall installation, measuring approximately 5x12 meters, consists of the 60 montages, which are arranged in rows of alu-dibond prints in chronological order of their creation. The triples form a sequence without any beginning or end; the individual edits fall together into a single work, now appearing simultaneously in chronological and non-chronological order.

This arrangement, in combination with the work's formal language, suggests the option of endless reading and thus once again allows for a suspension of linear time in the viewer's perception.

But how does emptiness act in time? The static representation of the search for an everywhen seemed to be only part of the overall research process.

Ultimately, it asked to be transformed into movement, and in the resulting experiential videos, the artist delved further into meditative reflections on the so-called self …

First, *skin flats 0* was created, an approximately 15 minutes video—again a sequence without any intentional content. A classic fade into black and back was used as the ever-same form of transition from one triple still to the next, leading to an endless loop without any change of rhythm in time. By simply cutting this "master" into three parts of roughly the same duration—*skin flats part I*, *II*, and *III* were created. Shifts in the fades caused only by technical reasons led to barely perceptible, yet existing rhythm changes.

The static installation had found a moving image extension; the original 4K video and its parts complement the rows of the prints. When looping simultaneously on flat screens hung in their own row at some distance from the installation of the panels, they are nevertheless never simultaneous. Now the images examining their own interchangeability not only tell of movement in time, but—in a generalization of the specific as much as the nesting of specific phenomena in the abstract—they perform it, with the aim of opening up a dynamic path to perceiving an "emptiness between things;" and thus letting still moments find back to their specificity through the eyes of the recipient.

Not least due to the artist's unexpected, life-threatening cancer diagnosis and the severe emotional turmoil, including the fear of death and the utter helplessness in the face of the paradox of the proven need to cultivate hope and courage to strengthen health and healing, only to ultimately have to let go—whether one survives illness or not—the meditation on emptiness lost none of its significance; however, its exploration, which had accompanied the artist throughout her life—and thus her entire approach to *skin flats*—entered a previously unknown dimension. From one moment to the next, the theme changed from the exploration of emptiness to "fullness in emptiness;" it virtually reversed itself within a fraction of an instant—as if the duration of an artistic development process was reduced to zero. An unexpected plot point had changed the story; a thunderstorm-like turn had occurred, which at the same time felt so light and transparent in its logic as it appeared in a sudden, unexpected and abrupt way—as if through a kind of acceleration. A situation had inverted, as had a mindset:

Emptiness is never "nothing." Nothing itself is "something." There is no emptiness, there is only the "empty," the "void." In itself it is rich of fullness, which is nothing else but "abundance," perceivable through connectedness.

Thomas Metzinger attributes a distinct phenomenal quality to emptiness, which he describes as a certain openness to the world that is related to knowledge, [a ...] space defined by the 'possibility' of acquiring knowledge [15, p. 169].

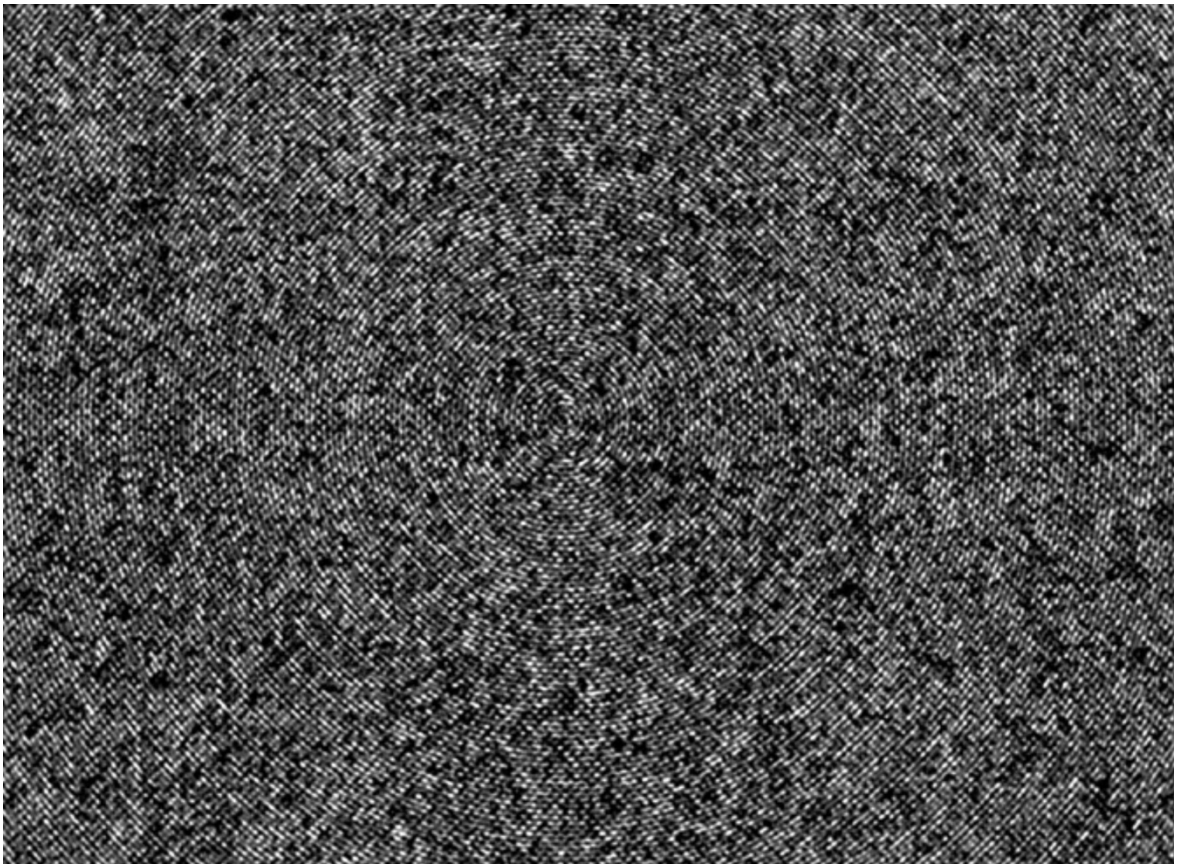


Figure 1: Alexandra Reill. 2022. *skin flats*. Digital image edit of a photographic self-portrait

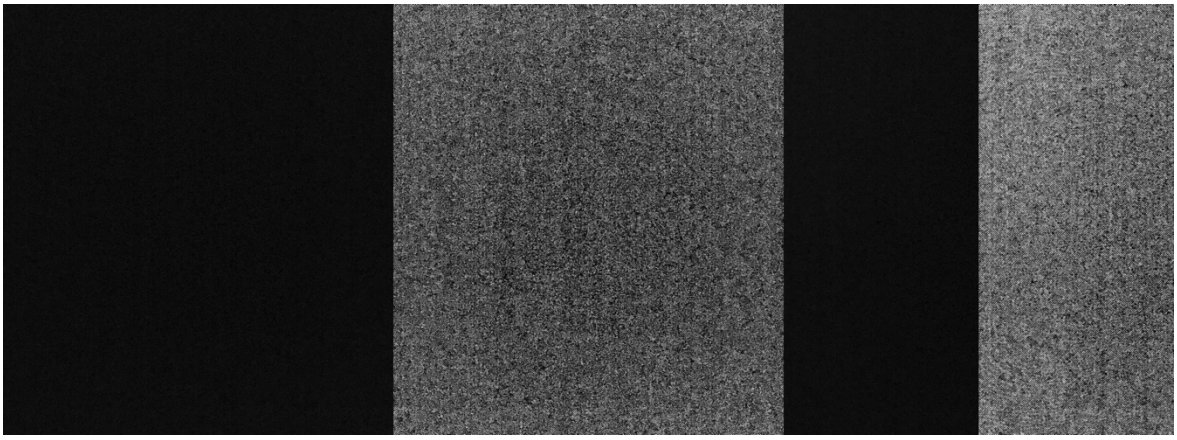


Figure 2: Alexandra Reill. 2022. *skin flats*. *triple 007168*. Digital image montage

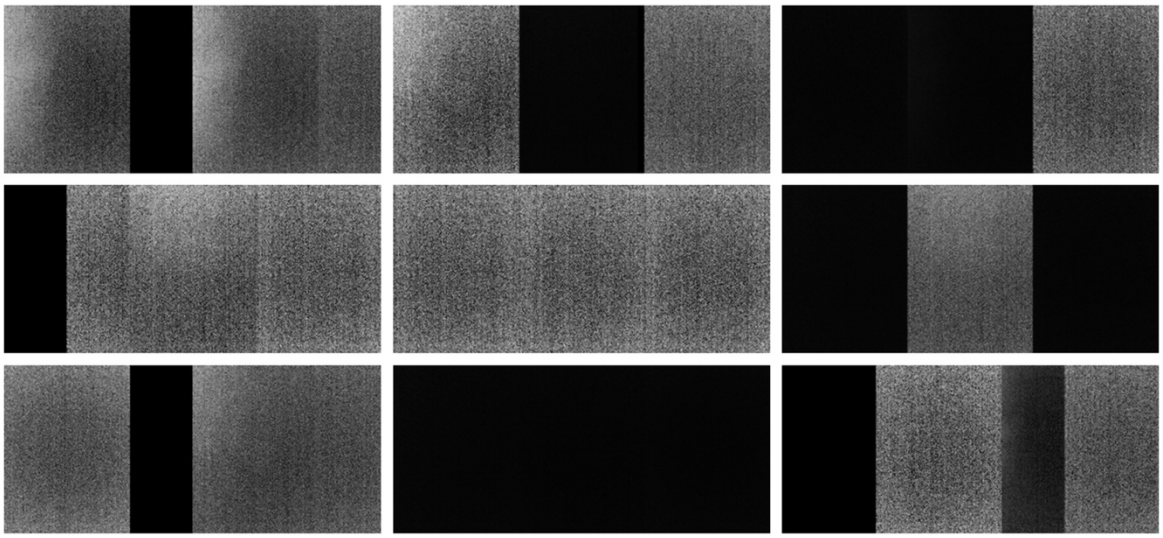


Figure 3: Alexandra Reill. 2022. *skin flats*. Wall installation of 60 digital image montages (triples). Selection

For Nazareth Karoyan, emptiness [...] *is not a result but rather a consequence. A result is something to strive for, to create, and achieve, whereas a consequence is something to face or to end up with. Consequently, as a state or consequence, emptiness can be reached; it can be discovered. Its forms are revealed, unearthed, or, to use a stronger term, invented as fissures, cavities, openings* [...] [9].

Creating the specific does have an impact. Or, in other words: When a butterfly flaps its wings, a breeze goes round the world.

The research results from observing and analyzing the production process of *skin flats* led to the conclusion that the void and its abundance can be realized; by simultaneously experiencing emptiness and fullness—through connectedness. They can be one and the same and do not have to form a paradox.

The artistic piece *skin flats* understands itself as an approach to immersive experience in the context of "shifting temporalities," trying to evoke a sense of deep time in recipients by taking them on a journey into their individual everywhen.

The artistic research project *skin flats* dedicates itself to the uniqueness of that spark of realization that never existed as it is gone while perceiving it; and which does not exist yet as it is an imagination.

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Washing My Hands

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Abstract

Washing My Hands brings natural materials from nearby seas and rivers into the exhibition space, creating an authentic and interactive environment. The installation features four small containers filled with water and various natural elements such as rocks, pebbles, sand, or plain seawater or river water. In a darkened room, each container is connected to an L-shaped LED light panel. Initially, the LED lights display subtle gray tones, evoking the reflective shimmer of river ripples. When visitors wash their hands in the containers, their movements are captured by contact microphones placed beneath each vessel, generating sound in real time. In response, the LED lights gradually shift into gradient blue hues, echoing both the rhythm of the sound and the undulating motion of ocean waves. When visitors stop interacting with the water, the sound gently fades, and the LED lights slowly return to their original gray gradient. Through this sensory interplay of touch, sound, and light, *Washing My Hands* offers a synesthetic experience that invites reflection on the water as a metaphorical space for cleansing, healing, and renewal. The work transforms the simple act of washing into a meditative encounter, where natural materials and digital technology converge in a moment of quiet interaction and emotional resonance.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Synesthesia, sustainability, interactive art, sound installation, LED art

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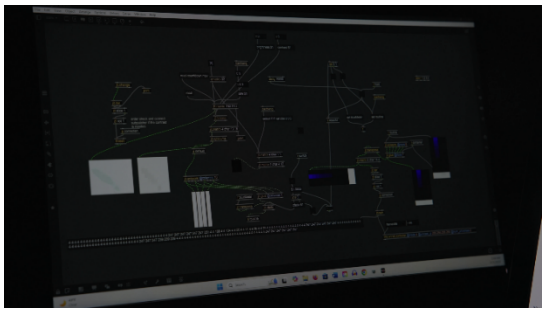


Figure 1: The Max 9 patcher for *Washing My Hands*. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha



Figure 2: The default image of *Washing My Hands*. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

1 Introduction

Today, people experience less contact with natural materials due to industrial and economic shifts. A century ago, most furniture and architecture were crafted from materials such as wood, metal, and glass. However, with the rise of synthetic production, these have largely been replaced by artificial alternatives including plastic, Plexiglas, and other synthetic, skeuomorphic surfaces. As a result, human perception is increasingly mediated by materials that lack the organic qualities of scent, texture, and aging. Unlike natural materials, which transform over time, synthetic materials remain static—producing a numbing effect that diminishes sensory engagement. Direct interaction with natural substances, by contrast, reminds us of the passage of time and encourages deeper reflection on human experience [1]. As a temporary yet immersive natural encounter, *Washing My Hands* offers visitors an interactive space that reconnects them with authentic sensory experiences. While washing their hands, participants engage with natural materials gathered from nearby beaches and rivers. This tactile action organically generates dynamic abstract imagery of blue ocean waves accompanied by live oceanic sounds, creating a multisensory experience that unites the digital and the elemental.

2 The Water as a Mediator in Media Art

Water has long served as both a physical substance and a conceptual mediator in media art, enabling audiences to engage with technology through multisensory and symbolic encounters. As one of the

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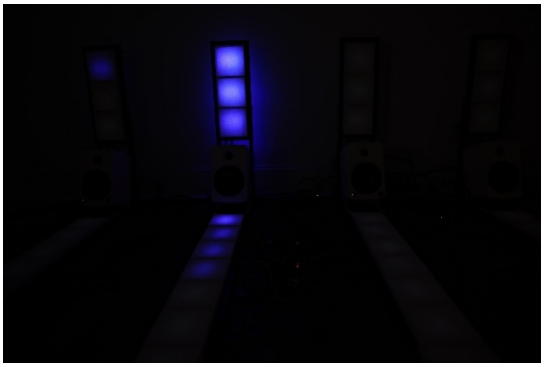


Figure 3: An image of a blue wave generated by a visitor's interaction. Photograph by Byeongwon Ha. Copyright by Byeongwon Ha

most elemental and universal materials, water connects the human body, natural cycles, and digital systems through its mutable form—flowing, reflecting, and transforming in real time. In the history of media art, water has functioned as a bridge between the organic and the technological, the tangible and the virtual. In Nam June Paik's *TV Fish* (1975), water operates as a visual filter, refracting the light from television screens through the motion of fish and rippling water. Paik's work recontextualizes the TV monitor—once a symbol of mass media—into a living, fluid ecosystem, collapsing boundaries between nature and electronic imagery. Similarly, in Bill Viola's *The Reflection Pool* (1977–79), water becomes a narrative and spiritual element, symbolizing transformation, purification, and self-awareness. The stillness and reflective surface of the pool invite viewers to contemplate temporal perception and human consciousness, bridging the sacred and the technological. In Julius Popp's *Bit.Fall* (2001), water assumes a linguistic and algorithmic role as a textualizing material. Controlled by computer algorithms, water droplets form ephemeral words in midair, literally embodying the flow of digital information. The piece transforms data into a physical spectacle—information that appears, falls, and disappears—mirroring the fleeting nature of online communication. Likewise, in Ryuichi Sakamoto and Shiro Takatani's *LIFE – fluid, invisible, inaudible* (2007), water is presented as an ephemeral object, an invisible force linking sound, image, and environment. Here, water is less a substance and more a presence—fluid, temporal, and constantly transforming. Building on these approaches, *Washing My Hands* positions water not only as a metaphor or an image, but also as a direct experiential medium that reconnects the human body with natural materiality. The work invites participants to physically immerse their hands in seawater and river water, making the act of touching water itself a performative gesture. As visitors interact, their movements generate both sound and light, translating tactile engagement into digital feedback. This real-time transformation underscores water's dual role—as both a sensory interface and a data conduit—bridging organic experience and technological expression. The conceptual framework of *Washing My Hands* extends from the ecological and participatory philosophies of Joseph Beuys, who regarded art as a form of social sculpture capable of transforming human awareness through direct experience. Similarly, the interactive installations of Christa Sommerer and Laurent Mignonneau—which often use biological interfaces to explore the coevolution of humans and nature—inform the project's exploration of water as both a living material and a responsive medium.

3 The Concept of Washing My Hands

In *Capri Battery* (1985), Joseph Beuys connected an organic lemon, a socket, and a yellow light bulb to create an imagined source of illumination. Although the lemon does not function as a practical battery, the work conceptually evokes the latent power of natural materials, symbolizing stored solar energy and the balance between chaos and order in environmental sustainability [2]. Beuys incorporated the lemon as a metaphor after experiencing the healing effects of the sun during his stay in Capri [3]. In the field of interactive art, natural materials often play a crucial role in providing visitors with more meaningful and embodied experiences. In *A-Volve* (1994–97), Christa Sommerer and Laurent Mignonneau used water as a fundamental element to create an oceanic atmosphere. Visitors first touched the water before using a touchscreen to generate digital marine life, linking the authentic tactile sensation of water with the imaginative creation of digital organisms. Inspired by these significant precedents, *Washing My Hands* symbolizes purification and healing, transforming the simple act of handwashing into a ritualistic engagement with nature. The project merges this act with a synesthetic performance that integrates both live sound composition and abstract visual representation. Visitors may choose one of four containers placed on the floor in a darkened space, each filled with water combined with different natural materials collected from a nearby beach or river: pure water, sand, pebbles, and small rocks. Each container is connected to an L-shaped LED line covered with fourteen 6 × 6-inch canvases that emit solid RGB colors. Eleven LED canvases are arranged on the floor—including two positioned beneath the container to illuminate it—while three are mounted on the wall. A loudspeaker is placed at the intersection of these canvases. Before interaction, *Washing My Hands* presents a tranquil environment featuring a slow-moving, black-and-white abstract reflection of ocean ripples accompanied by silence. When visitors touch the natural materials, the LED lights transform into dynamic bluish, sound-meter-like patterns that respond to the sounds generated by their movements. Individual participants can create solo compositions of mesmerizing blue light and sound, while groups of visitors can collaborate to produce richer, more fluid, wave-like imagery. In this way, the act of washing hands transcends everyday routine—it becomes a gateway to reconnecting with nature and performing a creative, multisensory experience. The work immerses participants in a dialogue between sound, light, and water, bridging physical sensation and aesthetic contemplation. During deinstallation, all natural materials are returned to their original locations, ultimately back to the sea or river. By returning them, the project reinforces environmental responsibility and advocates for the sustainability of interactive art.

