Module 1

Sustainability & Climate change: historical perspective and their relationship with Arts

Short Learning Program of “Art & Design & sustainability with special focus on environment and climate change. Cooperation partnerships in higher education.

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EINA Centre Universitari de Disseny i Art de Barcelona Adscrit a la UAB
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Lesson 3

Topic 2

Life Cycle Assessment

Essential Questions

What is the concept of Life Cycle Analysis/Assessment?

How can an environmental load of a product, process, or activity be assessed throughout its life cycle?

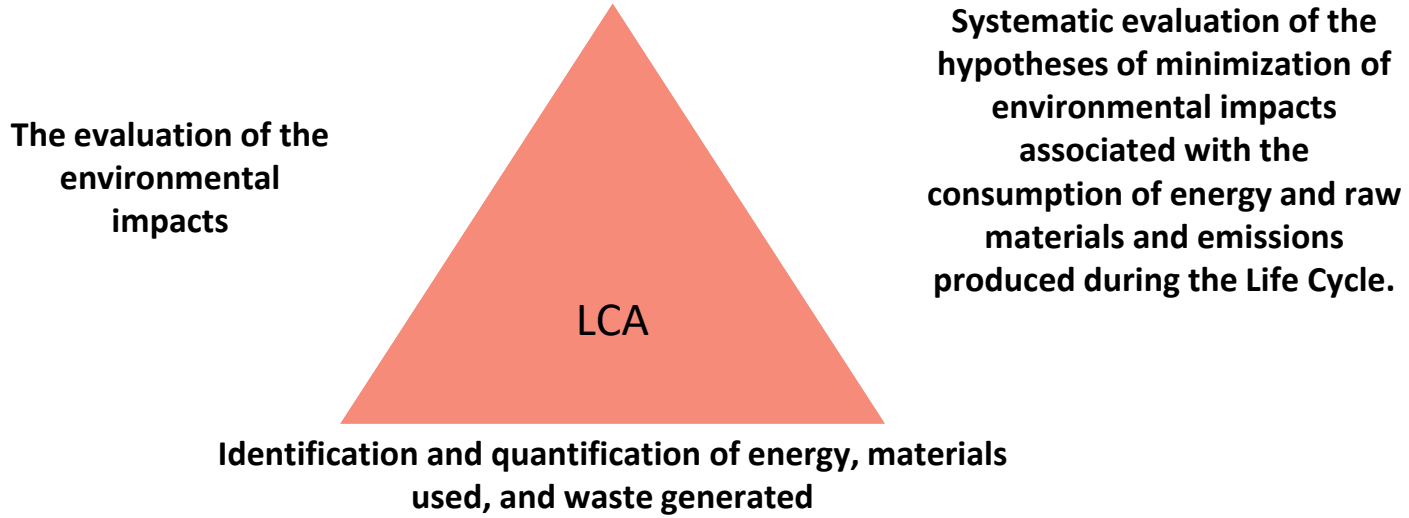
I. Life Cycle Analysis/Assessment

Definitions and Concepts

Life Cycle Analysis/Assessment (LCA):

concept and aim

The Process of integrated assessment of the environmental effects associated with a product, process, or activity.



Source: Cairo, S. 2015. Life Cycle Analysis of Products or Services. Universidade Aberta, https://repositorioaberto.uab.pt/bitstream/10400.2/5415/3/topico2ACVV2015.pdf

Life Cycle Analysis/Assessment (LCA):

Concept and aim

- Life cycle assessment (LCA), sometimes referred to as life cycle analysis, measures the impacts on the environment associated with the life cycle of a product, process, or service.
- Every part of a product's life cycle – extraction of materials from the environment, the production of the product, the use phase and what happens to the product after it is no longer used – can have an impact on the environment in many ways. These parts of a product's life cycle are called life cycle stages. With LCA, you can evaluate the environmental impacts of your product or service from the very first life cycle stage to the very last or to any life cycle stage in between (Golstejin, 2022)

Source: Golsteijn, L. 2022. Life Cycle Assessment (LCA) explained. https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/

The product life cycle stages

Life cycle studies can be performed for various scopes: cradle-to-gate (raw materials until factory gate), gate-to-gate (only focusing on the manufacturing processes), or cradle-to-grave (raw materials until disposal).