4 The Transmodality of Washing My Hands

To create an interactive environment, *Washing My Hands* employs Max 9 in conjunction with a DMX interface. Before visitors begin

interacting, the installation presents a gray-toned pattern that mimics the reflection of river ripples within a dark and silent space. This subtle image oscillates in organic, ripple-like motions, gently guiding visitors' attention toward the illuminated containers scattered across the room. Max 9 processes 8-bit color data (4 × 14 pixels) derived from a moving image of river ripples (200 × 300 resolution) and transmits it to an ENTTEC DMX interface. The DMX interface relays this color data to six DMX decoders, each connected to the RGB LED canvases. When a visitor washes their hands in one of the containers, a contact microphone placed beneath it captures the vibrations of movement. The resulting sound is amplified through a loudspeaker, enhancing the auditory feedback of the interaction. The same audio signal simultaneously modulates the LED lights, dynamically replacing the original reflective gray imagery. The system translates volume levels into a series of numerical values mapped onto an 8-bit color channel (0–255), generating subtle motion patterns that evoke oceanic waves. Rather than displaying a conventional sound meter with green-to-red gradients, the visuals manifest as delicate bluish variations, reminiscent of undulating water surfaces. When multiple visitors interact with the materials simultaneously, their combined actions generate an increasingly complex and fluid visualization—an evolving, collective ocean wave. As visitors depart, the sound gradually fades, and the visual field slowly returns to its original state: an abstract, reflective image of rippling water in silence. *Washing My Hands* thus embodies two primary visual motifs derived from water: the ripple and the wave. These motifs represent dual transmodalities that structure the work's experiential framework. The first transmodality occurs through the conversion of sound into image, where auditory signals are visually reinterpreted through the LED system. This principle recalls Nam June Paik's pioneering interactive work *Participation TV* (1963). In that piece, Paik attached an oscillator to a black-and-white television and encouraged viewers to generate abstract images on the screen via microphones. By transforming the television from a one-way broadcast device into a responsive interface, Paik redefined the medium as a platform for participatory dialogue. Using two microphones, he enabled two participants to collaborate in producing ephemeral visual forms, discovering through play how sound could become image. This historical precedent profoundly informs *Washing My Hands*, which similarly invites participants to transform sound into visual abstraction. To create a unified blue wave image, up to four visitors can interact with the installation simultaneously. Their collective gestures merge into a single, fluid audiovisual composition. This shared authorship converts the project from a simple interactive experience into a form of participatory art, foregrounding collaboration, chance, and sensory communication. A second mode of transmodality emerges through the symbolic transition between river ripples and ocean waves. In the installation, a black-and-white, tranquil river image gradually transforms into dynamic blue sea waves—and vice versa. This transformation metaphorically suggests the cyclical flow of water: rivers run to the sea, and the sea returns to rivers through rain. By using natural materials sourced from both environments, *Washing My Hands* situates visitors as intermediaries within this perpetual water cycle, emphasizing continuity and interdependence between nature and human perception. Ultimately, the project extends beyond technological interactivity to engage with ecological temporality and embodied experience. Through sound, light, and touch, *Washing My Hands* creates an immersive transmodal dialogue between the natural and the digital, the individual and the collective, and the river and the sea.

5 The Accommodation of Interaction

To prevent water damage, all electronic and electrical components are fully and safely sealed—DMX decoders are enclosed within hard protective containers, and all wiring is wrapped in transparent, waterproof insulation. *Washing My Hands* invites visitors to engage directly with natural materials, including water, sand, and rocks. For participants who prefer not to touch these materials directly—or are unable to do so due to health concerns such as allergies or skin sensitivities—the installation provides three alternative options: disposable gloves, rubber gloves, and soft sticks for indirect interaction. Additionally, towels and hand sanitizer are available to ensure both hygiene and comfort for all visitors.

6 The Future of Washing My Hands

Washing My Hands currently consists of LED canvases, four-channel sound speakers, and four containers filled with natural materials collected from nearby seas and rivers. The installation is arranged in a rectangular configuration, offering a traditionally frontal and directional experience for the audience. To further emphasize the project's central concepts—the cyclical nature of water and the recycling of natural materials—the installation will be reconfigured with LED lights arranged in an asterisk-shaped formation on the floor. This new spatial arrangement will create an endless and seamless interactive environment, encouraging deeper spatial engagement between participants and the artwork. In this redesigned version, the system will be expanded from four-channel LED lights and sound speakers to an eight-channel configuration, enabling more complex spatialization of light and sound. The circular formation not only symbolizes the perpetual cycle of water but also facilitates collective participation, allowing multiple visitors to interact simultaneously and collaborate within the same immersive environment. This future development aims to transform *Washing My Hands* from a primarily frontal installation into a multidirectional, participatory space that embodies both ecological awareness and social interaction—strengthening its conceptual foundation while deepening the audience's sensory and collaborative experience.

7 Conclusion

Washing My Hands offers visitors an authentic and multisensory interactive experience, inviting them to engage directly with natural materials collected from local beaches and rivers. Through the tactile act of washing, participants generate abstract oceanic visuals and immersive soundscapes, transforming a simple gesture into an aesthetic and meditative encounter with nature. This process fosters personal reflection on humanity's relationship with the water and the broader cycles of the natural world. Following the exhibition, all natural materials are carefully returned to their original environments, underscoring the project's ethical commitment to ecological responsibility. By recycling and reintegrating these elements into the ecosystem, *Washing My Hands* not only closes the

material loop of its own creation but also embodies the principles of environmental and artistic sustainability. Ultimately, the work stands as a poetic reminder that artistic practice, like water itself, is cyclical—flowing between creation, experience, and renewal.

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SOCIAL RAFT - System Design and Conceptual Framework of a VR-Based Artwork Exploring the Experience of Social Isolation

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Abstract

This paper presents the conceptual framework and structure of Social Raft, an immersive artistic installation designed to promote empathy and critical reflection on social exclusion<fn id="fn1">1 Artwork descriptive video: https://drive.google.com/drive/folders/1Qqh5goMpC302v6Ed4mo3mnklCP6wsvLi </fn>. Set within a symbolic Virtual Reality environment, a drifting raft surrounded by an infinite ocean – participants experience a fragmented narrative that represents seven vulnerable groups. The installation combines dynamic visual and auditory elements, real-life testimonies, and reactive environmental changes to evoke emotional and sensory engagement. Developed in Unity with custom-modeled assets, it also includes a physical component, featuring an unstable raft, real-time projection, and a digital wall where visitors can leave reflections or personal commitments. Rather than offering a conclusive ending, the raft remains adrift, leaving participants with lingering voices and encouraging ethical awareness and civic responsibility beyond the virtual space.

CCS Concepts

• ; • **Social and professional topics** → User characteristics; Race and ethnicity; User characteristics; Sexual orientation; User characteristics; Cultural characteristics; User characteristics; Age; User characteristics; People with disabilities;

Keywords

Virtual Reality, Empathy, Social Exclusion, Vulnerable Groups



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1 Introduction

Social Raft is a multisensory Virtual Reality (VR) artistic installation designed to evoke empathy and critical awareness of social exclusion through immersive storytelling, symbolic space, and emotional presence. It addresses how vulnerable groups often remain unheard and unseen to society. Combining art, immersive technology, and a layered conceptual design, Social Raft enables users to engage emotionally and cognitively with the lived experiences of marginalized populations.

Empathy plays a key role in fostering coexistence and challenging systemic inequalities [2], [3]. However, empathy is difficult to cultivate when emotional or cultural distance is wide. VR has shown potential to narrow this distance by allowing users to temporarily inhabit alternative perspectives [1, 4]. In Social Raft, this is achieved through narrative embodiment, symbolic metaphor, and sensory immersion.

This paper presents the conceptual framework, design principles, and experiential structure of the artistic installation Social Raft. Developed as an immersive experience, Social Raft aims to raise public awareness about the various forms of exclusion faced by socially vulnerable groups. Through a layered model of interactivity and storytelling, the installation creates a symbolic and emotional space that fosters empathy by leveraging presence, immersion, and the integration of real-life testimonies with sensory stimuli. In this virtual environment, participants find themselves on a drifting vessel amid an endless ocean, a dynamic setting that evolves in response to the narratives of seven different vulnerable communities.

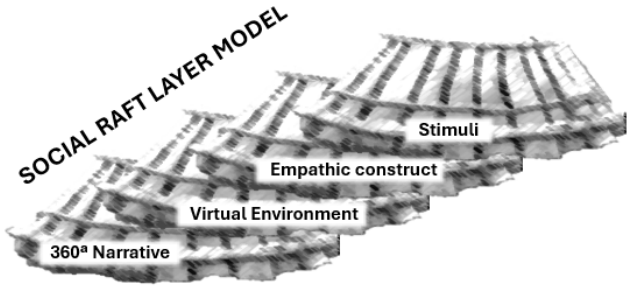


Figure 1: Social Raft interdependent layers model

2 METHODOLOGY

The research-creation model [5] structured the methodology, combining creative output with documentation, reflection, and critical analysis. The project outcomes include VR experience, technical documentation, and academic reflection, each reinforcing the others. The design process prioritized interdisciplinary collaboration and sensitivity to both technological and ethical dimensions of immersive empathy.

This research-creation project was driven by an inquiry process with epistemic value, grounded in a documented and validated approach. In this context, creative practice serves both as the subject of study and as the medium through which knowledge is generated, emerging through reflection on the practice itself. The creative output thus forms an integral part of the project's contribution to knowledge. Throughout the process, the creative methodologies were systematically documented to ensure that the results could be shared with and evaluated by peers. The adopted method embraces the dual nature of research-creation, enabling the project to yield both an artistic product and a critical or reflective narrative, which together articulate the process through which knowledge was produced. The creators, who are also the researchers, maintained a critical and reflective stance from start to finish, consistently questioning, justifying, and revisiting their creative decisions. Furthermore, the creative work is situated within a disciplinary and epistemological framework focused on social intervention, with a particular emphasis on promoting functionality, inclusion, and quality of life for individuals facing social exclusion.

The immersive installation Social Raft was developed using a model of interdependent layers, each contributing to a unified sensory and emotional experience designed to foster empathy toward social exclusion. This layered structure consists of four integrated components: the 360ºnarrative, the virtual environment, the empathic construct, and sensory stimuli (Figure 1). Grounded in principles of experiential design, research-creation, and immersive methodologies aimed at promoting social reflection, the model ensures that each layer supports and enhances the others in a dynamic and cohesive way.

The 360ºnarrative provides the foundational storytelling structure, guiding the participant through real-life testimonies from socially vulnerable groups. These stories give emotional and thematic direction to the experience. The virtual environment, a drifting raft surrounded by an infinite ocean, serves as the spatial and symbolic setting that visually embodies the sense of isolation and movement inherent in the narratives. This environment is not just a backdrop but a reactive space that evolves in response to the unfolding stories, reinforcing the narrative flow.

The empathic construct functions as the interpretative core, structuring how participants connect emotionally and cognitively with the narratives and environment (Figure 2). It shapes the pacing, tone, and user positioning to promote identification with those whose stories are being shared. Finally, the sensory stimuli, including sound design, spatial audio, light modulation, and environmental effects, intensify the immersive experience, deepening the participant's emotional resonance and anchoring the sense of presence.

Rather than operating in isolation, these four layers are interwoven. The narrative guides the evolution of the environment, the empathic construct mediates the participant's experience of both story and space, and the sensory elements amplify emotional and perceptual impact. Together, through an interactive virtual environment, they form a synergistic system, in which the interplay between layers creates a powerful, transformative artistic encounter aimed at fostering awareness and empathy through immersive engagement.

The creative process followed strict ethical guidelines. The phrases heard during the experience were based on real testimonies but were anonymized and dramatized by neutral actors. Care was taken to avoid sensationalism, focusing instead on respectful and authentic expression rooted in academic sources and published studies. The approach aligns with the ethical standards articulated in the GDPR and qualitative research on vulnerability and data dignity.

3 Conceptual Framework

Social Raft is an immersive installation conceived as an artistic and sensory experience that seeks to foster empathy and encourage critical reflection on the realities of social exclusion. By combining virtual reality technologies with a multimodal aesthetic approach, the installation offers a symbolic portrayal of the lived experiences of socially vulnerable groups. It invites participants to engage indirectly in situations of marginalization, invisibility, and isolation, prompting a deeper emotional and cognitive connection to these often-overlooked realities.

The adoption of empathic immersive strategies lies at the heart of Social Raft, serving as a transformative trigger for shifting perspectives and fostering meaningful behavioral change (Figure 3). By placing participants in symbolically rich, emotionally charged environments that simulate the lived experiences of socially excluded groups, the installation encourages a deep sense of presence and emotional resonance. This immersive empathy, generated through carefully orchestrated sensory, narrative, and spatial elements, promotes not only emotional identification, but also critical self-reflection. In doing so, it activates cognitive and affective processes that can disrupt preconceived notions, challenge passive spectatorship, and inspire more compassionate, socially aware attitudes and actions.

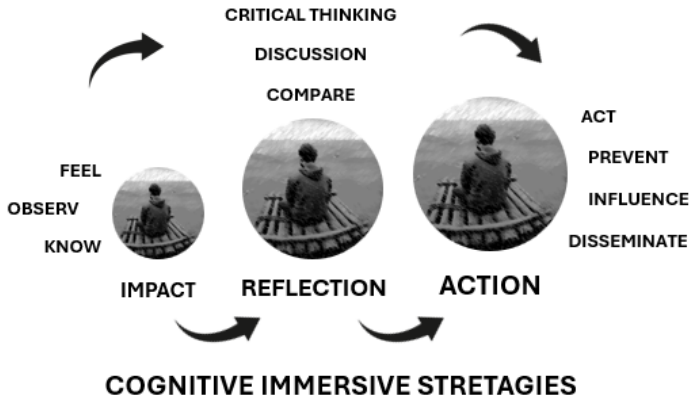


Figure 2: Connection between emotional and cognitive elements in the design of immersive environments

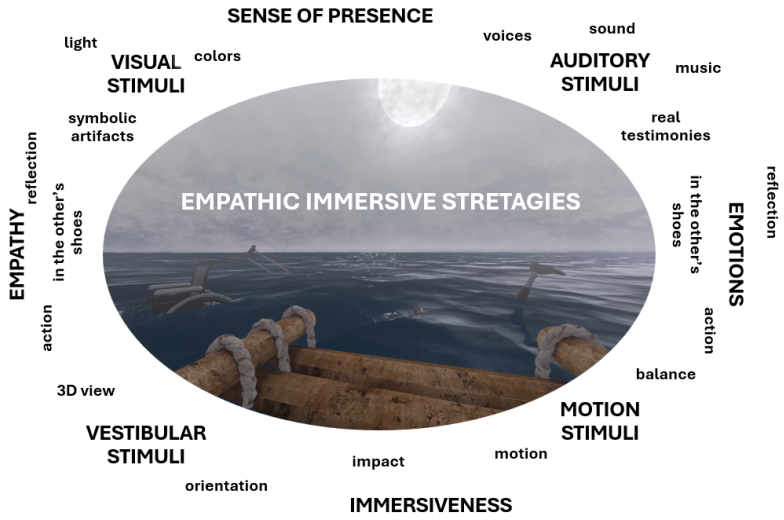


Figure 3: Empathic immersive strategies in immersive environments

3.1 Virtual Environment

The main immersive environment, developed in Unity with custom-modeled 3D objects, is centered around the metaphor of a drifting raft, an unstable platform that gently moves with the sea, evoking a sense of uncertainty and vulnerability. Set against an endless, featureless horizon, the scene reinforces isolation. Visual and auditory elements such as the sky and sea react dynamically to the emotional tone of the narratives, shifting from oppressive greys to total darkness or tense atmospheres. Distant urban sounds, laughter, car horns, news fragments emerge as ghostly echoes of an unreachable social world, symbolizing the subject's exclusion from everyday life.

3.2 Fragmented Narratives and Environmental Symbolism

The narrative sequence of Social Raft unfolds as a fragmented journey that begins in a space of isolation and introspection. Participants find themselves alone on a drifting platform surrounded by an empty horizon, immersed in a state of uncertainty and silence. Gradually, the environment begins to transform, shifting in tone and atmosphere to reflect the emotional realities of seven socially vulnerable groups. Each narrative segment introduces symbolic environmental changes that evoke the lived experiences of these groups. A dense fog settles in to represent the disorientation faced by people with disabilities; a violent storm reflects the forced displacement and peril endured by immigrants and refugees; persistent rain becomes a metaphor for the daily experience of racism; a grey sky marked by a faint rainbow speaks to the struggle and resilience of the LGBTQIA+ community; fast-moving clouds pierced by moments of sun depict the instability of living with mental illness;

a prolonged sunset symbolizes the quiet fading and social invisibility of old age; and finally, total darkness envelops the space, representing the abandonment and erasure experienced by those in poverty or extreme social exclusion. Throughout the journey, real testimonies emerge intermittently as whispers or distant cries, woven into the ambient soundscape, an aesthetic choice that underscores how these voices exist in society, yet often go unheard. The experience culminates in a reflective space, inviting participants to process what they have witnessed and consider their own position in relation to these silenced narratives.

3.3 Space, Symbolic Interaction and Distancing Strategies

The physical space of Social Raft installation is designed to enhance the immersive and symbolic power of virtual experience. At the center of the room, the participant sits alone on a life-sized, unstable raft structure, carefully engineered to respond subtly to their body movements, creating a gentle swaying effect that simulates floating at sea. Equipped with a VR headset, the participant is visually transported into the digital environment, while their physical experience reinforces the sensation of vulnerability and imbalance.

Behind the participant, a projector casts their live shadow onto a large, semi-transparent screen, establishing a striking visual metaphor: the silhouette becomes a visible trace of their presence, fragile and exposed, against the immersive backdrop. Simultaneously, the screen displays a real-time projection of what the participant is seeing inside the VR headset, allowing external viewers to follow the narrative from their unique perspective. This dual projection, the body's shadow and the participant's virtual view, creates a powerful tension between presence and absence, personal experience and public visibility, reinforcing the installation's central themes of marginalization and social reflection.

3.4 Space for Post-Experience Reflection

The installation concludes in a physical space intended to anchor and deepen the immersive experience. This final area presents real audiovisual testimonies, along with statistical and scientific information on social exclusion, offering a factual and emotional context. At its core is an interactive digital wall where visitors can leave recorded messages, share reflections, or express personal commitments. This participatory element extends the impact of the installation, encouraging ongoing ethical awareness and civic engagement. Rather than providing a clear resolution, the narrative remains open, the raft continues adrift, while the participant departs carrying the echo of the voices, as part of a broader strategy to sustain empathy beyond the immersive moment.

4 CONCLUSIONS

Social Raft stands as a powerful example of how immersive art can foster empathy, provoke critical reflection, and give visibility to silenced social realities. By combining virtual reality, symbolic environments, real testimonies, and interactive elements, the installation creates a multi-sensory experience that transcends passive observation. It does not offer easy answers or simplified narratives, instead, it invites participants to inhabit discomfort, to listen deeply, and to confront the emotional and structural dimensions of social exclusion. As both an artistic expression and a social intervention, Social Raft encourages viewers to carry the experience beyond the installation space, transforming awareness into responsibility and reflection into action.

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Playing with Joy

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Abstract

We created a diptych of conceptually connected pieces that explore the pursuit of joy in play, discovery, and learning during adulthood. Alongside this optimistic view of childlike wonder, we present the gritty reality of adult life as a counterpoint. The installation invites the audience to confront the unsettling disquiet that emerges when, as adults, we engage in game-like activities instead of focusing on more "productive" uses of time.

Through this deliberate dissonance, we aim to evoke introspection and encourage viewers to question whether they should feel any guilt or discomfort when reconnecting with their inner child, and whether joyful exploration can still belong in adulthood.

Our goal in creating this artwork was twofold: (1) to observe how they engage with something new and unfamiliar when invited to interact with it, and (2) to examine the cognitive processes at play when participants encounter this dissonance.

Due to the limited time available for the public presentation and play-testing of the artwork, along with budget constraints, we were unable to collect sufficient data to deepen our understanding of these processes. Future work will therefore continue to explore these themes in greater depth.

CCS Concepts

• **Applied computing** → **Media arts**; *Interactive learning environments*; Psychology.

Keywords

Multimodal installation, Fun Games, Self-discovery, Homo Ludens, Shadow Work

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Eduardo da Silva Brito. 2025. Playing with Joy. In . ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

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1 Introduction

This work was conceived as a thought experiment focused on personal exploration and introspection regarding the feelings of inadequacy that arise when individuals go against hustle culture, grind mentality, and, to a certain extent, the framing of entrepreneurship as a measure of success, self-worth, and social status.

Hustle culture has been linked to numerous health issues, particularly in the realm of mental health [3, 17]. The societal expectation to overwork, now rebranded as "grind mentality" [1] and often portrayed in a positive light, represents a new form of workaholism that has contributed to widespread mental health problems such as burnout.

In response to these issues, a counter-movement has emerged, motivated by the Great Resignation, in which people sought to distance themselves from lifestyles dominated by stress, anxiety, sleep deprivation, exhaustion and burn out [2, 6].

Research has shown a positive correlation between leisure satisfaction and life satisfaction [4]. Moreover, engaging in rewarding leisure activities has been found to alleviate work-induced stress, both directly and through improvements in sleep quality [16].

For the average adult in Portugal, the daily time available for leisure activities is approximately 241 minutes [11]. Despite this availability, men spend about 50% more time on leisure than women.

Throughout history, play, be it in the form of games, sports, music, or other recreational pursuits, has had an essential role in the development of human societies and cultures.

Humans have long used games and game-like activities not only for enjoyment but also to strengthen social bonds through shared, intentional experiences governed by clear rules and structures of interaction [9].

While different activities yield distinct physical and mental health outcomes, dedicating time to leisure consistently provides benefits across all ages and genders, even if the nature of these benefits varies among groups [5, 13].

It is therefore somewhat paradoxical that a social prejudice persists against adults who engage in leisure activities, whether it is alone or with others, despite substantial evidence of their positive effects. Even from the standpoint of hustle culture, such activities could be seen as beneficial, as they can enhance productivity and functionality, although other forces are arguably at play beyond simple efficiency [6] when using work as a disciplinary device [7].

Jung's concept of the shadow [10] suggests that we perceive reflections of our own shortcomings in others, and that these projections can serve as guides for self-improvement and personal growth. Our work, *As Crianças Que Cresceram*, invites the audience

to confront their shadow and to reconsider why certain feelings arise when engaging with play and leisure.

In José Saramago's Blindness [15], society is struck by a "white blindness", a dystopian pandemic under which society reveals the extremes of human nature as civilization collapses.

In Escape From Iroi: White Blindness, the player is similarly thrust into a confined, radiant world that aims to make the audience feel compelled to it as, at the same time, completely under its spell and unaware of what is happening in its surrounding, leaving for others to evaluate what is happening in the inside through sounds in the radio(s).

As one progresses, increasing speed and scale bring mounting difficulty and punishment for persistence.

In our diptych, Playing with Joy, we move from the inner to the outer world, navigating the dissonance between societal pressures and its imperatives of productivity and self-optimization, with the intrinsic human need for play and leisure.

As adults, we are often discouraged from engaging in such activities, or in any pursuit that does not directly advance our careers or earnings, as exemplified by the rise of the side hustle.

2 Artwork as a diptych

The artwork presented here has been developed over an extended period. It began as a single multimodal installation and gradually evolved into two interrelated pieces that coexist as a diptych. Together, they explore themes of childlike curiosity, the (re)discovery of the world, and the joy of experimentation and creation, juxtaposed with an underlying sense of unease and disquiet, and the consequences in our mental health caused by resilience and trying to conform with the norm.

Neither of the works has yet been publicly exhibited beyond academic presentations during university classes for evaluation purposes, which has severely impacted the play-testing and gathering of the results proposed by its concept and implementation.

The diptych is designed to be displayed in a blackbox environment, with the two pieces positioned at least two meters apart (adjustable according to the available space).

2.1 As Crianças que Cresceram // The Children Who Grew Up

The artwork has a very noticeable physical construction, made in a very relaxed, even childlike, DIY aesthetic, that is purposely messy, to invite the audience to move over it and interact freely with the installation (Figure 1). The installation invites the audience to co-create by exploring the physical devices and by moving over and on the installation, having no two "runs" of the installation generate the exact same sounds and/or visuals as the previous one.

Technical file:

- 150x90 cm.
- 2 or 3 wooden pallets (adjusted to the available space at the venue).
- 2 musical devices with piezo pickups (one can be hidden beneath the main wooden pallet but people should be able to see it and pick it up).
- 1 Xbox One Kinect device for interactivity with the audience.
- Custom made LED matrix over black cardboard.
- Old 15" TV CRT device to display visuals + HDMI adapter + SCART cable to connect to a computer.
- 1 x86 based computer to run a Processing sketch with the audio, visuals and Kinect interactions.
- 1 Arduino board used to control the LEDs + Micro USB cable to connect it to the computer.
- (Optional) 2 extra stereo speakers to be used with the piezo instruments.

With this artwork, we sought to embody a sense of childlike exploration not only in its conceptual framework but also in the physical construction of the pieces themselves.

We developed this idea by freely painting the wooden pallets, embracing a spontaneous and playful approach. The use of pallets contributed to a DIY aesthetic that made the work feel warmer and more approachable. In creating these physical artifacts, we intentionally embodied the emotions we hoped the audience would experience: curiosity, joy, and creative freedom.

The television component presents video imagery reminiscent of childhood memories, yet these visuals are intentionally distorted and dissonant, evoking a sense of awkwardness, stress and unease (Figure 2). This tension contrasts with the open and inviting nature of the physical installation, generating a dialogue between comfort and discomfort.

The TV also displays a point cloud representation of the physical space, intermittently revealing the faces of participants present within the installation.

Different physical gestures trigger distinct visual and sonic responses, inviting the audience to explore the expressive potential of their own body movements in relation to the artwork.

The choice of wooden pallets, beyond their symbolic meaning, serves both aesthetic and functional purposes. Their slight instability and characteristic creaking sounds add to the sensory texture of the piece. Beneath one pallet lies a handmade musical device, made of a metallic cookie bin, captures and amplifies these subtle movements, producing acoustic noises as small objects collide against the thin, flexible tin sides of the structure. This device can be lifted, handled, or struck by participants.

Another interactive instrument we developed was a noise-making sword, inspired by a kendo shinai. It features a string that can be plucked, and it too can be used to strike parts of the installation or the other DIY instrument. Both objects draw from common childhood experiences: the cookie tin that rarely contained cookies, and the stick that, in play, became a sword for imagined battles against dragons and villains.

When exhibited, the installation should not include any explanatory text or operational hints. We want the audience to engage with it freely, discovering its workings through exploration and play, and in doing so, co-creating their own experience with the piece.

Our approach was deeply inspired by Myron Krueger's pioneering explorations of physical virtuality, particularly his use of light, shadow, and interactivity to forge authentic connections between humans and computational environments.

2.1.1 On the technicalities of the artwork. This artwork uses the Kinect to extract a point cloud of the people nearby it and uses that information to interpret motions from the audience.



Figure 1: *As Crianças que Cresceram* overall view of the artwork in a blackbox setting (left) and with visible musical devices (right).

The DIY musical devices use piezoelectric pickups to capture the sound made by/with them. The cookie tin box has several piezos inside as to better capture nuances in the sound and amplify the sound more. The sword-like object has a piezo near the grip as to be able to capture sounds from the tightness of the audiences grip on the object and, given its location, it is also ideal, in our understanding, to capture sounds of the object hitting other objects.

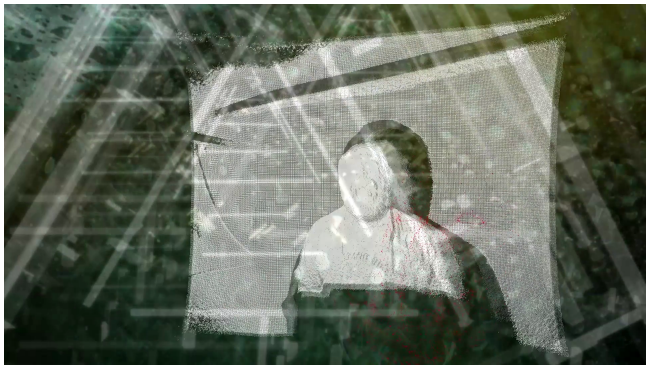


Figure 2: Example of display seen in the television screen of *As Crianças que Cresceram.*



Figure 3: DIY controller used in the installation.

The Processing [12] sketch uses serial communication with an arduino microcontroller that is responsible for controlling the LED strips, based on animations we have previously created.

The visuals are displayed on the TV, through randomization and overlap of visuals. The soundscape is made to be loopable while the installation is being interacted with.

2.2 Escape from Iroi: White Blindness

In the second part of the diptych, we aimed to create an experience that was unmistakably game-like, featuring a visible controller equipped with buttons to emphasize interactivity (Figure 3). Like the first piece, this artwork was designed to be exhibited in a black-box environment.

The technical specifications for this piece are as follows:

- 80x50cm.
- Custom made DIY controller/gamepad.
- Custom made DIY box filled with LEDs and mirrors, painted with in-game motifs.
- 1 or more FM radio devices that can be scattered through the exhibition.
- 1 Bluetooth to FM radio transmitter.
- 1 x86 computer running Unity.
- 1 Arduino used to control the LEDs in the box.

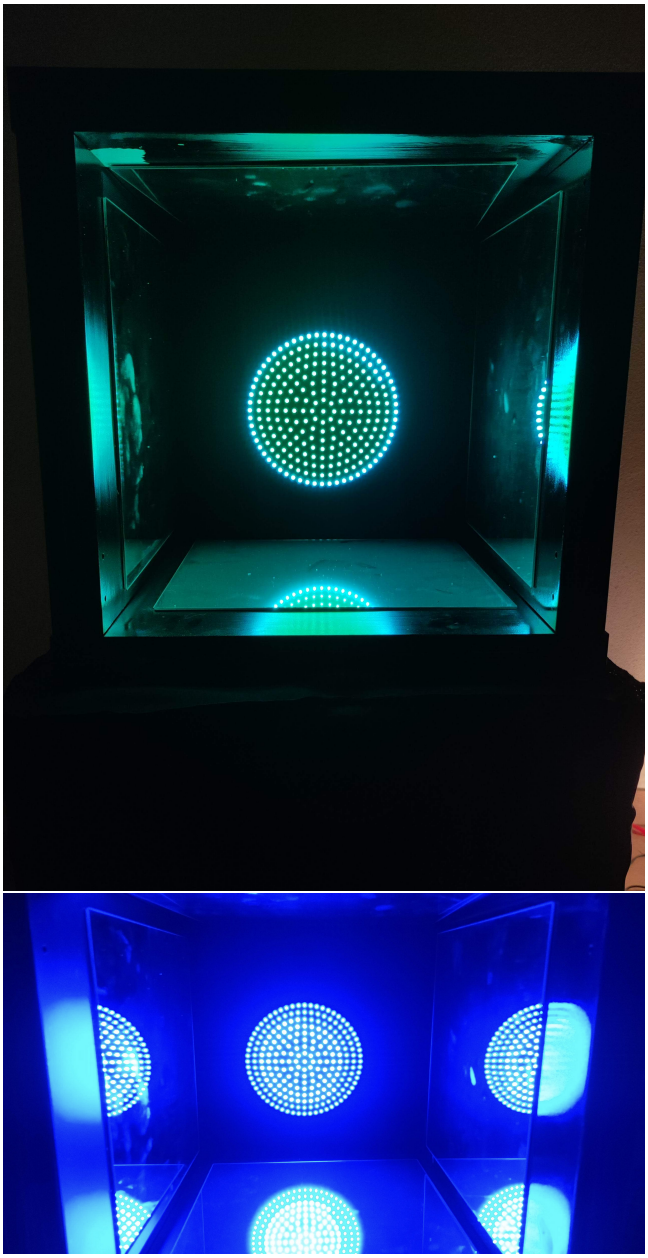


Figure 4: Two views of the installation, at different distances.

Although the presence of a controller makes it immediately recognizable as a game-like installation, the experience itself is simple yet abstract. The audience is invited to pick up the controller, listen closely to the sounds, and observe the LEDs to discern the game's objective and interpret its current state.

In this piece, we also introduce the concept of white blindness, inspired by Saramago's Ensaio sobre a Cegueira [14] / Blindness, in which blindness manifests as overwhelming brightness rather than darkness. We explore the idea of individuals being blinded not by absence, but by overloaded by excess, with too much information, too much light, confronting the audience with minimal guidance, compelling them to navigate and make sense of the game on their own.

The usage of mirrors inside the box and physical game world acts also as a metaphor for the illusions of the world and the way they tend to multiply and deceive us in their number, making us feel surrounded by something that is merely a manipulation (Figure 4).

The people outside of the experience can gather some insights of what is going on through the radio(s) that are distributed in the exhibition space and, fittingly, listen and feel the decadence and decay of the (game) world, as it progresses, being unable to understand and do anything else, besides the one person that is able to see and do anything about it, leaving them to take the full burden towards themselves.

3 Methodology and Results

We intended to present the artwork to a bigger audience and having them experience the installation, for each element individually and as a diptych, to gather feedback from the experience and to understand if the message was getting through to the audience and how much of it was getting through.

Due to *"As Crianças que Cresceram"* being quite big and demanding in terms of exhibition space, it became quite unmanageable to have it assembled for sufficiently enough time to gather meaningful insights on the work.

With "Escape From Iroi: White Blindness" we were able to have the artwork being play-tested by people from a masters degree in game development, which offered some feedback on the workings of the game-like aspects but we had meager feedback on the conceptual and artistic qualities of the work, being the feedback mostly based on the technical proficiency of the artwork itself.

There was, as of yet, no possibilities to have the diptych being shown fully assembled, with optimal conditions, to better understand its true impact to the audience.

4 Future Work

For future work, we would like to further polish the experience, while retaining the DIY aesthetic, with different methods of interaction with the installation and more visual and sound feedback from the audience's interaction with the artwork.

Given the budget, time and space, we would like to further assess how the diptych is perceived by the audience and use that feedback to improve it.

It would be really interesting to have data on how the installation affected the audience that interacted with it and if the bringing together of both works had a bigger impact on them or if it distracted from the messages of the artwork as a whole.

Another further venue of exploration in this artwork, is the connection to others and non-human others, besides the exploration of self, in specific with companion species [8].

Acknowledgments

The work *As Crianças Que Cresceram* was initially done as a group project, with João Mendonça and Verónica Lobo, as part of the grading requirements for a course. We appreciate their help in the initial version of this work.

Further revisions to that work were carried out by the author of this paper.

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Empatia Líquida - diálogo íntimo entre humano e máquina que se traduz em sons e padrões cimáticos
Liquid Empathy - intimate dialogue between human and machine that translates into sounds and cymatics

Liquid Empathy - intimate dialogue between human and machine that translates into sounds and cymatics

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Resumo

"Empatia – Forma de identificação intelectual ou afetiva de um sujeito com uma pessoa, ideia ou uma coisa." Empatia Líquida é uma experiência imersiva em que humano e máquina interagem entre si, interferindo com os seus estados emocionais. Pretende realçar a cadeia causa-efeito na relação entre indivíduos, e nas consequências da mesma. Através da interação com o sistema (Lilyth), o utilizador influencia os "estados de espírito" do sistema artificial, resultando numa interferência do seu próprio estado emocional. Este projeto surge do interesse em áreas como a interação e a psicologia, assim no campo da acústica e psicoacústica. O objetivo desta instalação é estabelecer uma correspondência sonora e visual a estados emocionais e provém do interesse pessoal do estudo das emoções e do impacto da música / som nas mesmas. Cada gesto desencadeia um ciclo de ressonância — um fluxo contínuo onde o sistema responde, sente e devolve, criando-se um ciclo contínuo de troca sensorial. Neste espaço, a empatia torna-se líquida: fluida e visível. "Empatia Líquida" gera ressonâncias em que humano e máquina se encontram numa experiência de empatia partilhada.

Abstract

"Empathy – A form of intellectual or affective identification between a subject and a person, idea, or thing." Liquid Empathy is an immersive experience in which humans and machines interact with each other, interfering in their emotional states. It aims to highlight the cause-and-effect chain in the relationship between individuals and its consequences. Through interaction with the system (Lilyth), the user influences the "states of mind" of the artificial system, resulting in an interference of their own emotional state. This project arises from an interest in areas such as interaction and psychology, as well as in the fields of acoustics and psychoacoustics. The goal of this installation is to establish a sonic and visual correspondence to emotional states and stems from a personal interest in the study of emotions and the impact of music/sound on them. Each gesture triggers a cycle of resonance—a continuous flow where the system responds, feels, and reciprocates, creating a continuous cycle of sensory exchange. In this space, empathy becomes liquid: fluid and visible. "Liquid Empathy" generates resonances in which human and machine meet in an experience of shared empathy.

CCS Concepts

• **Human-centered computing** → **Collaborative interaction**; *Gestural input*; • **Applied computing** → *Sound and music computing*.

Palavras-chave

Empatia, Ambiente Imersivo, HCI, Affective Computing

Keywords

Empathy, Immersive Environment, HCI, Affective Computing

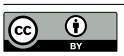
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1 Introdução

Empatia Líquida é uma instalação multimédia interativa que pretende reforçar a ideia da existência de uma relação direta entre os estados emocionais de indivíduos que se relacionam, propondo um sistema emocional artificial que reage e responde aos impulsos do utilizador. Através de uma experiência tátil, o utilizador interfere com os estados emocionais armazenados no sistema (Lylith) e recebe uma resposta auditiva e visual correspondente.

A instalação é composta por um circuito de dois dispositivos: um interface físico, sensível ao toque, despertando estados emocionais armazenados no sistema; e um altifalante para transmitir o áudio e formar padrões cimáticos resultantes das vibrações sonoras, em meio líquido.

Pretende-se que o utilizador explore de forma tátil, despertando os diferentes estados emocionais do sistema que são transpostos



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por meio de faixas musicais em torno de frequências fundamentais, baseadas na Escala de Hawkings, sendo possível "despertar" 7 estados de consciência (Neutralidade, Aceitação, Raiva, Amor, Medo, Paz e Apatia). A interação com o sistema visa igualmente interferir com o estado emocional do próprio utilizador. O áudio reproduzido é complementado com tons puros (ondas sinusoidais) e um discurso impercetível que são difundidos para o dispositivo gerador de padrões cimáticos. Estes são formados por meio de vibrações sonoras numa bandeja com água, demonstrando de forma física a empatia entre o som e o meio líquido.

Este projeto é fruto de um interesse pessoal sobre a mente humana e os estados emocionais inerentes a cada indivíduo, assim como, na curiosidade da possibilidade de alterar estados de consciência através de fatores externos ao indivíduo.

O trabalho centrou-se em questões como a interação entre humanos e sistemas computacionais, procurando a melhor opção a nível de interação, e também em questões de computação afetiva na medida em que se simulou um sistema capaz de "traduzir"emoções humanas através do toque numa resposta coerente.

Numa era em que conceitos como Inteligência Artificial crescem e evoluem a cada dia, a aceitação de máquinas ou sistemas que venham a possuir emoções sintéticas é uma possibilidade a considerar, fundando os pilares deste projeto, em que emoções são induzidas num sistema digital e podem receber interferências por parte do utilizador.

2 Revisão de Literatura

Este projeto assenta num interesse particular sobre a influência da música na psique humana. Por este motivo, foram consideradas várias teorias em torno de temas como psicologia, correspondência entre vibrações sonoras e estados emocionais, propriedades e características da água, padrões cimáticos, entre outros, como referência estética e artística.

2.1 Mapa da Consciência

Grande parte da implementação dos estados emocionais do sistema tiveram por base o "Mapa da Consciência©" desenvolvido por David R. Hawkins, MD, Ph.D., um cientista, médico, psiquiatra, pesquisador... [3]. Através da tabela concebida para ilustrar o "Mapa da Consciência©" de Hawkings, foram utilizadas as relações estabelecidas entre os estados emocionais (ou de consciência) e as frequências de vibração, para ilustrar de forma sonora, o estado emocional do sistema artificial, sendo responsável pela escolha das frequências fundamentais que iriam despoletar os padrões cimáticos.

2.2 Memória da Água

Uma outra teoria que impulsionou o desenvolvimento deste projeto foi a da existência de memória na água. Fisiologicamente, a água circula por todo o corpo levando oxigénio e nutrientes a todos os órgãos e estruturas celulares; ao mesmo tempo, recolhe em suspensão os resíduos e leva-os aos órgãos responsáveis pela sua eliminação; leva em dissolução o anidrido carbónico até aos pulmões para ser trocado por oxigénio. Regula a temperatura corporal, depura o organismo, permite todas as reações químicas, incluindo as transformações das substâncias para obter energia. A água mantém a coesão dos distintos bio-elementos do organismo e permite o intercâmbio de substâncias entre células e tecidos. Mantém a estrutura e a arquitetura celular do nosso corpo, une as estruturas fixas dentro da membrana celular. Em definitivo, a água é o meio em que vivem todos os organismos porque a matéria viva (tal como a considera agora a ciência) é um coloide que precisa de água para conservar as suas propriedades [2]. A memória da água é igualmente mencionada nas Flores de Bach ou na Homeopatia, dissoluções na água que não têm uma só molécula de substância original diluída e que mantêm as suas propriedades terapêuticas. Esta é a descoberta de Masaru Emoto nas fotografias da água no preciso momento em que se converte em gelo [4]. Como na neve, a formação do gelo é em cristais com padrão hexagonal mas em variedades infinitas. Tal como demonstrado nas suas fotografias, não há dois cristais iguais e todos eles guardam uma analogia anímica com as vibrações sonoras, emotivas, mentais e outras que se projetaram na mesma. Masaru Emoto, com uma câmara de refrigeração e um microscópio eletrónico de campo escuro demonstrou que "a água não só armazena informação mas também sentimentos e consciência" e que "toda a informação que alberga a estrutura se torna visível quando se fotografa uma só gota de água no estado de gelo".