Source: Golsteijn, L. 2022. Life Cycle Assessment (LCA) explained. Available at: https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/

LCA - Product evolution

- Gold Energy Conference in 1963 – the calculation of energy needs in production systems begins;
- In 1969, the Midwest Research Institute (MRI) began studies on Resource and Environmental Profile Analysis (REPA), which served as a Model for Life Cycle Analysis (LCA) methods – the first study to The Coca-Cola Company
- Dennis Meadows publishes 1972 – Limits to Growth, the result of studies by the Club of Rome on the evolution of world population and the consequent demand for raw materials and energy.
- Directive 85/339 of the European Commission in 1985 obliges the member states to monitor the consumption of energy and raw materials resulting from the production and final destination of food packaging.
- In recent years, increasing environmental pressures have led to the inclusion of liquid, gaseous, and solid emissions in LCA studies.
- Nowadays, most studies use LCA results for marketing purposes and to support consumers in **choosing more environmentally friendly products.**

Source: Cairo, S. 2015. Life Cycle Analysis of Products or Services. Universidade Aberta, https://repositorioaberto.uab.pt/bitstream/10400.2/5415/3/topico2ACVV2015.pdf

Example – The life of shoes


Image Source: Screenroad. https://unsplash.com/photos/FquDp5N1Gw0

- **Upper part of the shoe**

Saudi Arabia

Enter	Exit
Feed	Untanned Leather
Fertilizers	Waste
Slaughterhouse consumptions	
Materials for containers	
Energy for transportation	

South Korea

Enter	Exit
Leather	Tanned Leather
Chemicals	Hair
	Epidermis and other waste
Energy	Liquid effluent discharged into the Naktong River

Ryan, Durning, 1998 "Stuff: The secret lives of Everyday Thing"

Example – The life of shoes


Image Source: Patrick Hendry. https://unsplash.com/photos/6xeDIZgoPaw

- **Midsole of the shoe**

Saudi Arabia and South Korea

Enter	Exit
Petroleum	Acetate – Vinyl-Ethylene
Chemicals	Gaseous effluents
Pigments	
Anti-oxidants	
Energy	

EUA

Enter	Exit
unknown composition	Amber polyurethane bag with pressurized gas

Example – The life of shoes


Image Source: Patrick Hendry. https://unsplash.com/photos/6xeDIZgoPaw

- **Outer sole**

Saudi Arabia e Taiwan

Enter	Exit
Oil	Folhas de borracha de
Coal-benzene	Butadieno-estireno
Energy (nuclear source)	

Indonesia

Enter	Exit
Leather	Pair of sports shoes
Intermediate Foam-Sole	Toxic fumes
Rubber sheets	Rubber waste
Amber polyurethane bags with pressurized gas	
Glues, paints, toxic and non-toxic solvents	
energy	

Example – The life of shoes

- **Packaging**

Indonesia e EUA

Enter	Exit
Sumatra Rainforest	Vegetal paper
Paper pulp	Recycled cardboard box
Recycled cardboard	
Energy	

It makes you think how a simple American shoe (sneakers in this example) needs raw materials, which come from far away countries and materials with such different characteristics…