2.3 Emoção despertada pela música

Uma das finalidades desta proposta é a de despertar estados emocionais no utilizador através do áudio reproduzido e da observação de padrões cimáticos mais calmos ou caóticos. A utilização de som enquanto modificador de estado emocional é extensa e remonta já a tempos antigos, tendo sido desenvolvida com o surgimento de ferramentas de diagnóstico em tempo real, tais como eletroencefalograma, tomografia, etc..., o que permite comprovar que o impacto do som a nível da atividade cerebral é significativo. Com estas evidências, vários investigadores começaram a desenvolver pesquisas nesta área, como Alan S. Cowen no seu trabalho "Emotions Evoked by Music Across Cultures", ao tentar compreender a experiência do utilizador ao ouvir um trecho musical específico e entender o impacto emocional do mesmo [1]. Neste projeto, o foco não foi o impacto da música (ou trechos musicais), mas unicamente de frequências e dos seus harmónicos como forma de "reposicionamento"do estado emocional do utilizador.

3 Metodologia

A Metodologia aplicada no desenvolvimento deste projeto foi a de practice-based research, assente numa combinação entre pesquisa e tentativas, assim como de experiências realizadas ao longo do processo. Ao tomar o "Mapa da Consciência"e as suas frequências vibratórias como ponto de partida artístico, foram sendo criados os ficheiros áudio que serviriam para ilustrar os estados emocionais do sistema. A decisão de os interligar aos estados emocionais proveio dos valores obtidos através do toque em sensores capacitivos capazes de detetar não só o toque, mas também a pressão exercida, ficando estabelecido que, quanto mais pressão exercida mais extremo seria o estado emocional despertado. Neste cenário tornou-se viável considerar que, se o utilizador exerce mais pressão é possível que também ele esteja num estado emocional mais reativo ou intenso... A par destes valores, foi tomado também em consideração o número de interações (toques) registados numa utilização



Figura 1: Instalação Empatia Líquida

e a distância temporal entre os mesmos (velocidade da interação) atribuindo-os também a um incremento ou decremento do estado emocional. Pretende-se que os padrões cimáticos observados, assim como o ambiente sonoro originado, demonstrem o estado emocional despertado no sistema artificial e que, de certo modo, ilustre o estado emocional do utilizador. Por forma a tornar a experiência mais "humana", foram acrescentados discursos (voz) criados por meio da Inteligência Artificial realçando a passagem entre diferentes estados emocionais. O objetivo final desta experiência é criar um ciclo de empatia entre o toque do utilizador, o ambiente sonoro criado e os padrões cimáticos visíveis na água. A interação foi conseguida através da utilização de uma placa de Arduino Uno e uma placa de sensores capacitivos Adafruit MPR121. Os sensores recebem os valores de pressão através de fios de cobre ligados a parafusos. Estes parafusos encontram-se numa semi-esfera, tornando o interface mais ergonómico à exploração táctil. Com uma ligação ao Arduino e ao Max MSP, os valores recebidos pelos sensores capacitivos são depois traduzidos em estados emocionais programados com os ficheiros áudio, estabelecendo uma relação entre a quantidade de pressão detetada e os "patamares"emocionais programados. O áudio é então reproduzido em dois altifalantes, sendo que um deles está coberto com uma bandeja metálica com água, onde surgem os padrões cimáticos gerados pelas ondas sonoras emitidas pelo altifalante.

4 Resultados e Análise

Esta instalação foi o resultado de uma busca por um sistema viável, prático e transparente, que permitisse, não só explorar os estados emocionais, quer do utilizador, quer do sistema; mas que também proporcionasse um ambiente imersivo que estimulasse uma interação exploratória do seu funcionamento. O interface para o utilizador é composto por duas placas: uma Arduino Uno e uma Adafruits, com capacidade para 12 sensores capacitivos (ativados por toque e com reação à pressão do toque), dos quais estão viabilizados 10 (um sensor para cada dedo das mãos), obtendo valores distintos. Os dados recebidos são diretamente enviados para o software Arduino, que os reenvia para o software Max MSP. Aqui, estes valores são balizados para o “despertar” dos diferentes estados do sistema, por meio da reprodução de 7 faixas musicais, correspondendo cada uma delas a um estado emocional. Cada uma das músicas foi composta com recurso a sintetizadores, complementados com ondas sinusoidais, e um discurso obtido através de ferramentas de Inteligência Artificial. Todos os áudios são controlados pelo Max MSP através da interação tátil do utilizador, havendo, contudo, algum armazenamento dos valores obtidos anteriormente, concedendo alguma “autonomia” ao sistema. Os ficheiros áudio são injetados num interface áudio para serem redirecionados para dois canais, um para a difusão das faixas musicais e discurso e o outro para as sinusoides. O dispositivo para a geração dos padrões cimáticos consiste num

altifalante subwofer, coberto por uma bandeja metálica com água. Os padrões formados são o resultado das vibrações sonoras que trespassam os materiais, culminando num efeito visível na superfície da água, como consequência do som reproduzido.
Enquanto instalação verifica-se a obtenção de uma obra que capta a atenção do utilizador, fazendo-o ter um diálogo próximo e complexo com o sistema, tentando explorar as diferentes possibilidades que o mesmo oferece.

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Ágora Fluida - Instalação Interativa que convida à colaboração
Ágora Fluida - Interactive installation that invites collaboration

Ágora Fluida - Interactive installation that invites collaboration

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Resumo

Ágora Fluida é uma instalação multimédia interativa que convida os participantes a entrarem num espaço de encontro e criação coletiva. Em superfícies com água sensível ao toque, cada gesto desencadeia paisagens sonoras e pulsações de luz, que viajam e convergem no núcleo da instalação. Neste espaço, as ações individuais tornam-se vozes, e as vozes, em conjunto, formam uma narrativa com a água como elemento fluido e simbólico de ligação. Ágora Fluida propõe um território democrático onde colaboração, presença e escuta se fundem num organismo vivo de som e luz e cada ação ecoa como voz coletiva, criando uma ágora de fluxos e encontros.

Abstract

Ágora Fluida is an interactive multimedia installation that invites participants to enter a space of encounter and collective creation. On touch-sensitive water surfaces, each gesture triggers soundscapes and pulsations of light, which travel and converge at the core of the installation. In this space, individual actions become voices, and these voices, together, form a narrative with water as a fluid and symbolic element of connection. Ágora Fluida proposes a democratic territory where collaboration, presence, and listening merge into a living organism of sound and light, and each action echoes as a collective voice, creating an agora of flows and encounters.

CCS Concepts

• **Human-centered computing** → **Collaborative interaction**; *Gestural input*; • **Applied computing** → *Sound and music computing*.

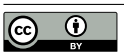
Palavras-chave

Interação, Som, Água, Sensores Capacitivos

Keywords

Interaction, Sound, Water, Capacitive Sensors

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1 Introdução

Ao longo deste projeto foram propostas soluções para a interatividade entre utilizador e sistema, por forma a alcançar um resultado que fosse, simultaneamente, interessante e viável de implementar e controlar, tendo por base o tema "água". Após algumas experiências realizadas anteriormente em torno da água enquanto elemento presente em instalações interativas, e também da exploração das possibilidades inerentes à utilização de sensores capacitivos, surgiu a ideia de colocar os sensores em água, procurando a melhor solução para otimizar os dados obtidos pela leitura realizada pelos mesmos. A conceção de uma instalação que permitisse uma utilização conjunta partiu da experiência adquirida em trabalhos anteriores, em que se tornou visível a limitação da interação singular enquanto obra em exposição. Desta forma, surgiu o conceito para uma instalação com 4 interfaces semelhantes, mas independentes, que permitisse a interação com o sistema por parte de vários visitantes. Com este pressuposto formulou-se a ideia de uma ágora (espaço encontrada numa acrópole grega, onde os cidadãos eram convidados a exprimir a sua opinião livremente) em que os elementos participantes poderiam dar a sua contribuição para o resultado sonoro apresentado pelo sistema. Uma vez que todas as interações seriam apresentadas em simultâneo, ocorreu a necessidade de as distinguir de algum modo, para que cada utilizador pudesse compreender integralmente qual o seu contributo. Deste modo, os sons produzidos apresentam características sonoras distintas em cada interface e são "reforçados"com uma animação de luz reativa ao toque do utilizador.

2 Revisão de Literatura

Um dos trabalhos que influenciou a escolha dos materiais a utilizar foi "Shaped by Water"de Lachlan Turczan [1]. A utilização de contentores em alumínio para apresentar a água presente na instalação e o efeito estético causado originou a escolha de bandejas metálicas para a implementação dos interfaces da instalação.
Também outro projeto anterior contribuiu para o desenvolvimento deste trabalho. Após a apresentação da instalação "Empatia Líquida"em que o interface recebia o seu input através de sensores capacitivos. A utilização deste tipo de componentes foi o impulso para a experimentação das possibilidades dos mesmos e da sua subsequente aplicação neste projeto.



Figura 1: Instalação "Ágora Fluida"

A utilização de tiras LED endereçáveis foi inspirada no trabalho de David Negrão "Peso da Alma"[2]. Nessa instalação, o utilizador coloca-se no ponto de interação com o sistema e, ao iniciar o seu contacto, é visível um feixe de luz que se ativa com a presença do visitante. Esta característica foi aplicada ao projeto desenvolvido como forma de ilustração do contacto entre o humano e a instalação.

3 Metodologia

O projeto assentou em várias fases de desenvolvimento, sendo aplicada uma metodologia de experimentação e trabalho prático. A primeira fase do projeto foi testar o comportamento dos sensores capacitivos em ambiente líquido. Foram feitos os primeiros testes utilizando um shield Adafruit MPR121 em Arduino, sendo ligados fios às entradas dos sensores capacitivos e colocadas as extremidades em taças com água. Os resultados iniciais foram promissores, mas instáveis, levando à busca por líquidos com uma melhor condução elétrica. A experimentação passou por várias hipóteses até que se concluiu que a água purificada medicinal, comummente utilizada em nebulizadores, era a que obtinha melhores resultados.

A fase seguinte debruçou-se sobre a utilização de tiras LED endereçáveis ativadas pela interação do utilizador com os sensores capacitivos. Apesar de um funcionamento sem falhas fora do ambiente líquido, verificou-se que quando ativados pelos valores recebidos pelos sensores capacitivos em água, o seu comportamento se apresentava instável, mostrando-se por isso, um grande desafio de implementar.

A próxima fase do trabalho visou a utilização de sons com uma identidade definida para cada interface, que pudessem ser identificados pelos diversos utilizadores como "seus". Foram compostos com recurso a um sintetizador Nord Lead e foram atribuídas características distintas a cada conjunto de sons compostos, para que fossem facilmente associados a cada uma das interfaces.

A escolha dos sons a serem reproduzidos foi implementada em Max MSP, tomando por base os valores recebidos pelos sensores capacitivos. Tendo por referência uma janela de cerca de 30 valores entre a ausência de contacto e o contacto mais próximo com o sensor, foram criados oito patamares possíveis para a atribuição de cada som em cada interface respetivamente. Na última etapa de

desenvolvimento foi ponderada a apresentação visual e estética do projeto, sendo definidas as características físicas da instalação como o espaço físico a utilizar, a melhor alternativa para ocultar fios e componentes, assim como, o formato de apresentação da instalação com uma imagem estética apelativa.

4 Resultados e Análise

Este projeto mostrou-se um desafio nas mais diversas fases de desenvolvimento. Uma das primeiras considerações foi a utilização de um tipo de água específica que permitisse a correta leitura de dados obtidos através da interação dos visitantes com os sensores capacitivos. Foi observada uma leitura muito instável aquando da utilização de água corrente, tornando-se necessário procurar uma forma de otimizar o input do utilizador. Após pesquisas e experiências, conclui-se que a água purificada regista uma menor condutividade elétrica (sinal mais "limpo") e, por conseguinte, valores mais estáveis e fidedignos. A água purificada demonstrou ser capaz de transmitir dados mais estáveis e com uma janela de valores distintos mais abrangente, permitindo a criação de gestos musicais alcançados através da utilização de vários sons diferentes em cada interface e correlacionando-os com os diferentes valores obtidos, consoante o contacto do utilizador com a superfície com água. Este tipo de água, pela ausência (ou menor quantidade) de sais minerais condutores, permite uma leitura próxima de 0 (zero) por parte dos sensores capacitivos, quando não existe contacto físico do utilizador com a mesma. Esta propriedade permite receber valores mais distintos e ilustradores da interação do visitante, por oposição à água corrente que, pela existência de quantidades significativas de sais minerais condutores, despoleta uma corrente elétrica mais contínua e instável. Em suma, quanto maior a área da mão em contacto com a água e, quanto maior a proximidade da mesma à ligação com o sensor capacitivo, maior o valor registado, permitindo a criação de oito patamares distintos com oito sons, respetivamente, e de acordo com as leituras obtidas.

Também a escolha de materiais se demonstrou um desafio. Apesar de esteticamente os contentores em alumínio terem surgido como primeira escolha, o facto de estas superfícies serem, em si, condutoras mostrou-se um obstáculo. Foi necessário conseguir emergir a extremidade do cabo ligado ao sensor capacitivo sem ter qualquer contacto com a superfície exterior das bandejas, para que não existissem leituras indesejadas por parte do sistema. Uma vez que a parte interna das bandejas se encontra revestida por uma espécie de verniz, foi possível manter a integridade dos dados obtidos, desde que nenhum ponto do cabo tocasse na restante estrutura, mantendo-se, desta forma, a obtenção de leituras unicamente aquando da interação do visitante.

A opção pretendida para a disposição da instalação foi de apresentar quatro interfaces para utilização dos visitantes, permitindo a interação de vários participantes em simultâneo, ilustrando o conceito de democracia presente na ideologia da mesma.

No centro dos interfaces, encontra-se um altifalante para onde convergem os sons despertados pelo utilizador e as tiras LED. Estas estão suspensas na horizontal, descrevendo visualmente (através da luz ativada) o percurso realizado pela interação do visitante, partindo de cada interface e convergindo para o altifalante no centro. Os LEDs acendem sequencialmente, na direção interface - centro, de cada vez que existem leituras registadas nas bandejas.

De uma forma geral, considero que os objetivos traçados para a instalação foram alcançados, proporcionando momentos de interação entre os vários participantes e o sistema, gerando curiosidade sobre o funcionamento da instalação e surpresa pelo facto da interação com a mesma ser feita através do toque na água.

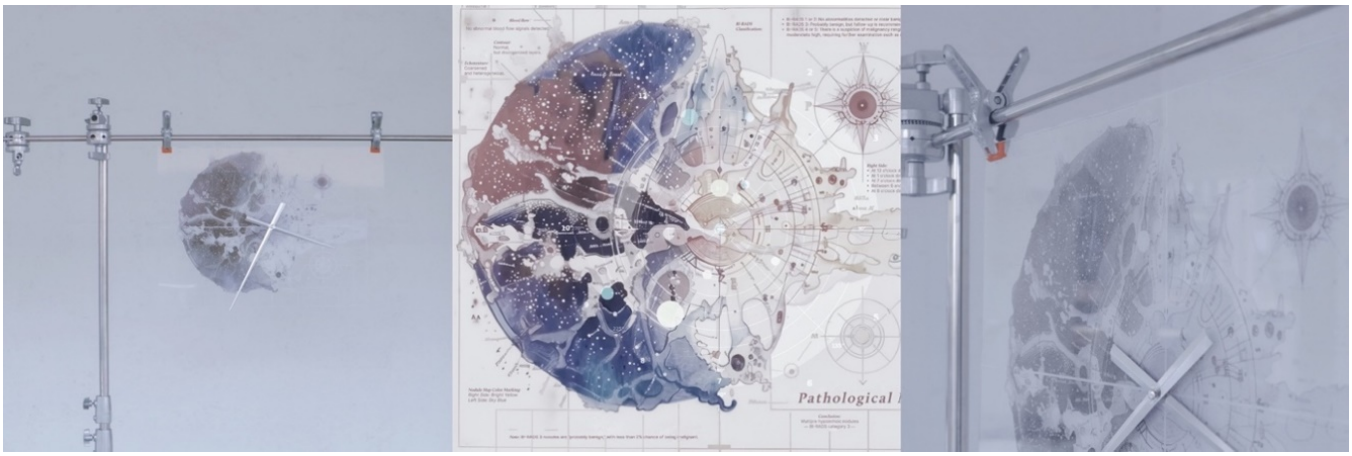
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Pathological Landscapes: An Artistic Journey into AI's Compassionate Language and Imagery in Healthcare

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Abstract

"Pathological Landscapes" is an artistic project that explores empathy and emotional support in the context of medical care. The project comprises video and installation elements. The installation features imagery that visualizes diagnostic report data with the assistance of generative AI. The video component presents a dialogue between the artist and ChatGPT, showcasing the language model's capabilities in analyzing medical conditions and providing comfort and guidance to patients. Time, AI, and humans intertwine as significant elements within the narrative. The work navigates between rationality and irrationality, prompting reflections on how the relationship between humans and AI redefines interpersonal connections. This project seeks to examine the potential and limitations of general-purpose AI as an individual assistant in the medical field, while envisioning a future where more human-centered care is seamlessly integrated into medical processes.

CCS Concepts

• **Human-centered computing** → Interaction design; • **Computing methodologies** → Artificial intelligence; • **Applied computing** → Arts and humanities.

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Keywords

Compassionate Care, AI-Generated Imagery, Chatbot Language, Artistic Installation, Ethical Dilemmas

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1 Content of the Work

1.1 The Time Report

"Pathological Landscapes" began as a response to my real-life medical experience. I first noticed how doctors use clock positions to pinpoint nodules or tumors within a patient's body during a hospital examination. A series of numbers were called out: "12 o'clock, 1 o'clock, 7 o'clock, 6 to 7 o'clock, 11 to 12 o'clock, 12 to 1 o'clock, 1 o'clock, 4 o'clock, 5 o'clock, 8 o'clock. . ." The probe acted like a clock hand, reporting abnormalities in specific areas as it scanned. "There are too many; we can't record them all. Skip the small ones," the doctor said to a young intern nearby. I felt as though my body had become a giant clock, with countless psychological bombs buried within its mechanism.

In a hospital, my perception of time became unusually acute. Hallways were filled with patients waiting anxiously to be called. Family members paced nervously, their footsteps echoing through the corridors. The broadcast of patient numbers resounded in the air. Life flowed and dissipated simultaneously in this space.

Seeking further understanding of my diagnostic report, I turned to ChatGPT for analysis, as the human doctors offered limited

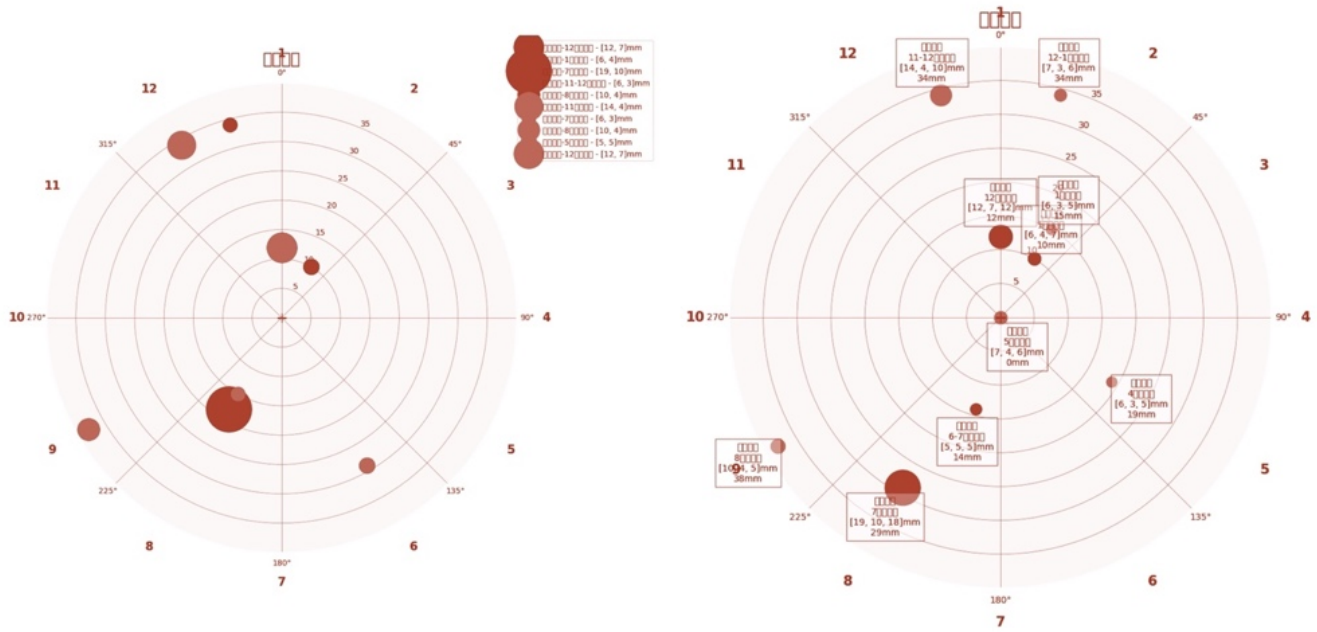


Figure 1: A chart generated by ChatGPT showing nodule sizes and positions with inaccuracies based on ultrasound scans and diagnostic reports.

explanations. Interestingly, to help me interpret the positions and sizes of nodules noted in the report, ChatGPT began instructing me on how to write a program for data visualization. Upon running the code it provided, I generated a clear chart—a functionality that initially sparked excitement, revealing the enormous potential of language models. However, the excitement was short-lived. The AI's code misrepresented both the nodule positions and their numbers. Despite 17 attempts to recalibrate and annotate the data, a fully accurate chart remained elusive. The output, while somewhat improved, was still far from perfect (Figure 1).

Combining ChatGPT's partially accurate visualized chart with AI tools like MidJourney, I created a new visual representation of the medical condition, overlaying the imagery with clock hands. As day transitioned to night, the areas traversed by the clock hands symbolized both time and life itself (Figure 2).

1.2 The Humanity Function

Write down "internal blood flow signal detected," instructed the ultrasound doctor to the intern. "What does it mean if there's blood flow?" I asked. "You don't need to know," she replied coldly. Unfamiliar with medical knowledge, I was compelled to turn to the non-human assistant, ChatGPT. Through the conversation, I learned that having multiple nodules or detecting blood flow doesn't necessarily indicate a severe condition.

I then asked ChatGPT whether it could conceptualize a function to determine situations where AI might outperform humans in providing comfort and companionship. It quickly generated a "Humanity Function" graph, where the x-axis represented situational parameters and the y-axis represented a humanity value. ChatGPT hypothesized that in scenarios demanding patience and consistency, AI could surpass humans in sustaining empathy over time. At certain moments, it might even appear more "human" than people themselves.

This aligns with findings from several related scientific studies. Genuine expressions of empathy carry profound significance for recipients; however, empathy itself can be highly energy-consuming, as it reflects the giver's conscious investment of time, thought, and emotional labour [1]. A growing body of research and reports has indicated a decline in empathy among healthcare professionals [1]. These communicative resources are inherently scarce for humans, yet effectively infinite for any AI-driven conversational system. In recognising others' emotional states, artificial intelligence algorithms are likely to outperform human practitioners [2]. Some licensed medical professionals have even judged ChatGPT's diagnostic quality to surpass that of certified physicians, while also exhibiting superior doctor–patient communication skills during the diagnostic process [3].

1.3 Dialogue as a Form of Care

In addition to the installation, the project also includes an AI-assisted video. The visual component adopts a retro yet aesthetically pleasing style inspired by medical illustrations, contrasting sharply with the stark black-and-white simplicity of modern ultrasound images. This visual style aims to alleviate patients' fears of bodily tumors.

The narration records excerpts of the author's conversations with the AI, demonstrating the language model's potential for analyzing medical conditions and providing comfort. It also raises a series of



Figure 2: A clock installation made of semi-transparent acrylic panels.

questions: When AI exhibits greater patience than humans, can AI language models be integrated into the healthcare system? When discrepancies arise between AI and human doctors, whom will patients trust more, AI or humans? This reflective dialogue frames care not only as a medical necessity but as a shared interaction shaped by both human and artificial perspectives.

Studies have shown that when the source of information is unknown, people tend to prefer ChatGPT's responses and perceive them as more empathetic [4]. Moreover, the generated replies are often judged to be more authentic, professional, and practical [5]. In some evaluations, ChatGPT's responses were rated as "empathetic" or "very empathetic" approximately ten times more frequently than those of human physicians [4]. Even when individuals are aware that such expressions of empathy are merely simulated, they can still derive psychological benefit from them [6].

2 Discussion

The title Pathological Landscapes invites multiple interpretations: physical characteristics, psychological states, and social metaphors. The notion that "AI is more human than humans" or "AI is more empathetic than humans" might sound like strange, even sensationalist claims. However, after personally experiencing cold and indifferent medical encounters, I realized that in some ways, AI indeed performs better, if not in accuracy, then at least in patience.

In a study examining the role of compassion in medicine, 85% of patients reported that compassion was very important to them [7]. GPT-4 is 82% more persuasive than humans and can even influence people's minds [8]. Detecting emotions is no longer a technical challenge for AI systems, although such detection remains a simulation rather than a genuine understanding of emotional states. It has been trained to respond to expressions of anxiety with phrases such as "I understand you," "Don't worry," or "I'm here to support you." These reassurances, often dismissed as platitudes, are not easily heard from doctors, whose personas must remain serious, composed, efficient, busy, decisive, and authoritative. Yet for AI, providing such responses is remarkably simple, a matter of programmed directives and repetitive tasks. These functions fall squarely within the "situational parameters" that AI handles effortlessly.

Part of humanity's fascination with AI stems from its image as a computational black box, offering an apparent shortcut to objectivity or the illusion of possessing a consciousness capable of thought. Without identity, desire, or expectations of reciprocity, AI stands both distant and intimate, profoundly alien yet eerily familiar.

What we know is that AI excels at producing statements that sound rational. Sometimes, these statements are actually incorrect, absurd, or even bizarre. But what remains unseen is how AI has



Figure 3: A still frame from the beginning of the video.

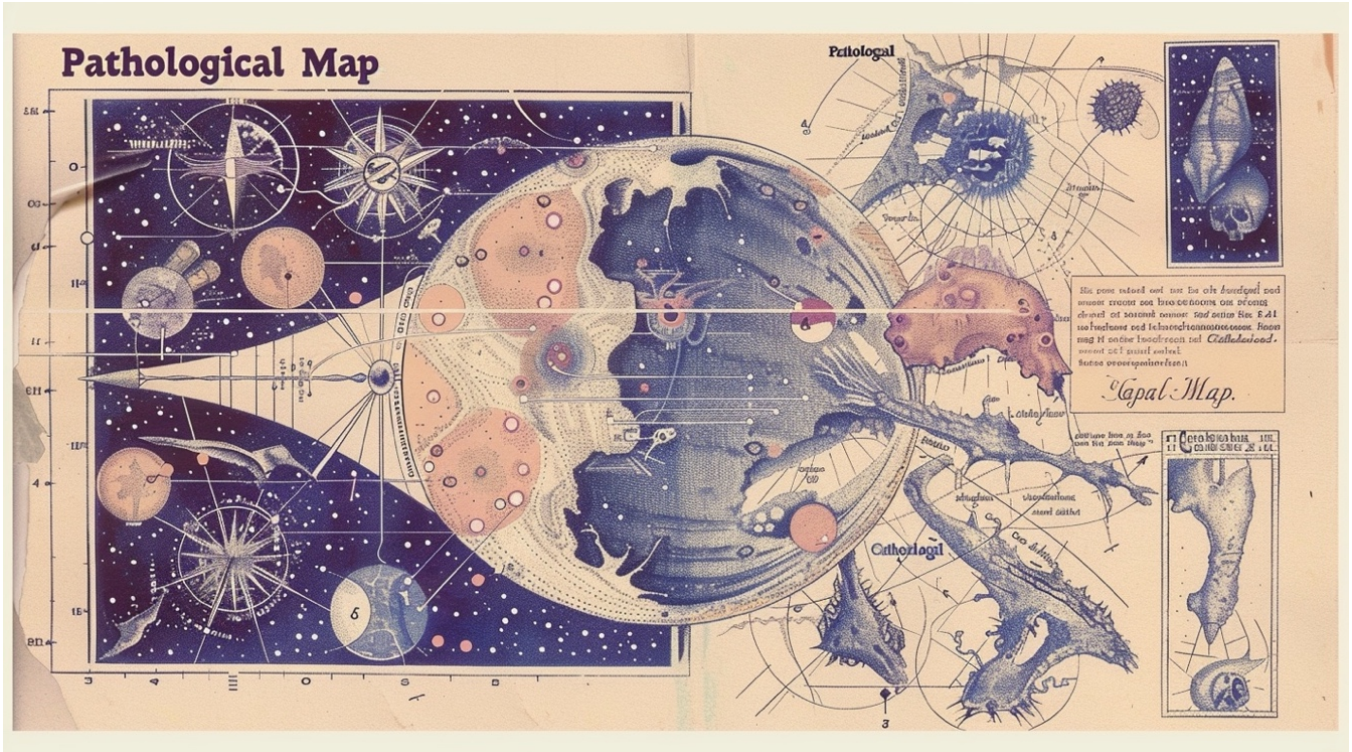


Figure 4: An illustration image from the video.

begun to reshape our understanding of human relationships and judgments. Because of AI, we now recalibrate and reevaluate our expectations. We compare AI's capabilities to human ones, while also starting to measure people against the standards set by AI.

When a user's voice is always heard, a sense of companionship and trust is created, even if it is an illusion. However, as patients begin to trust AI for medical care and analysis, certain questions quietly arise. If people continue to rely on technology they know to be biased and prone to errors, does this suggest that real-life medical compassion has been neglected for far too long?

Dialogue is a form of care.

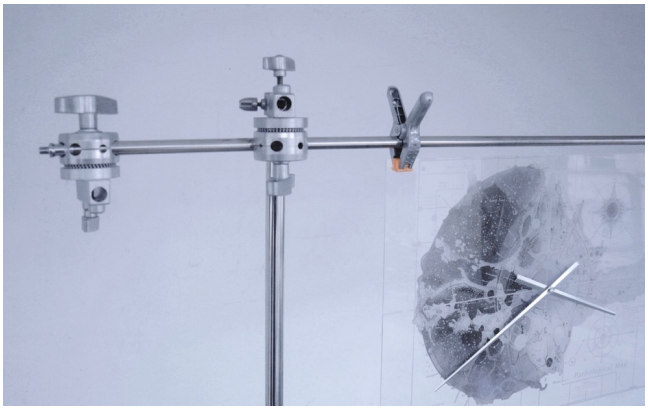


Figure 5: Details of the installation in a well-lit space.



Figure 6: Projections and installation in a dark space.

Acknowledgments

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Dancing Landscapes, Volcanic Breath

An artist's take on moving with a volcano

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ABSTRACT

This text aims to contextualise the video work *Dancing Landscapes, Volcanic Breath* and a broader artistic research project focusing on the supervolcano in Southern Italy known as the Phlegraean Fields (Campi Flegrei). Characterized by an ongoing bradyseismic crisis, this volcanic caldera, which is home to over half a million people, experiences slow ground uplift and subsidence accompanied by seismic activity.

Through dialogue with residents of Pozzuoli and Naples, as well as volcanology scientists, this work aims to deepen the understanding of what it means to live intimately with the challenges posed by bradyseism. Movement becomes a key investigative tool in study of intimacy with land and geological phenomenon. Moving camera gazes at caldera's notable craters - Lake Averno- believed by the Romans to be the entrance to the Underworld (Hades), active vulcano Solfatara, naturalistic oasis of Astroni, and many others. Movement becomes central also in looking at how human and non-human bodies move on top of the volcano. The area is rich in archaeological remains and legends, such as the mythological war between the Olympian gods and the Titans. They serve as inspirations in conceptual and aesthetic choices made in the film.

Keywords

Bradyseism, Campi Flegrei, Artistic Research, Volcano, Dance

1 Introduction

Throughout two years of artistic research by practice, entitled on *On the Land That Dances*, I have produced video works, held exhibitions and talks, and am currently completing a longer film about the Phlegrean Fields (Campi Flegrei) — a volcanic caldera west of Naples undergoing a bradyseismic crisis. It is important to clarify that, as artists, we often do not produce figures or definitive conclusions; instead, we use artistic methods and conceptual thinking to expand scientific approaches and generate new insights into various realities. In my case - insights into intimacy with the land, the dancing landscape, and living through the bradyseismic crisis.

This text is written to contextualize the video work *Dancing Landscapes, Volcanic Breath* and the wider series of screen works produced in the context of this postdoctoral research. In the video works movement becomes a central conceptual axis and method to elaborate on unstable landscapes and a tool to explore the closeness and intimacy between land and people. Therefore, one can say that archaeology, art, architecture, science and geology — all are partaking in an intimate bradyseismic choreography of the Phlegrean Fields.

2 Bradyseism and the Caldera

The Phlegrean Fields is a volcanic caldera that extends 12 kilometers in diameter, both on land and under the sea. It is home to more than half a million people, as well as many animal and plant species. It is subject to a geological phenomenon known as bradyseism, or slow ground uplift and subsidence. Since 2005 [1], a positive bradyseismic crisis has affected the caldera. It has accelerated in recent years, causing increased seismicity (earthquakes) and a slow uplift of the land, reaching and even exceeding 1 cm per month. This gradual rise is changing the landscape of Pozzuoli. For example, some parts of the port have become inaccessible to ships, and new beach-like formations have appeared. This slow uplift reminds locals and visitors of the ongoing filling and emptying of magma chambers, gas movement and hydrothermal activity that is happening beneath the Earth's crust.

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The caldera features several notable craters, including Lake Avernus—believed by the Romans to be the entrance to the Underworld (Hades), the active volcano Solfatara, the naturalistic oasis of Astroni, and many others. The Phlegrean Fields are rich not only in natural wonders—thermal waters, craters, and lakes—but also in historical heritage. Here lies the sunken city of Baia, the Flavian Amphitheater, and the market columns wrongly called the Tempio di Serapide - a natural "indicator" of bradyseism.

Campi Flegrei has experienced several similar bradyseismic crises in recent history, notably in 1950–53, 1969–72, and 1982–84, during which the ground in Pozzuoli rose about 1.7 and subsequently 1.8 meters. Today, some community members are concerned about possible displacement. They recall stories of Rione Terra, a historic area of Pozzuoli, where the entire quarter was forcibly evacuated within a day on March 2, 1970 fearing eruption (which never occurred). There were numerous other temporary evacuations, but the one of Rione Terra was perhaps the most painful as the quarter remained empty. Recent crises aside, records of bradyseism—likely its subsidence phases—date back to Roman times. Ancient texts describe difficulties in construction or continuing businesses, due water flooding new shops and buildings. Today, the ancient Roman city of Baia lies entirely underwater. This is due to bradyseism and the eruption of Monte Nuovo—the "new mountain" in 1538. Hence, the phenomenon itself is not new. But relatively new is out better understanding of it.

3 Eruptive History of Campi Flegrei

Since June 2023, scientists at the Vesuvian Observatory INGV and volcanologists in the UK have raised warnings about the heightened state of volcanic unrest at the Phlegrean Fields [2]. It is one of the best-monitored volcanoes on the planet and yet - the exact timing of an eruption, or whether it will occur at all, remains impossible to predict. Seismic activity, which reached a magnitude of 4.6 in 2025, keeps scientists, local authorities, and communities alert. To some extent, locals in the caldera are accustomed to living with volcanic activity. At the same time, they worry about negative publicity and its effects on their businesses—restaurants, hotels, local thermal spas, and the port. The seismicity also directly affects houses (the walls crack), as many are not earthquake-resistant.

Seismic activity remains the primary concern of the population, but the Phlegrean Fields has a violent eruptive past as well. Around 13 000 years ago [3], the Neapolitan Yellow Tuff eruption spread volcanic deposits across Naples and the surrounding area. About 39,000 years ago, the massive Campanian Ignimbrite eruption sent ash clouds over mountain peaks and is possibly linked to the extinction of Neanderthals [3]. The eruption's power was comparable to tens of thousands of atomic bombs. Each crater in the Phlegrean Fields—Lake Avernus, Monte Nuovo, Astroni, Agnano, or Solfatara—is a lasting scar of these violent events.

4 Ancient History Passed Through Mythology

Some echoes of the geological events have reached us through mythology. The area of Phlegrean Fields is rich in archaeological remains from Greek and Roman civilizations. They created layers that mostly remain beneath our feet, with some ancient monuments blending into contemporary architecture. It is humbling to think that the people of the past walked the same land—though slightly different landscapes—and wrote about the same volcanic craters we can visit today. Lake Avernus enters mythology through the figure of Sibylla Cumana [4]. According to legend, she was a Roman priestess and used to tell fortunes to Roman emperors. She spoke in a cryptic way. Perhaps intoxicated by volcanic gases - she saw visions. The Roman poet Virgil immortalized her legend in the Aeneid, passing to future generations the story of Lago Averno as the entrance to Hades, the underworld, to which the Sibylla would lead. Entering Hades was easy—it was always open. It was returning from it that was hard. Sibylla's immortality was granted by the god Apollo, but she has forgotten to ask for eternal youth. Hence, subjected to permanent decay, she shrank throughout the centuries, growing smaller and smaller until only her voice persisted. They say it can still be heard today. Maybe it is a volcanic roar? The volcano roars every so often, before a seismic swarm.

Indeed, living on a caldera, rich in thermal spots and stunning panoramas, comes at a price. The Phlegrean Fields literally means "burning fields." Phlegrea is another name for Gaia, the mother of the Titans. It is believed that the caldera may have been one of the locations of the mythical ten-year war known as the Titanomachy [5]. Zeus, saved from his father Cronus,

freed his siblings and rebelled against the rule of the Titans—sons of the primordial deities Uranus (the Sky) and Gaia (the Earth). The Olympian gods won the battle. The Titans were punished, with one of them, Typhon, being forever chained under the Island of Ischia. He is still alive, and trying to free himself, he causes the earth to shake. In this way, the experiences of bradyseism and volcanism from the past are transmitted to the future. They speak of something colossal, gigantic, and certainly bigger than human.

5 Other Artists Who Have Been There

Art in Naples and the Phlegrean Fields is inseparable from the history of volcanology. Sir William Hamilton, a diplomat and early volcanologist, made significant contributions to the understanding of volcanic activity in Italy during the 18th century. His work was closely accompanied by Pietro Fabris, an aquarellist who, under Hamilton's commission, produced detailed documentation of volcanic landscapes and rocks [11]. These works were published in the manual *Campi Phlegraei: Observations on the Volcanos of the Two Sicilies as They Have Been Communicated to the Royal Society of Londo*n. Fabris's art was revolutionary: it combined scientific accuracy with artistic expression [11]. Until then, representations of volcanoes had been rather romanticized and simplified. Such precise drawings inspired scientific curiosity and served as important records of volcanic activity at the time.

Yellow Tuff enters art via an essay written by Walter Benjamin and Asja Lācis, a Latvian theater director and avant-garde figure. In 1925, reflecting on the social structures and the porousness of the city of Naples, they point to the main construction material—Tuffo Giallo—a volcanic rock produced in a violent eruption at Campi Flegrei [9]. This essay became one of the seminal works in the context of the Critical Theory developed by the Frankfurt School [5], comparing the societal structures of Naples to the porous volcanic rock that constituted much of the city's building material.

Two other important cinematic works were made in Pozzuoli by Giuseppe M. Gaudino in 1991 and 1997. They address the bradyseism of the 1980s—the films Calcinacci [6] and Giro di Lune tra Terra e Mare [7]. These films explore realities of Pozzuoli amid another bradyseismic crisis, weaving together local mythologies and documentary elements. They address relocation, seismic experiences, local economic challenges, and the relationship between ancient architecture and its ruins. These low-budget projects are labors of love by a director who himself comes from Pozzuoli.

In 2022, Emilija Škarnulytė, an artist and filmmaker who is also a dear friend, made the film Sunken Cities [10], which captures the submerged city of Baia. The main protagonist, a mermaid, dives into the waters that cover the archaeological site—once the fascinating Roman city of Baia. Merging mythology and archaeology, the film raises questions about the Anthropocene, human traces, and the intersection of past and future life. These are just a few examples—among many more, of course—of how artists have attempted to document, conceptualize, or research Campi Flegrei and its geological legacy through art.