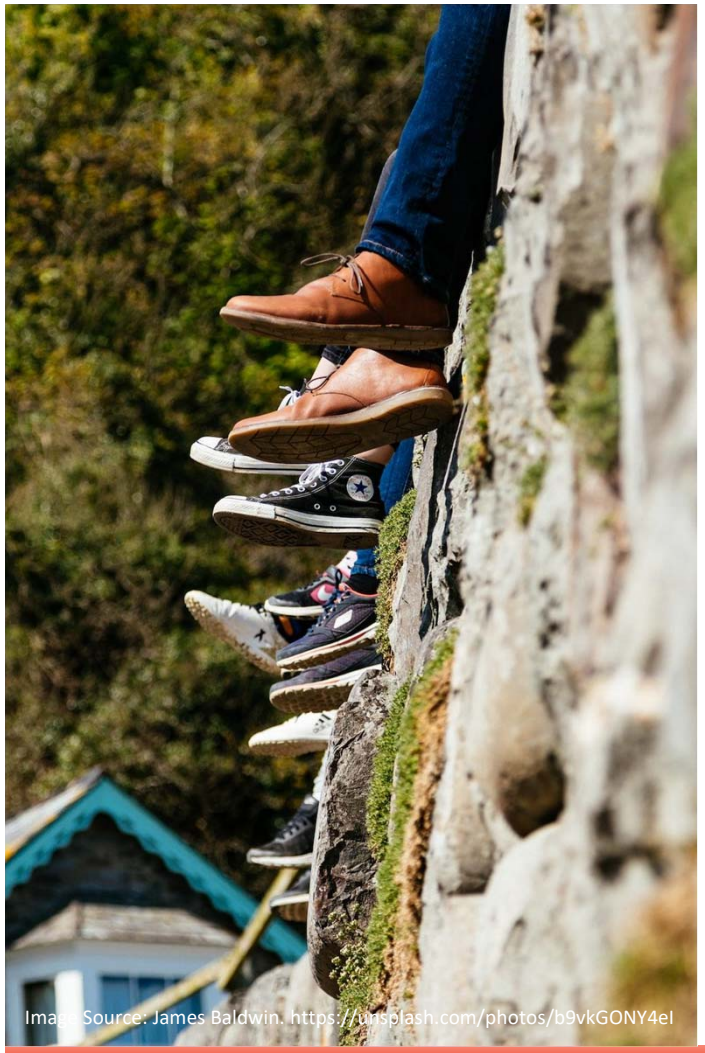


Image Source: James Baldwin. https://unsplash.com/photos/b9vkGONY4eI

Example – The life of shoes

- This example demonstrates how complex the analysis of a product's life cycle is, ranging from the raw materials used in its manufacture to its final destination.

- However, for its correct quantification, it is necessary to know its entire manufacturing process….