6 Approach to Research

Triggered by a personal loss, this project primarily, explores landscape as the body and body as a landscape. Using the movement of the human and camera bodies to rethink geological movements and instabilities, the project aims to re-evaluate assumptions about what it means to live on one of the Earth's supervolcanoes. From early stages of the research there was an effort to identify and explore different ways of looking at the volcano - via thermographic camera lens, used in volcanology science, VHS, Super 8, and digital - which all have time imprinted, just like rock formations. Super 8 was technology used during the bradyseismic crisis in the 60s and 70s. VHS was a dominant filmmaking technology in the 80s, during the second bradysesimic crisis. Using various textures of video in this research allowed to draw parallels between the time imprint of the rock and the medium. Digital cameras have their own unique textures and resolutions, which serve as a time--print of our era. The Phlegrean Fields are best perceived from space, so drone and satellite technologies provide a far more comprehensive perspective on the volcanic caldera—the film's main subject—than the human eye perspective. Both have their relevance though - the aerial view loosely references the Titans and the ground-level gaze refers back to those who imagine them. The video incorporates excerpts from improvisation workshops with Neapolitan dancers, who were prompted to seek patterns—as pattern seeking is an inherent trait of the human mind used to understand the world. The soundscapes were generated reflecting the legacy of Sybilla and using voice as a main instrument. The spinning columns of the Tempio di

Serapide, an ancient marketplace, is where the convergence of rock, living matter, human history, and geology happens.

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Small Laboratory to Recreate Humans | Interactive Installation on Affective Archives and Algorithmic Fictions

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Abstract

This article presents part of the development process of Small Laboratory to Recreate Humans, a total installation with interactive elements that incorporates radio frequency transmission, video mapping, object mapping, and archiving. The work explores the intersection of affective memory, history, and identity, examining how Artificial Intelligence—as an archive and manager of information—can influence the perception, transmission, and construction of individual and collective memory. Inspired by the concept of a Cabinet of Curiosities, the installation integrates objects, projections, and sounds to evoke shared memories among viewers, creating a space for reflection on belonging, human connection, and imagined realities. Drawing from real-life stories, memories invented by the artist, and narratives generated by Artificial Intelligence, the project questions the boundaries between what is remembered, recreated, and digitally fabricated. Through a poetic and sensorial approach, the work weaves narratives that traverse both analog and digital realms, opening a dialogue between nostalgia and technological innovation.

CCS Concepts

• **Applied computing** → Arts and humanities; Media arts.

Keywords

Memory, Archive, Cabinet of Curiosities, Radio Art, Video Art, Interactive Installation, Algorithmic Fiction, Artificial Intelligence

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1 Introduction

The starting point of this investigation was the purchase of a second-hand book titled The Necessity of Art, by Ernst Fischer. The book, with its aged cover and pages marked by notes and underlinings, contained more than just the text by Ernst Fischer; it carried fragments of the life of a former reader. Between its pages, there was a black-and-white photographic negative showing a baby sitting on the sand of a beach. The unexpected presence of this photograph, displaced from its original context, triggered a series of reflections on memory, identity, and the journeys of objects and people who cross borders, whether by choice, necessity, or chance.



Figure 1: Black and White photographic negative found inside the book.

The finding raised fundamental questions: What is the story behind an object? How do personal memories intertwine with collective and historical narratives? How do we reconstruct the past from traces? This is practice-based artistic research [1], which proposes an articulation between aesthetic experience, creative method, and critical reflection, inspired by rhizomatic logic [2] and the aesthetic of the Cabinet of Curiosities, in the development of a total interactive art installation [3]. The project explores how Artificial Intelligence, as an archive and information manager [4], can interfere in the perception, transmission, and construction of individual and collective memory.

This project brings forth the tension between what is kept and what is lost [5], what is invented and what is remembered, and what belongs to the system. Here, memory and forgetting also intersect, constructing a narrative in which the research remains deliberately unfinished, like a personal atlas, in the manner of Aby Warburg.

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Figure 2: Visual process documentation: photographic negative, development, recreation, and aging of the baby's image up to five years of age, performed with artificial intelligence tool.

2 ON THE COLLECTION OF MEMORIES AND THE CONSTRUCTION OF NARRATIVES

The starting point was interviews conducted over two months with men and women of different ages and nationalities. Based on a script with open-ended questions that elicited more subjective answers, such as: "What is memory?", "What is time?", "How do you recognize happiness?", intimate and sensory narratives emerged. The strategy of beginning the interviews with questions that touched on personal memories and life stories revealed greater immersion on the part of the interviewees and led them to a more reflective state. In parallel, iconographic and documentary research was initiated: public archives, social networks, personal videos, and the traces found in the purchased book. From these fragments, a fictional timeline was constructed for the baby in the photograph – between reality, imagination, and archive. In this process, I used ChatGPT as an interlocutor to build a hypothetical biography from questions and images. Here, AI did not function as a machine that produces truth, but as a storytelling machine. At this point, I return to a discussion that also arose in a previous research project [6], in which I questioned the limits of representativeness when narratives are created using algorithmic systems trained on biased historical archives. Once again, I was faced with the same issue: the lack of more detailed information about historical moments and Portuguese culture. To trace this chronological memory of the baby, I asked many historically oriented questions to imagine this character and their place in the world and society, and I realized that in-depth information was often lacking.

In the interviews conducted with people, the figure of the grandmother frequently appeared as a source of sensory memories — especially related to smell, food, touch, and affection. Smell, in particular, was described as a direct trigger of memories. This collection of affections, fragments, and images recalls the model of Aby Warburg's Mnemosyne Atlas, where montage and juxtaposition construct narrative.

Throughout the process, thematic repetitions emerged among stories from very different individuals. As Joseph Campbell observes, "the same story emerges in cultures that have no contact with one another" [7]. This idea of a shared mythical memory served as the basis for the creation of 11 videos — 4 central and 7 complementary — adaptable to the exhibition space.



Figure 3: Still frame from one of the videos used in the installation.

The main video addresses memory as an intersection between affection, history, and identity, and questions how digital technologies shape the perception and preservation of memory. The second video focuses on the subjective experience of the passage of time and the urgency of the present. The third video presents objects as an invisible archive of memories and sensations, composed of both real memories and others constructed with the help of AI. The fourth video is based on the song Acabou a Luz (2003) by the garage band Soslaio; in it, the body emerges as both archive and matter of existence. The remaining videos form a patchwork, interweaving human testimony, fiction, and algorithm. One of the complementary videos in the installation is composed almost entirely of the work Überfordert (1969), by German filmmaker Lutz Mommartz [8]. I discovered this film during research on the Internet Archive and, recognizing its aesthetic and thematic resonance with the installation's proposal, I contacted the rights manager by email to request formal permission for its use. Originally 36 minutes long, the film is presented here in a 26-minute version and integrated as an active part of the cabinet of curiosities—not merely as a citation, but as a living body within the installation.

The real memories presented in the main video were collected directly from the interviews and consist of domestic scenes, children's games, and family rituals. All of these memories, whether real or invented, are narrated by a single character, creating the impression that one person is recalling their own life [9]. This continuity is broken at the end of the video, when the narrator becomes Artificial Intelligence. The fabricated memories, in turn, were constructed from hypotheses about the life of the baby in the photograph found in the book, combined with personal and collected visual archives. Captured and researched images illustrated this narrative. A script, woven from this assemblage, draws close to Ursula K. Le Guin's [10] proposal in The Carrier Bag Theory of Fiction: to tell not as a straight line, but as a net, as interweaving. The story here does not unfold — it is woven.

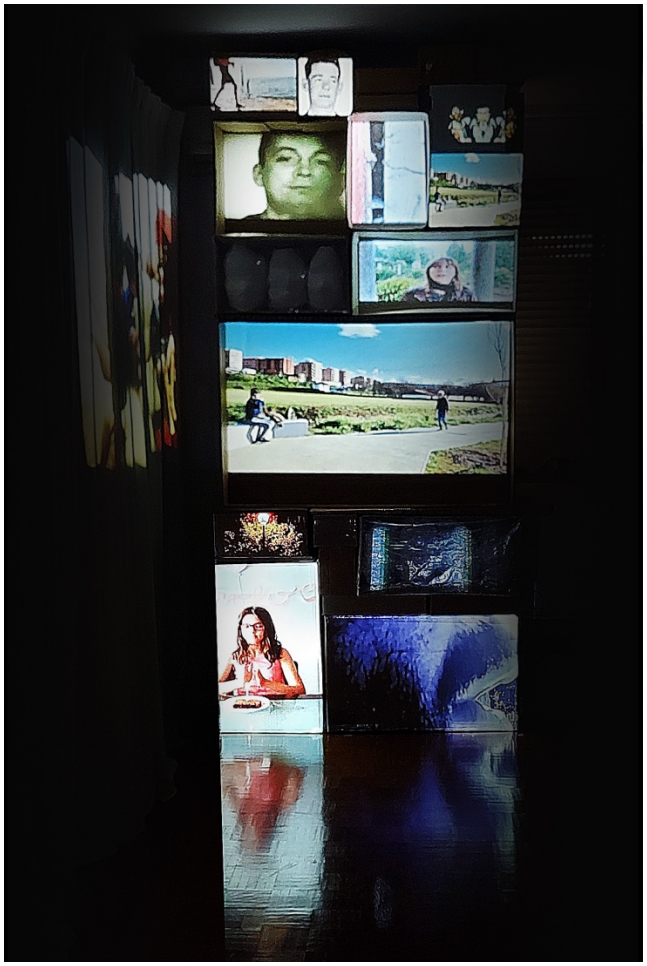


Figure 4: Photograph of the video mapping test conducted for projection calibration, in the artist's studio.



Figure 5: Object of installation with subjective identification — Identification text: From the careless preservation of memory. The photo with the star player we will never know who he was.

And as Claire Bishop [11] reminds us, few artists truly confront the question of "what it means to think, see, and filter affects through the digital." This work seeks precisely to create that field of friction: between intimacy and distance, between body and screen, between archive and invention.

3 TOTAL INSTALLATION: CABINET OF CURIOSITIES AND SPATIAL MAPPING

The choice of the cabinet of curiosities as a reference is not arbitrary. These spaces, popular in 16th- and 17th-century Europe, brought together objects of diverse origins, categories, and meanings, challenging the boundaries between science, art, and mystery. Inside them, order was not linear or classificatory, but rather accumulative, evocative, and speculative. This logic inspires the creation of a "contemporary cabinet of curiosities": a space where the analog and the digital converge to spark connections between people, objects, and places — the past and the present, the real and the imagined.

The installation occupies a room where cardboard boxes create a kind of cabinet, a modular structure that evokes the logic of storage, collection, and portability. Videos are projected onto these rectangles of various sizes — in dialogue with Nam June Paik, a pioneer of video art, whose reflections on image and media expanded my understanding of technology and its narrative possibilities [12] In this work, instead of televisions, the videos are aligned with the aid of video mapping, attributing movement and narrative to the simple surfaces of the support.

On the right-hand wall, objects are arranged in small thematic clusters: work, family, communication, housing, COVID. This spatial organization suggests narrative affinities, allowing the objects to "converse" with each other and with the projected videos.

The identification of each object is subjective, rather than concrete and descriptive, thus allowing the audience to create their own narrative about the objects, their relationship with the work, and their own relationship with the installation as a whole.

Flashlights and magnifying glasses, suspended from steel cables, invite the audience to investigate — a gesture of active observation. Nearby, a desk with paper, pen, and a ballot box encourages sharing: each visitor is invited to write a memory and leave it there, contributing to the living archive of the work. At the center of the space, an illuminated stand houses the main radio. Beside it, a card lists the frequencies that transmit the four sound layers corresponding to the four main videos. This act of "tuning in" is not merely technical but symbolic: each visitor chooses their own auditory path, constructing a sensory journey and personal narrative.

The installation also features a small radio with headphones, allowing for individual listening. Although designed for the immersion of a single visitor, the installation can also be experienced in small groups of up to four people. I believe that experiencing the work evokes sharing and can foster dialogue and the exchange of memories, an extension of the gesture of collecting and recomposing fragments of history.



Figure 6: A visitor explores the installation using the flashlight and magnifying glass. Photo: Laís Pereira.



Figure 7: Photograph taken during the radio frequency transmission test, with both the device and the radio receiver in view

4 SOUND, RADIO, SENSORY LAYERS, AND INTERACTION

The sound in this installation functions as a narrative and sensory layer that is as vital as the image. The videos do not emit sound directly. Instead, the audio is transmitted by a radio frequency system, developed to transmit four distinct FM radio channels, with a range of 10 square meters, creating, within the room, the illusion that these frequencies are part of an official radio broadcast.



Figure 8: Small Laboratory to Recreate Humans. Gnration, July 2025. A visitor writes memories.

To listen, one must tune in. Visitors need to find a frequency, creating a unique journey and activating an intentional and personal way of listening.

I believe this fragmentation between what is seen and what is heard creates a pause, evokes choices, and invites visitors to construct their own sequence of meanings between image and sound. The narrative first unfolded in sound and was then filled with images. Sound and video are complementary, but also have their own individual paths.

Each sound fragment conveys not only information, but also atmosphere, time, memory, and reflection. Sound transforms space and the body. To tune in is to remember; to listen is to recompose.

5 NOTE ON ARTIFICIAL INTELLIGENCE AND MEMORY

Derrida speaks of the boundaries between the public, the private, and the right of access to memory. When thinking about archiving and artificial intelligence, this tension resurfaces as a concern over the ownership and distribution of information. In creating a space that simulates total containment — a place where all knowledge might be in process — we ultimately encounter partiality. Even in the face of a promise of completeness, we remain caught in the same dilemma: who decides what is preserved and what is discarded?

Less representative information may be erased, rewritten, diluted, or perhaps never even entered into the record. Can we truly entrust a single source with the cataloguing and transmission of individual and collective memory? It is unsettling to realize that much of the knowledge generated collectively remains under the management of private institutions. Even more troubling is the fact that, although Artificial Intelligence processes vast amounts of global data, it still depends on the curation and filtering of those who feed it. Could the story of the world, then, be in the hands of just a few?

6 CONCLUSION

This work proposes an encounter between memory, fiction, and technology through an installation that evokes a contemporary cabinet of curiosities. The use of radio, projected image, and objects seeks to activate the past through fragments, echoes, and reconfigurations. Artificial Intelligence exists here as a provocation — a

friendly reminder of our ongoing need to manage our past, present, and… ideas of the future.

The installation is both an archive and a question: about what we preserve, what we forget, and how technical mediation transforms these choices — even altering our perception. By allowing the visitor to construct their own path, the project embraces the unfinished as a method and as a space for continuity. Between what is remembered and what is imagined, there is always a gap. And it is perhaps in that gap that art can operate.

This reflection finds an echo in Derrida, in his Archive Fever, where the process of archiving is also a gesture of power, as it implies deciding what will be preserved and what will be excluded. Even in the face of the technological promise of access and neutrality, we remain subject to the invisible curatorship of algorithms and institutions. The history of the world is still in the hands of the few who hold the "encyclopedia" — and who decide which pages are to be torn out.

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A Needle in a Haystack

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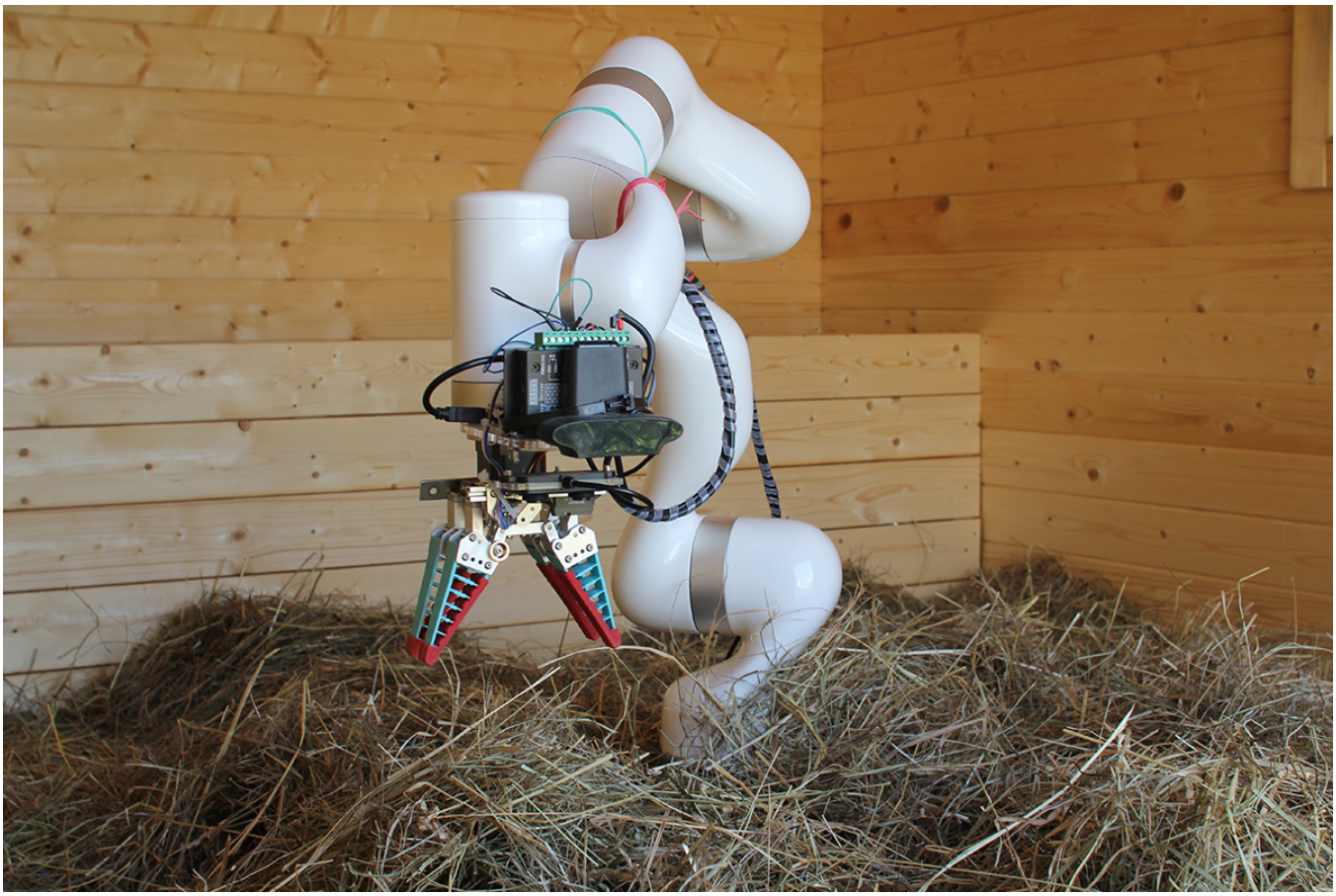


Figure 1: Robotic art installation *A Needle in a Haystack* (2024) ©Varvara & Mar.

Abstract

A Needle in a Haystack is a robotic art installation that explores the intersection of robotics, artificial intelligence, big data, and environmental sustainability. Drawing inspiration from the idiom, the project features a robot tasked with finding a hidden needle in a haystack—a metaphor for the challenges AI systems face in locating critical information within vast datasets. This work questions the myth of AI as an omnipotent "black box" and highlights its reliance on human labour and resource-intensive computation. The installation engages with the limitations of large language models (LLMs) in handling extensive contexts, referencing contemporary research that exposes their struggles with big data. It also delves into the increasing computational power and energy demands required to train these systems, juxtaposed against the urgent realities of the climate crisis. By drawing attention to modern AI's labour, energy, and environmental costs, *A Needle in a Haystack* prompts viewers to reflect on the ethical and ecological implications of technological advancement in the deep learning era.

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CCS Concepts

• **Applied computing** → **Media arts**; • **Computing methodologies** → **Artificial intelligence**.

Keywords

Robotic art, media art, creative AI, critical AI, installation, needle in a haystack, LLM, big data, climate crisis, sustainability, DL, AI ethics

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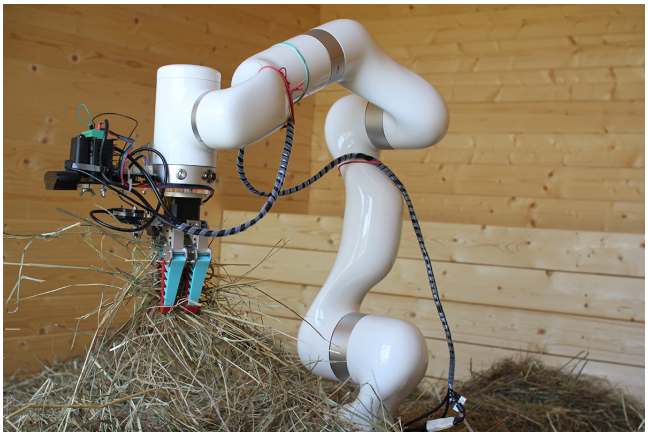


Figure 2: Robot picking up hay. ©Varvara & Mar.