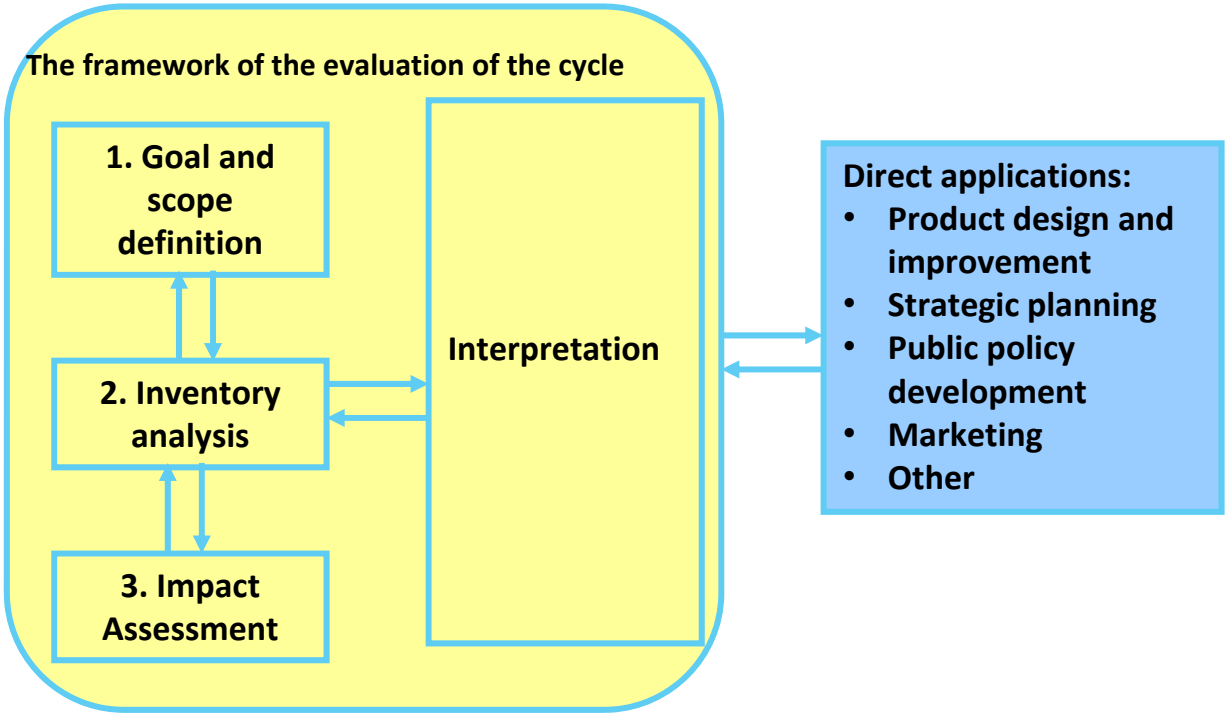
Ryan, J., Durning, A.T. 1998 "Stuff: The secret lives of Everyday Thing"

II. The steps of LCA

Four steps of LCA

LCA is a standardized methodology, which makes it reliable and transparent. The International Organization for Standardization (ISO) provides standards for LCA in ISO 14040 and 14044. These standards describe the four main phases of an LCA:

- Goal and scope definition
- Inventory analysis
- Impact assessment
- Interpretation



Source: Cairo, S. 2015. Life Cycle Analysis of Products or Services. Universidade Aberta, https://repositorioaberto.uab.pt/bitstream/10400.2/5415/3/topico2ACVV2015.pdf

Step 1- Goal and Scope Defenition

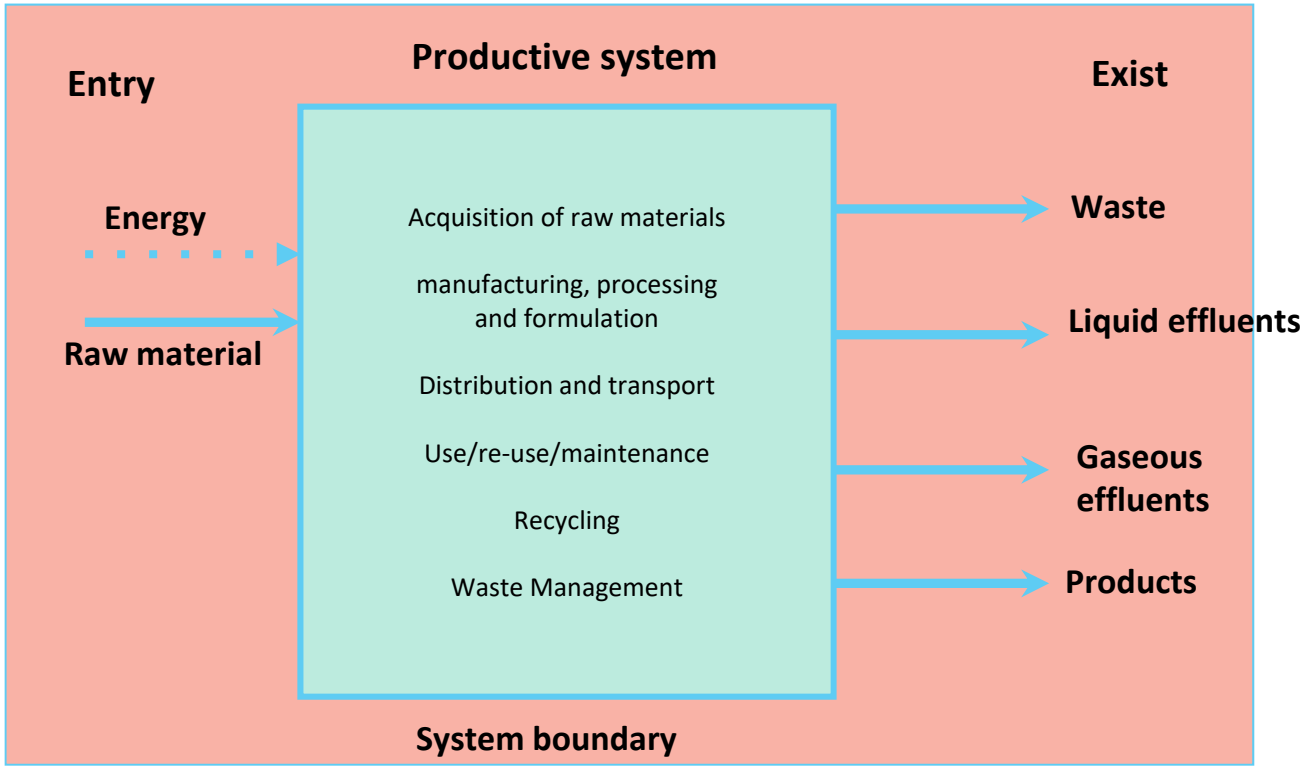
- The goal and scope definition step ensures that your LCA is performed consistently.
- An LCA models a product, service, or system life cycle. A model is a simplification of a complex reality. As with all simplifications, this means that reality will be distorted in some way. The challenge for an LCA practitioner is to make sure the simplification and distortions do not influence the results too much. The best way to do this is to carefully define the goal and scope of the LCA study.
- The goal and scope describe the most important choices, which are often subjective. For instance, the reason for executing the LCA, a precise definition of the product and its life cycle, and a description of the system boundaries.
- The system boundaries describe what is taken into the assessment and what is left out. For instance, small amounts of ingredients that contribute little to the total footprint can be left out of the scope of the study. Thus, the system boundaries exclude this.

Source: Golsteijn, L. 2022. Life Cycle Assessment (LCA) explained. Available at: https://pre-sustainability.com/articles/life-cycle-assessment-lca-basics/

Step 2. Inventory analysis

Inventory - Data collection and calculation to quantify inputs and outputs of the production system

In the inventory analysis, you look at all the **environmental inputs and outputs** associated with a product or service.
An example of an environmental input – something you take out of the environment to put into the product's life cycle – is the use of raw materials and energy. Environmental outputs – which your product's life cycle puts out into the environment – include the emission of pollutants and waste streams for example.
Together, this gives you the complete picture of the life cycle inventory which is all about collecting relevant data and modeling this data via inputs and outputs in a correct manner (Golsteijn, 2022).



Source: Cairo, S. 2015. Life Cycle Analysis of Products or Services. Universidade Aberta, https://repositorioaberto.uab.pt/bitstream/10400.2/5415/3/topico2ACVV2015.pdf

Step 3- Impact assessment

- The impact assessment phase of the LCA is designed to assess the significance of potential environmental impacts using the results of the life cycle inventory analysis. Generally, this process involves associating inventory data with specific environmental impacts and trying to understand these impacts.

- The level of detail, the choice of impacts assessed and the methodologies used depend on the purpose and scope of the study.

- The impact assessment phase may include, among others, the following elements (in accordance with Standard 14040):

  - imputation of inventory data to impact categories (classification);
  - modeling of inventory data within impact categories (characterization);
  - possibility of aggregating the results in very specific cases and only when significant (weighting).