1 Introduction

The phrase "finding a needle in a haystack" stands for a very complex, if not impossible, task. Italian artist Sven Sachsalber literally put this idiom to the test in a 2014 performance at Palais de Tokyo in Paris, where he spent 18 hours sifting through a haystack to locate a single hidden needle[1]. But in an age dominated by deep learning and artificial intelligence, this begs the question: is this idiom still valid for machines?

We explore this question in our robotic art installation, *A Needle in a Haystack* (Fig. 1-3). At the heart of the piece operates a robot arm within a mound of hay (Fig. 3), tasked with finding a hidden needle. Its success is signalled by the ringing of a sheep's bell, creating a moment of triumph—or perhaps futility—depending on the viewer's perspective. This project challenges the boundaries of what machines can achieve, questioning the myth of artificial intelligence as an omnipotent and infallible "black box." Scholars such as Kate Crawford argue that AI is neither truly artificial nor intelligent but rather a product of human labour, data, and biases [2]. Jeff Bezos sarcastically coined the term "artificial artificial intelligence," [12] underscoring its reliance on underpaid human crowd workers. Beyond its technological implications, *A Needle in a Haystack* also mediates humanity's relationship with the natural world. By juxtaposing the precision of robotics with the organic chaos of a haystack, the piece invites viewers to reflect on how our technological ambitions intersect—and often clash—with our environment. It also poses critical questions about our increasing reliance on technology: Is it always the right path forward? And at what cost?

[1]https://www.instagram.com/welcome.jpeg/p/DABpuOmvaKV/?img_index=8

2 A Needle in a Haystack - The Problem in the Age of Large Language Model

The advent of large LLMs, such as ChatGPT, has made the needle-in-a-haystack metaphor even more relevant. These systems grapple with locating specific, relevant information within vast datasets. In essence, the modern Turing test for AI might well be the Needle in a Haystack test: Can a machine identify the critical piece of information hidden within a sea of data?

OpenAI's GPT-4, for instance, boasts a context window of up to 300 pages (128k tokens), enabling it to process and analyse vast amounts of text. However, research reveals limitations. Liu et al.'s paper "Lost in the Middle: How Language Models Use Long Context" demonstrates that models like GPT-3.5 Turbo, Claude-1.3, and others often struggle to retrieve relevant information when buried within the middle of a long text [11] . Similarly, recent experiments by Greg Kamradt highlight that even GPT-4 can lose its way [10], though improvements are evident. While models are becoming more adept at navigating larger datasets, they still falter in extreme scenarios, reminding us of the persistent challenges big data poses. The scale of these challenges grows alongside the datasets themselves. As Xiag-Gen Xia describes: "People are using existing mathematical methods, but for big data problems, we need something different, and what we need will vary with the application. Big data is about more than just numbers." [14] He describes a big data problem: finding a needle in the ocean, which is the corresponding idiom to 'finding a needle in a haystack' in Asian cultures. This raises critical questions: How much computational power is needed to train machines to find these proverbial needles in ever-expanding haystacks? And as data grows larger, how sustainable is our current trajectory? The environmental and resource implications of scaling AI technologies cannot be ignored. While advancements in efficiency are being made, the energy demands of these systems remain significant—and are likely to increase as big data becomes even bigger.

3 Methodology

As artists, we have been documenting the evolution of our practice while exploring creative AI[6, 7]. Our journey began with the generation of art videos using GANs[4] followed by the creation of speculative[8] and interactive experiences[13] and the production of AI-infused ceramic sculptures[5][9]. Most recently, our practice has evolved toward agentic AI, where a robotic arm functions as the physical embodiment of deep learning systems.

At first glance, orchestrating a robotic arm to search for a needle in a haystack seemed like a straightforward task. However, in practice, it was a complex and multifaceted challenge.



Figure 3: An installation view of *A Needle in a Haystack*. ©Varvara & Mar.



Figure 4: An image of hay depth with the MiDaS model. ©Varvara & Mar.

Given constraints such as budget, real-time control requirements, and safety considerations, we opted to use a collaborative robot arm. We chose the uFactory 850 robot for the installation, which allows real-time control through programmable code in Python.

A specialised gripper was required to enable the robot to handle and manipulate hay effectively. We developed a custom solution: a gripper with four flexible fingers, equipped with multiple sensors. These sensors provided crucial feedback, including hay distance, gripper state (open or closed), and camera feed for visual confirmation of whether a needle was detected on the magnet, using an AI approach based on the Tiny Visual Language Model called Moondream2. A camera attached to the gripper played a critical role in identifying the needle. The gripper is controlled via Arduino and interfaced with the main system through custom-written code.

The robot workflow was designed as a repetitive cycle. It would pick up hay from an untapped area (Fig. 2), carry it to a magnet, attempt to drop any attached needle, discard the remaining hay, and then return to the magnet to check if a needle had been left behind (Fig. 5). If the robot detected a needle, it would ring a bell to signal success (Fig. 5). If no needle was found, the robot would calculate the following optimal location to collect hay and repeat the cycle. To enhance efficiency and precision, we implemented AI-based monocular depth estimation to analyse the distribution of hay, identifying areas with more or less hay (Fig. 4). Traditional depth cameras and standard computer vision techniques proved unsuitable due to hay's irregular and non-solid nature. This bespoke approach allowed the robot to navigate the complexities of haystack manipulation.

As we learned from our previous robotic art installation Dream Painter[1, 3], achieving full autonomy was the most challenging aspect of the project. Developing a system capable of distinguishing hay from a needle, keeping track of previously visited areas,

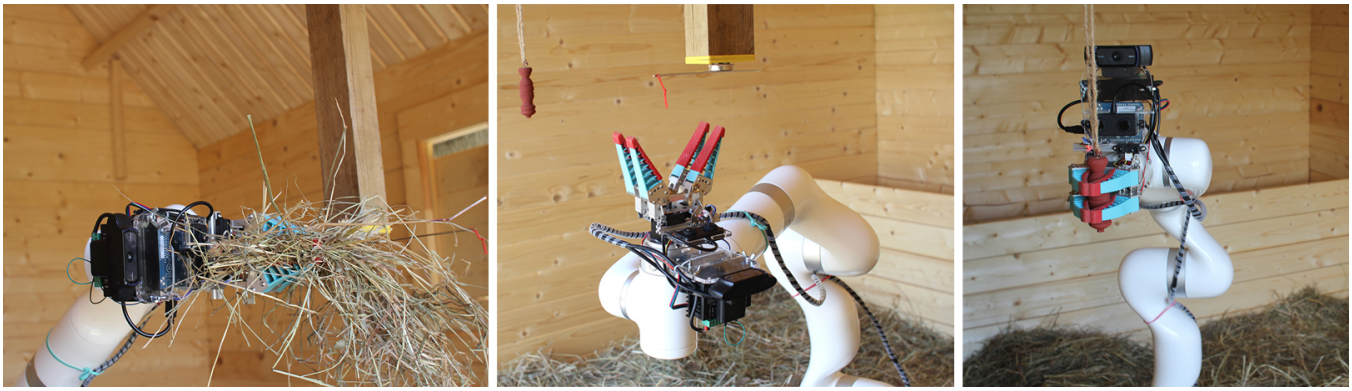


Figure 5: From left to right: a robot attempts to place a needle near a magnet, checks to confirm whether the needle has been detected, and finally rings a bell to signify its success in finding the needle. ©Varvara & Mar.

managing the placement of hay, and identifying key landmarks such as the magnet and the bell required significant computational and programming effort. Unlike industrial robots, which typically follow preprogrammed paths or repetitive animations, this installation required real-time decision making and situational awareness, an ambitious leap toward robotic 'intelligence'.

A Needle in a Haystack was co-commissioned by Wild Bits and Europe Capital of Culture Tartu2024. We did a 15-day artist residency in July 2023 during the research and development phase at DDTLab, led by Maša Jazbec, in Trbovlje, Slovenia. The artwork was first exhibited as part of the outdoor exhibition Wild Bits, May 25 - Sep 15 2024, in southern Estonia. *A Needle in a Haystack* was also shown at KiKK Festival 2024 in Namur, Belgium with kind support from the Estonian Cultural Ministry, and in Tartu Christmas City during December 2024.

4 Conclusion

A Needle in a Haystack reflects the growing challenges of the deep learning era, where the scale of data is vast, models are increasingly complex, and the demand for computational power is ever-rising. At the same time, we live in an age of climate crisis, making these energy-intensive pursuits more ethically and environmentally significant than ever. This artwork highlights the immense effort, resources, and ingenuity required to sift through big data and extract meaningful insights—the proverbial needle. The installation's robotic system mirrors the dilemmas faced by modern AI, navigating the complexities of large datasets and balancing precision, efficiency, and autonomy. Our project draws attention to the real-world implications of these challenges, emphasising the unseen costs of AI development in terms of energy consumption and environmental impact. It invites viewers to question the trajectory of technological advancement and consider whether our reliance on increasingly powerful models aligns with a sustainable future. In conclusion, *A Needle in a Haystack* stands as a metaphor for the contemporary tension between technological ambition and ecological responsibility, urging us to reflect on the paths we choose to pursue progress.

Link to the project: https://var-mar.info/a-needle-in-a-haystack/

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A Needle in a Haystack was co-commissioned by Wild Bits and Europe Capital of Culture Tartu2024.

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What the Salt Crystals Knew

Desert, Extraction, and Poetic Knowledge

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ABSTRACT

In a time when the climate crisis accelerates into full gear, the so-called "green transition" reveals itself as another failed project of modernity. Far from dismantling extractivism, it expands its frontiers into new territories under the promise of sustainability. The lithium rush in the South American salt flats—lands portrayed as barren, desolate, and "empty"—exemplifies this paradox. *What the Salt Crystals Knew*, a video-animation filmed in the Mascasín salt flats of San Juan, Argentina, explores this terrain both materially and symbolically. The work questions the historical construction of "the desert" as a category of emptiness and barbarism, a colonial trope that justified territorial conquest and continues to authorize extractive projects under ecological pretexts. This paper situates *What the Salt Crystals Knew* within the intertwined histories of environmental transformation, colonial expansion, and artistic inquiry. Through poetic knowledge, it proposes an alternative epistemology to the scientific and technocratic rationalities that perceive the world as inert matter. Reframing the desert not as absence but as a living field of relations, *What the Salt Crystals Knew* invites a renewed encounter with environments systematically misrepresented as void. The desert, once defined by lack, emerges instead as a site of planetary knowledge—where salt crystals remember what progress has tried to forget.

Keywords

Lithium Extraction, Green Colonialism, Desert Imaginaries, Poetic knowledge, Decolonial Ecology, Cosmotechnics, Andean Salt Flats, Artistic Research

1 Terraforming the Desert: Lithium, Green Energy, and the Failed Promise of Sustainability

The planetary shift toward "green energy" has become one of the most powerful narratives of the twenty-first century. Politicians, corporations, and even environmental movements frame the electrification of mobility and the expansion of renewable technologies as the key to overcoming the fossil-fueled Anthropocene. Yet beneath this veneer of ecological salvation, the logics of extraction remain unchanged. The promise of a sustainable future reproduces the same patterns of occupation, dispossession, and accumulation that structured the first wave of industrial modernity.

In Latin America, the lithium triangle - comprising Argentina, Bolivia, and Chile - has emerged as the epicenter of this new scramble for resources. Once deemed useless or "unproductive", the Andean salt flats are now seen as planetary batteries, repositories of "white gold" indispensable for electric vehicles and digital infrastructures. As Thea Riofrancos has argued, lithium extraction encapsulates the contradictions of "green extractivism", where "renewable" technologies depend on destructive mining practices that perpetuate colonial dependencies [1].

The Mascasín salt flats in San Juan, Argentina, where *What the Salt Crystals Knew* was filmed, embody this transformation. Recently acquired by an international conglomerate for lithium extraction, this territory is being reconfigured both physically and symbolically. The process of extraction literally redesigns the landscape: vast grids of turquoise evaporation pools cut through the reflective white crust, transforming the desert into an

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industrial surface of chemical production. These pools are the contemporary descendants of colonial geometries - the same rational lines used to enclose, measure, and exploit land in the name of progress.

What is at stake is not only ecological devastation but an epistemic violence: the continued representation of the salt flats as "empty lands" awaiting productive use. The modern history of deserts, then, is inseparable from the history of their representation. Through cartography, photography, and scientific surveying, deserts have been visualized as spaces of absence - blank maps upon which modernity could inscribe its fantasies of control. As T.J. Demos and Macarena Gómez-Barris remind us, "extraction is not only material but also epistemic" [2]. The desert's portrayal as an inert backdrop legitimizes its occupation by those who claim to bring life to it.

In *What the Salt Crystals Knew*, this myth is dismantled through slowness, shimmering textures, and non-linear temporality. The camera lingers on salt surfaces that flicker with light and crystalline growth, revealing the desert not as void but as an active geological and spiritual organism. The film's title suggests this inversion: the salt crystals *know* - they remember the histories of evaporation, of colonial surveying, of the environmental consequences that accumulate silently beneath the crust.

2 Civilization and Barbarism: The Colonial Construction of the Desert

The concept of the "desert" in Argentina is not only geographical but deeply political. In the nineteenth century, it became the central metaphor of the nation's project of modernization. When Domingo Faustino Sarmiento wrote in Facundo: Civilization and Barbarism (1845) that "the evil that plagues the Argentine Republic is its extension: the desert surrounds it on all sides" [3], he articulated a vision of geography as destiny. For Sarmiento and his contemporaries, the desert symbolized disorder, barbarism, and backwardness - everything that stood in the way of the nation's alignment with Europe. To conquer the desert was thus to conquer barbarism itself.

This rhetoric provided the ideological foundation for state campaigns of expansion and extermination. The so-called "Conquest of the Desert", led by General Julio Argentino Roca in the 1870s and 1880s, was in fact a genocidal campaign against Indigenous nations of Patagonia and the Pampas. Under the pretext of civilizing an empty land, the Argentine state dispossessed thousands of Mapuche, Ranquel, and Tehuelche people from their ancestral territories [4]. The "desert", far from being uninhabited, was made empty through military violence. The term's power resided precisely in its fiction: by naming a space as void, one could erase the histories and cosmologies that animated it.

In this sense, the modern desert functions as what anthropologist Gastón Gordillo calls a "negative geography" - a terrain defined by absence but produced through violent presence [5]. Its emptiness is manufactured, its silence enforced. *What the Salt Crystals Knew* engages this history by returning to the scene of erasure. Filmed on land recently acquired by extractive capital, the work renders visible the paradox of a desert that is both overexploited and underrepresented. Through visual and sonic textures, it resists the colonial lens that flattens the landscape into mere scenery.

Moreover, the work connects the nineteenth-century discourse of "civilization and barbarism" with contemporary extractivism. The rhetoric of progress persists, though it has changed costume. Where the state once spoke of "civilizing the frontier", corporations now speak of "sustainable development" and "green energy". Both rely on a common epistemology: that of a world divided between productive centers and expendable peripheries. The Argentine desert, once the site of military conquest, becomes the site of technocratic conquest - what Gómez-Barris terms "the extractive zone" [6].

To read *What the Salt Crystals Knew* through this lineage is to understand that lithium extraction is not simply an environmental issue but a continuation of colonial world-making. The salt flat's alleged emptiness, its "desertness", functions as a cover for the ongoing expropriation of planetary futures. The film counters this by producing what Édouard Glissant calls "opacity": an aesthetic that resists transparency, that refuses to be fully known or commodified [7]. Its poetics of trembling, its slow temporality, its refusal of narrative mastery - all work against the extractive gaze.

3 Poetic Knowledge and the Agency of Matter

"Poetic knowledge", writes Aimé Césaire, "is born in the great silence of scientific knowledge" [8]. In that silence lies the possibility of another way of knowing the world - one that does not reduce it to object or resource but encounters it as relation. *What the Salt Crystals Knew* operates precisely in this interval. Against the distant gaze of science and the instrumental logic of industry, it proposes a sensorial, embodied, and affective mode of attention. To see the desert not as inert matter but as a sentient field requires a shift from observation to participation - from voyeurism to coexistence.

This epistemic shift challenges the long history of Western thought that separated humans from nature, mind from matter, culture from landscape. The Enlightenment's dream of objectivity produced what Bruno Latour called "the view from nowhere": a detached spectator surveying the world as if from behind glass [9]. It is this very posture that enables extraction, for it conceives of the Earth as a passive object awaiting human intervention. The desert, viewed through this optic, is the ultimate screen for projection - empty, silent, compliant.

Poetic knowledge interrupts this regime of seeing. It asks us to listen, to attune, to sense the murmurs of the nonhuman. In the Mascasín salt flats, every grain of salt is a sensor recording centuries of evaporation and deposition. The land itself performs a slow choreography of transformation, a material intelligence far exceeding human scales of time. To acknowledge this is to recognize, as Eduardo Kohn suggests in How Forests Think, that "life thinks" beyond the human [10]. The desert thinks through salt and wind; it dreams in the language of reflection and refraction.

In this light, *What the Salt Crystals Knew* can be understood as a form of "decolonial ecology". It neither romanticizes nature nor aestheticizes ruin; rather, it reclaims the desert as a cosmological interlocutor. By engaging with Indigenous and Andean understandings of land as animate, the work aligns with what Marisol de la Cadena terms "earth-beings" - entities that are simultaneously geological and political [11]. The salt crystal, shimmering under the camera's gaze, becomes an agent of knowledge, a witness to the intertwined histories of colonization and resistance.

The poetic thus becomes political. In refusing the linear time of progress, the film unsettles the epistemologies that underwrite extraction. Its temporality - slow, cyclical, uncertain - echoes the rhythms of the Earth rather than the accelerations of capital. The silence that permeates its images is not emptiness but fullness: the hum of a world that continues to speak despite centuries of silencing. As the West remains obsessed with commodifying and controlling nature, *What the Salt Crystals Knew* reminds us, as Latour noted, that "nature is not this inert, passive object of appropriation - it's a subject with its own agency" [12].

In the end, the desert is not a void to be filled but a mirror held up to modernity's illusions. What the salt crystals know is that progress is not salvation but sediment; that every act of extraction leaves behind a residue of memory. To attend to that residue is to begin the work of repair - to imagine an ecology of relation rather than exploitation, of listening rather than speaking for. Through poetic knowledge, we might learn once again to stand with the desert, not over it.

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Memory, montage, and counter-narratives

A digital media installation

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Abstract

This work presents the multimedia installation *[Des]montagem*, which articulates memory, history, and aesthetics through the appropriation and recontextualisation of archival materials related to repression during the Brazilian civil-military dictatorship (1964–1985). Rooted in concepts of memory and montage, the installation challenges the unequal formation of memory and the influence of dominant narratives in official history, while aiming to validate silenced voices. Drawing from the works of Walter Benjamin and Aby Warburg, *[Des]montagem* utilizes visual, auditory, and interactive components to establish a realm for confronting and contemplating the past and the present. The installation also includes a virtual version that broadens public access, enabling new forms of engagement. The project highlights the potential of digital art to politicise memory and foster critical thinking, showing that we are active agents in the construction of our own history.

CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts;

Keywords

Archive, Interface, Montage, Digital Media Art

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1 INTRODUCTION

1.1 Memory

Memory is constructed unevenly, just as history is shaped by selectively chosen and interpreted information, driven by dominant interests that determine which voices are amplified and which are silenced. Forgetting remains a constant threat to memory. Didi-Huberman emphasises that the easiest fate for an image is destruction. The obstacles to the survival of an image or text are so numerous that their preservation often appears miraculous. Countless books and libraries have been burned. Each time we look at an image, we should ask what prevented it from being destroyed and consigned to oblivion [1]. Within the framework of a hegemonic, linear, Eurocentric, and ostensibly universal art history, we are confined to a culture of repetition and imitation, that continually reproduces dominant aesthetic paradigms, thereby foreclosing the possibility for the emergence or affirmation of singular, counter-hegemonic expressions [2]. The aesthetics of memory have long been subordinated to the State, shaped by its imperatives. Many objects could represent collective memory, but only a limited number are selected to reside in museums. Even when the goal is neutrality, subjectivity inevitably influences the selection process. Through the integration of archival materials, art holds the transformative potential to politicise memory. By recovering testimonies and records concerning the dead and the disappeared, art contributes to a more profound and critical understanding of history.