Step 4- Interpretation

- Interpretation is a technique for verifying that an LCA study has met the requirements of the Standard with regard to methodology, data, and reporting.

- It should be defined within the scope of the study whether the interpretation will be carried out and how and who will carry it out. Generally, the interpretation of an LCA is optional.

- LCA studies used to make comparative claims that are released to the public should be critically reviewed.

- Interpretation can facilitate understanding and increase the credibility of LCA studies, namely through stakeholder involvement.

Step 4- Interpretation

- The critical review can be carried out internally or externally.

  - **Internally** it must be performed by an in-house expert independent of the LCA study.

  - Externally it should be performed by an external expert independent of the LCA study.

- These experts should be familiar with the requirements of the Standard and have the necessary scientific and technical knowledge. The review statement is prepared by the person conducting the LCA study and is then reviewed by the independent internal or external expert, or prepared in its entirety by the expert.

LCA and Design

Designers use LCA to gain insight into the environmental impact of their design. Through conducting an LCA, designers can:

- identify the relevant energy inputs (embodied energy) that go into the making, use, and disposal of the product
- identify relevant material inputs that go into the manufacture and use of the product (raw materials, consumable materials used in the use of the product -- coffee filters used in a coffee machine, for example)
- identify release of chemicals and harmful substances released into the environment (CO2 emissions, Greenhouse gases, etc.)
- evaluate the impact of their design on the environment

Source: Design and inquiry. LCA: Life-Cycle-Analysis. Available at: https://sites.google.com/view/designandinquiry/dp-sl-design/topic-2-resource-management-and-sustainable-production/2-6-eco-design/lca-resources

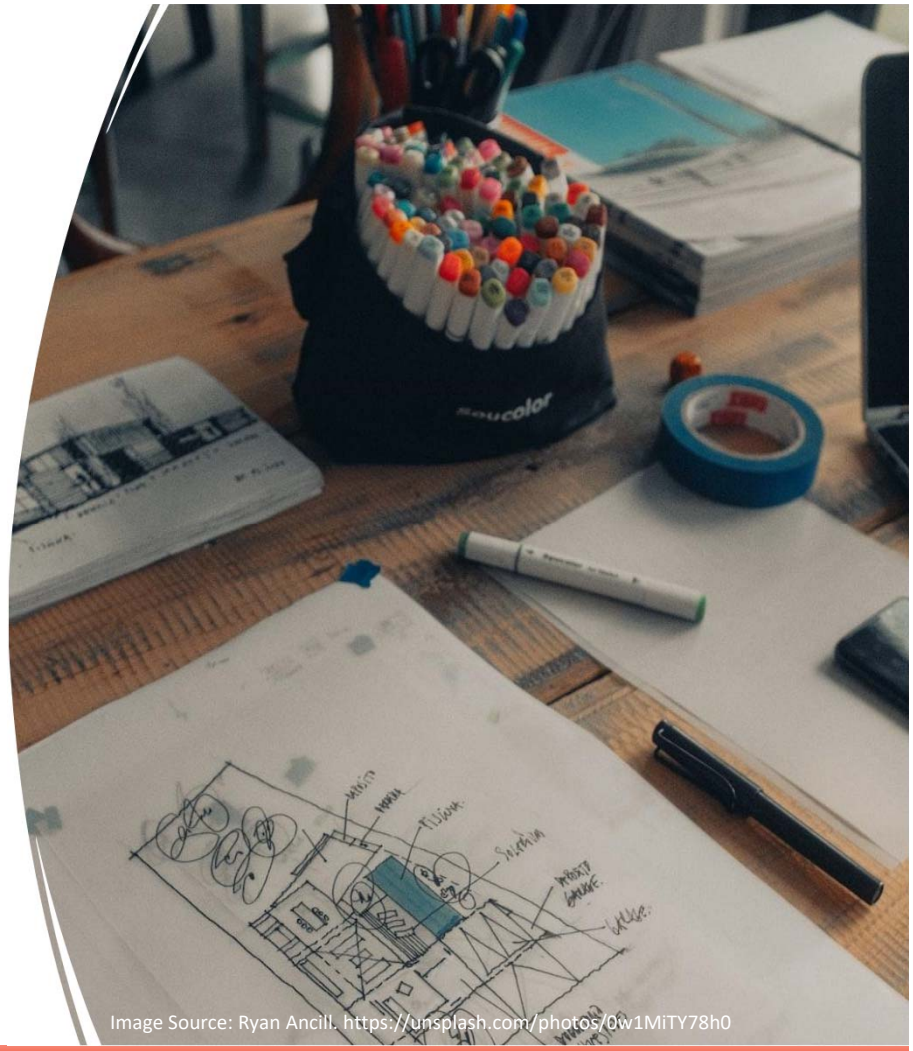


Image Source: Ryan Ancill. https://unsplash.com/photos/0w1MiTY78h0

An example: LCA and Design

- Take, for example, the LCA of a coffee maker. Using the Ecolizer database, the design is assessed as follows:

Production	Packaging	Transport	Usage	Recycling
4 components	2 components	2 transportsteps	2 entries	
870.8	83.84	101.38	7183.2	85.32

- From the analysis, we can see that 86% of the impact comes from the use of the design. Looking more carefully, we see that use has been broken down into two components: The electricity used to heat the coffee pot, and the use of disposable coffee filters:

Component	Material or process	Amount	Indicator	Result
Coffee filter	paper: wood-containing, light weight coated (LWC)	0 kg	268	978.2
Energy	low voltage Belgium	200 watt 0.5 hours/day	34	6205
			Total	7183.2

- This information can then be used by designers to improve the design in an innovative manner. For example, the use of a reusable coffee filter would greatly reduce the impact of disposable ones. In addition, the designer could examine alternative ways to improve the heat efficiency of the design - perhaps including insulative materials in the coffee pot could reduce heat loss and keep the coffee warmer for longer periods.

Source: Design and inquiry. LCA: Life-Cycle-Analysis. Available at: https://sites.google.com/view/designandinquiry/dp-sl-design/topic-2-resource-management-and-sustainable-production/2-6-eco-design/lca-resources

Activity 2 - Summary

Name of Activity	Setting	Aim	Time (h)
A2. LCA and artistic works/ design (Research activity)	Group work (3 or 4 students) Online and Classroom	The aim is a brief research activity on the link between LCA and artistic works or designs.	4

Activity 2 - Instructions

The students should participate in a brief research activity by searching how the LCA tool already has been used for the environmental impact of an artwork or design.

Step 1- Choose your group which should consist of 3 or 4 students.

Step 2- Search on the internet (papers, books, artworks, designs, etc.) and try to find some examples of how the LCA tool already has been used for the environmental impact of an artwork or design.

Step 3- Identify the main features/ highlighted points of using the LCA in your selected artwork/design and present your findings in the class by developing a brief PPT (maximum 10 slides).

Further reading

- UNEP/ SETAC Life Cycle Initiative. (2011). Towards a Life Cycle Sustainability assessment. Making informed choices on products. https://www.unep.org/resources/report/towards-life-cycle-sustainability-assessment-making-informed-choices-products

- Michael Z. Hauschild, Ralph K. Rosenbaum, Stig Irving Olsen (2018). Life Cycle Assessment Theory and Practice. Editors: Hauschild, M.Z., Rosenbaum, R.K., Olsen, S.I. Springer. ISBN 978-3-319-56474-6. https://doi.org/10.1007/978-3-319-56475-3

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- Ryan, J., Durning, A.T. 1998. Stuff: The secret lives of Everyday Thing. ISBN 1886093040, 9781886093041

Module 1 - Lesson 3 - Topic 2

Material Development

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