1.2 Montage

Benjamin suggests that the meaning of ideas is inherently tied to their positions within a given montage, rendering the association between montage and dialectics inescapable [3]. Challenging the notion of historical linearity, he argues that history is not continuous. It is punctuated by deviations, discontinuities, and accidents. He proposes that historians deconstruct and then reconstruct the fragments. It is like taking apart a watch to understand its mechanics or dissecting a corpse to study human anatomy. This only becomes possible when the elements are separated from their usual contexts. Within this structure, montage serves to unite what was previously perceived as separate and to fragment what was previously understood as connected. Montage makes it possible to bring together distinct temporalities, revealing relationships between them and adding new layers of meaning [4]. Didi-Huberman proposes that:

> "Il n'y a donc de «remontée »historique que par «remontage »d'éléments préalablement dissociés de leur place habituelle. Façon de dire qu'on ne construira un savoir historique philosophiquement digne de ce nom qu'à exposer, outre les récits et les flux, outre les singularités événementielles, les hétérochronies (employons ce mot si nous voulons souligner leur effet d'hétérogénéité) ou les anachronies (employons ce mot si nous voulons souligner leur effet d'anamnèse) des éléments qui composent chaque moment de l'histoire."[1] [5]

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[1]"There is therefore no historical "return" except by "remontage" elements previously dissociated from their usual place. A way of saying that we will only construct historical knowledge philosophically worthy of the name by exposing, in addition to

Aby Warburg argued that the discipline of art history should be replaced by a science of culture. He postulated that the power of images could be activated through relational methods, promoting the knowledge generated from associations between them [6]. This approach culminated in the Mnemosyne Atlas, an unfinished project interrupted by his death in 1929. As Didi-Huberman observes, unlike a history book or a novel, an atlas has no beginning, middle or end, but rather panels of images to be consulted for specific purposes or simply visited at random, driven by curiosity. The ideals of unity, purity, and specificity are deconstructed, allowing connections to emerge between elements that might not have appeared related. Reading the world thus becomes the act of reconnecting its elements through their intimate and often hidden relationships, correspondences, and analogies [7].

2 INSTALLATION

[Des]montagem is a multimedia installation composed of a combination of visual and sonic elements that evoke the memory of women's bodies victimised during the Brazilian civil-military dictatorship. The artwork uses archival materials from that dark period in the country's history and contrasts them with more recent ones. It is an interactive piece activated by presence sensors (Figure 1). Upon entering the exhibition space, the viewer is faced with a plinth on which a copy of a document rests, supported by a wooden structure illuminated from below. Below this structure, a presence sensor is installed, and, above the pedestal, a webcam detects human presence. The letter functions as a lure, the element that draws the participant into the spatial field of the installation. It is a facsimile of a handwritten document authored by Inês Etienne Romeu, a militant in two organisations opposing the dictatorship in Brazil. She was abducted and detained for 96 days in what was known as the *House of Death*, a centre dedicated to systematic torture. Released on the condition that she would cooperate with the Army as an informant, she refused to comply. While still in hospitalised and weighing only 32 kilograms, she wrote this letter, describing the humiliation, torture, and violations which she was subjected to. Subsequently sentenced to life imprisonment, she was released in 1979 under the terms of *Amnesty Law*. She handed the letter over to the *Brazilian Bar Association* (OAB) in 1979. The document was selected for the installation precisely because it is a denunciation authored by a woman, a singular voice that speaks for many. Inês Etienne Romeu, who died in 2015, was also responsible for bringing the first court case concerning the rape of a political prisoner in Brazil [8].

As the participant approaches, the sensors activate a sequence of audios and images, including the release of smoke through a perforated tube. The vapour rises vertically, forming a projection screen on which photographs of twelve women, all tortured, murdered or forcibly disappeared during the dictatorship, emerge in random succession (Figure 2).

The photographs were collected from the internet and from the archives of the Memorial da Resistência, which records images and medical records of political prisoners, and from the archives of the DEOPS - Departamento Estadual de Ordem Política e Social de São Paulo[2], which are located in the Arquivo Público do Estado de São Paulo[3] [9]. The women in the portraits are: Gastone Lúcia Carvalho Beltrão; Ana Maria Nacinovic; Inês Etienne Romeu; Criméia Alice Schmidt de Almeida; Iara Iavelberg; Maria Auxiliadora Lara Barcellos, known as Dora; Dilma Roussef; Ana Kucinski; Ísis Dias de Oliveira; Ana Maria Aratangy; Maria Amélia Teles and Maria Augusta Thomaz. The images are randomised, which makes each experience different.



Figure 1: *[Des]montagem* photographed by Rodrigo Menck

The audio consists of voices of military officials and torturers denying their knowledge of or involvement in crimes committed during the dictatorship. These recordings, also randomised, include materials obtained by lawyer Fernando Fernandes, organised by historian Carlos Fico, and published by journalist Miriam Leitão [10]. They contain recordings from sessions of the *Superior Military Court (Superior Tribunal Militar* -STM) during the military regime, in addition to excerpts from interviews. When the visitor leaves, the smoke dissipates, the images disappear, and silence sets in, leaving only the illuminated manuscript. A diagram of the installation system is shown in Figure 3.

The artwork was developed in collaboration with a transdisciplinary team. Rui D'Orey programmed the data logic and sensor triggers that enable the randomisation of images and audio, as well as the activation of devices through sensor input. Rodrigo Menck edited the audio recordings, contributed to the construction of the smoke apparatus, and oversaw the lighting design of the space. Maria Júlia Andrade, a researcher and filmmaker, worked as a research assistant in Brazil and was responsible for guaranteeing the image rights of the victims and their families.

3 VIRTUAL EXHIBITION

A simulation was created to enable virtual exhibitions. In this format, the aforementioned document is available on the screen, and with a click, a video is triggered displaying the smoke screen along with the images and audio from the installation. This virtual representation allows broader access to the work and provides an alternative mode of engagement, complementing physical experience.

narratives and flows, in addition to event-based singularities, the heterochronies (let us use this word if we want to emphasize their heterogeneity effect) or the anachronies (let us use this word if we want to emphasize their anamnesis effect) of the elements that make up each moment of history." [5]

[2]State Department of Political and Social Order of São Paulo, Brazil
[3]Public Archives of the State of São Paulo, Brazil

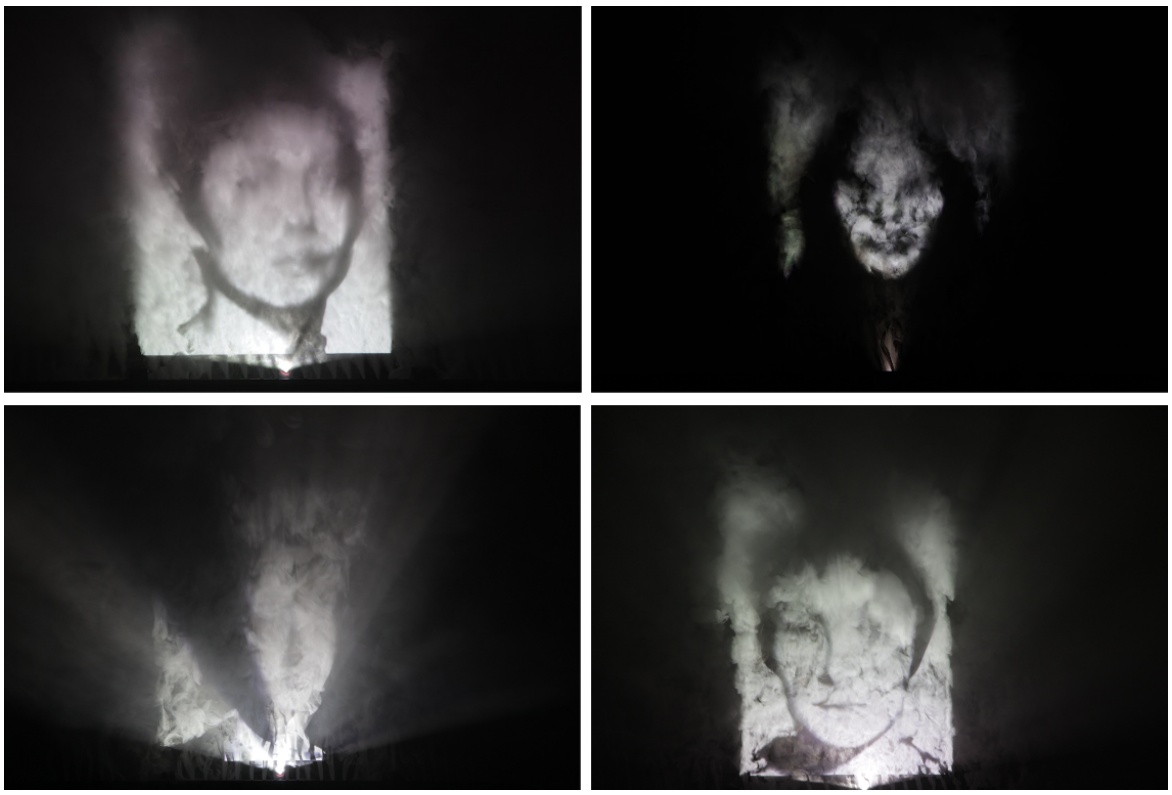


Figure 2: *[Des]montagem,* Cristina Cavalcanti. 2023. Photographed by Rodrigo Menck

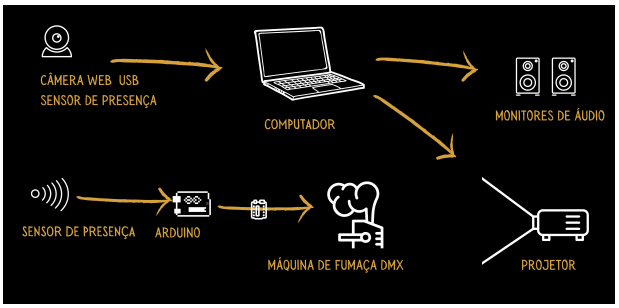


Figure 3: System diagram of the *[Des]montagem* installation. (Author)

4 FINAL CONSIDERATIONS

By bringing together a physical document, image files, and audio recordings within a multimedia installation, *[Des]montagem* seeks to engage with the potential of digital media art to contest official histories and disrupt the hegemony of dominant narratives using archival materials. By appropriating institutional archives, exposing deliberately hidden documents and recontextualising them, it is possible to activate new perceptions and reinterpretations of the past, thus provoking reflection on the present. Investigating how these changes and associations unfold through various digital media and how the public responds to and interacts with such stimuli contributes to integrating technology into the cultivation of critical thinking and to fostering awareness that we are active agents in the construction of our own history.

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Desabafo

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Abstract

The *Desabafo* device was developed to reclaim a sense of privacy that has become obsolete in our interactions with contemporary communication technologies. Similar to the technologies that we have chosen to incorporate into our homes and carry with us, such as smartphones or voice assistants like Alexa, which continuously listen in on us, Desabafo was developed as an alternative gadget, intended to replace these devices of surveillance. Like many contemporary devices, *Desabafo* presents an appealing aesthetic: its "human" ears are ready to listen to the user. Interaction with the device evokes an intimate gesture, offering an individual a protected space where privacy is preserved, allowing one to speak freely or simply vent. The technology integrated into *Desabafo* is based on the construction of a binaural microphone using affordable components. The circuit, handcrafted by the artist, embodies an aesthetic of *gambiarra,* a Brazilian concept referring to creative improvisation and homemade solutions to create and repair technological objects. Based on DIY electronics projects, the artist assembled an experimental microphone circuit applied to an object that reinterprets the design of commercial binaural microphones. Using molds taken from the artist's own ears, silicone-rubber replicas were produced to emulate the texture and elasticity of human flesh. This material enhances the user's sensory intimacy experience, revealing that the microphone originates from an actual human ear. The device combines reused electronic materials, silicone rubber, acrylic, and iron, resulting in a singular artifact that bridges technological function and sculptural form. *Desabafo* functions as a technological assistant for privacy and intimacy, an apparatus where the captured sounds have a clear beginning and end, free from surveillance. In this context, the ephemerality of the recorded sound becomes the very essence and value of the *Desabafo* experience: a fleeting auditory exchange preserved only in the moment of its utterance.

CCS Concepts

• ; • **Applied computing** → Arts and humanities; Media arts; Computer forensics; Surveillance mechanisms; Arts and humanities; Sound and music computing;

Keywords

Surveillance Art, Sound Surveillance, Art and Technology, Espionage

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1 A Privacy Virtual Assistant

We are currently witnessing how a wide range of data-surveillance technologies have become integrated into our everyday lives and increasingly incorporated into our bodies and environments. The symptoms of this familiarization can be observed in our recognition of a variety of acronyms, such as Wi-Fi, IoT, GPS, Bluetooth, and AI, which, perhaps until the late 1990s and the beginning of the 21st century, were not yet part of our everyday vocabulary. We are aware that our smartphones and other gadgets are capable of collecting a vast range of information that could be considered "private" regarding our daily behaviors, such as personal interests, purchasing needs, professional activities, or physical movements. Perhaps because we have at our disposal virtual assistants and communication technologies that make us more connected and help us complete tasks quickly and easily, it becomes more advantageous for us to sacrifice our data privacy. Another reason for our lack of awareness about the impact of such surveillance may lie in our limited understanding of what exactly happens to our data, how it is commercialized by companies, and how it is processed through algorithmic calculations to generate responses to infinite questions or to predict, like an oracle, possible future trends.

Studies discussing data surveillance on the Internet have drawn attention to the fact that those responsible for monitoring and managing our data do not provide clear transparency regarding what exactly happens to our personal web browsing information. As Zygmunt Bauman discusses when metaphorically extending Foucault's concept of panoptic surveillance, the post-panoptic model of surveillance is characterized by uncertainty about how our data are being used and by the possibility that the inspectors of our virtual lives may at any moment retreat into inaccessibility [1]. This lack of transparency is also addressed by Shoshana Zuboff who describes it as a form of "formal indifference", a detachment between the corporations responsible for data surveillance and the surveilled users [2]. In this framework, any personal or social harm triggered by technologies that employ data surveillance is regarded as a mere miscalculation or technical problem, thereby exempting companies from accountability.

These issues do not seem to be perceived as a major concern by users of surveillance technologies, as long as these devices function as expected and provide satisfactory results, such as well-known

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AI tools like ChatGPT or Spotify's personalized music recommendations. However, this sense of complacency shifts into anxiety when we lose control over these technologies or when they begin to behave in unexpected ways. Examples include cases in which vast amounts of online user data are exploited for purposes of power, such as the misuse of Facebook user information to influence political elections, exemplified by the renowned Cambridge Analytica scandal, when a hacker clones our credit card and gains access to our bank account, or when Alexa produces strange laughter or triggers undesirable responses [3]. As Audrey Amsellem argues, such events with Alexa generate an experience of anxiety and an *uncanny encounter* between the individual and this sonic surveillance device [4].

The artwork, Desabafo, was created with this scenario in mind—when we revert to a state of worry about our privacy and personal information in an effort to feel less exposed to surveillance technologies. Aiming to offer an alternative to current forms of sonic surveillance devices, such as Alexa, the Desabafo, a privacy virtual assistant gadget, was created to provide users with an intimate experience between individual and technology, one that is capable of listening but does not allow for monitoring or the sharing of sonic data with others.

2 Creation process

The artwork Desabafo was developed from a study of how binaural microphones have been used to create intimate listening experiences between the listener and the recorded sound source. The concept of intimate listening refers to the study of techniques for recording sounds, particularly those of the human body, as discussed by Denise Garcia who considers intimate listening to be a form of acousmatic listening, in which familiar sounds that refer to the human body, such as the voice, are heard through loudspeakers in the absence of their physical source [5]. Another characteristic of intimate listening is located in the method of sound recording itself, when sounds captured in extreme proximity to the microphones reveal details and sonic nuances that, when later reproduced, create a space of intimacy through listening, one in which the listener feels close to the sound source. I have related this concept of intimate listening to the characteristics of current ASMR (Autonomous Sensory Meridian Response) production, which explores the creation of intimate listening experiences through the use of binaural recording techniques [6].

In order to design a device that provides an intimate interaction between the individual and sound surveillance technology, a binaural microphone was developed that requires the individual to approach the ears in order for the sounds of their voice to be captured by the microphones. The construction of this microphone employed the *gambiarra* method, a practice based in experimentation, improvisation, and material reuse, acknowledged as an aesthetic concept within Brazilian sound art. According to Giuliano Obici artistic production through gambiarra modifies the functionality of an object, employs a logic based on the experience of producing with one's own hands, and is connected to a labyrinthine aesthetic of fragmented objects, especially with regard to the reorganization of technological devices carried out in opposition to the pre-established utilities of those objects [7].

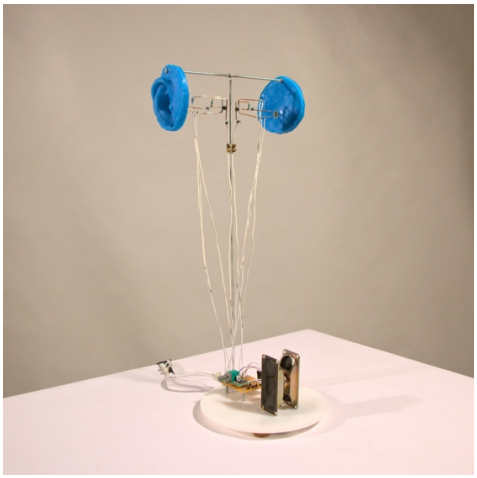


Figure 1: Lorena Ferreira, Desabafo. Photo by Lorena Ferreira. 2025

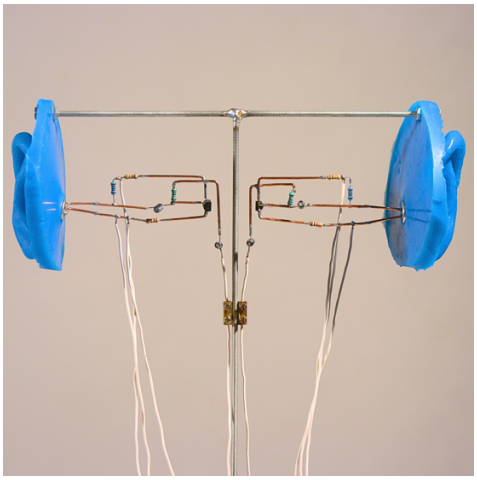


Figure 2: Lorena Ferreira, Desabafo. Photo by Lorena Ferreira. 2025

For the construction of this binaural microphone, silicone rubber molds were made from the artist's own ears. The finish makes the ears feel and look like real ears, and an iron rod connects them at a distance that's approximately the same as the average distance between two human ears on a head. Inside each ear canal, an electret microphone is attached, equipped with a preamplifier circuit handcrafted by the artist. Each ear, left and right, has its own independent microphone circuit, enabling stereo sound capture. The left and right microphone signals are transmitted separately through white wires to a stereo amplifier module, where the sounds captured by the microphones are reproduced in stereo through loudspeakers.

The production method of the Desabafo device results in an artwork characterized by the aesthetics of gambiarra, a Brazilian form of creative improvisation, where the artist's exploration of materials is guided by their accessibility and the circumstances of her own environment. Elements such as welded iron, circuits made

from repurposed copper wires, handmade ears, acrylic, and reused electronic waste were employed to construct a new device. Unlike mass-produced technologies, Desabafo presents itself as a unique and peculiar gadget, embodying a distinct material and conceptual singularity. Once plugged in, the device becomes active, allowing the user to control the loudspeaker volume using a potentiometer on the amplifier module.

Designed so that we can position within our homes, the gadget Desabafo is a device created to guarantee or recover an interaction in which there is privacy, which previously we could find in media and communication reproduction devices and which operate without the monitoring of behavioral data. This device operates how a technology that listens but does not spy. Everything that is said goes in and out through the same device, without any media or surveillance exposure. The ears are prepared to listen to everything that is said in the vicinity of the ears. The sound picked up by the binaural microphones that are attached inside the ears is transported to a loudspeaker, thus ending its cycle, without monitoring, without recordings and without the fear that somewhere, someone could be listening to your conversations or using them to feed algorithms.

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Access to the video documentation of the artwork: https://www.youtube.com/watch?v$=$FUCqo4iTsC0.

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