

Rethinking Curriculum Development through Design Thinking

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Abstract—Higher education institutions must be aware of the transformations that occur in societies in order to innovate and to offer revised educational curricula. Design Thinking is a tool that helps to foster innovation in business contexts. Could this methodology be used in higher education for curriculum development? The present article considers this question by presenting the Design Thinking methodology, establishing links with outcome based education, constructive alignment principles, and discussing the context specific to higher education institutions.

Index Terms—design thinking, curriculum development, outcome based education, constructive alignment, innovation, higher education

I. INTRODUCTION

There are great levels of uncertainty today regarding the way society will be like in ten or twenty years from now. Digitalization, Big Data and Artificial Intelligence are examples of innovations that have tangibly changed contemporary societies, dictating the extinction of certain professions and radically changing full sectors in very short periods of time. Naturally, higher education is not immune to such changes and since early 2000s it is possible to observe a gradual appreciation of STEM educational offers (Science, Technology, Engineering and Mathematics) at the expense of classical education in Humanities. However, due to the overwhelming raise of the computational power, traditional engineering educational programs and their professional correspondents are also being challenged. Among other phenomena, there is the decline of classical engineering educational offers (e.g., mechanical engineering) and the fusion of scientific areas that were originally independent, giving rise, for instance, to programs in biotechnology and in biomedical engineering [1]. This phenomenon, naturally, emerges from the changes in the demand and the expectancies from the market; but it also represents a newer form of conceiving the professional

activities of the future, on behalf of the higher education student candidates; such change in interests is also a sign of students desire to choose educational themes with which they can feel connected and have empathy.

The uncertainty in relation to the future that was referred above as the opening line has shifted the “balance” of higher education offer in the last quarter of the twentieth century and, in the present century, Higher Education Institutions (HEI) are being forced to accept such uncertainty and to try their best guess regarding their capacity to interpret societal changes and to act upon such changes adapting and revising, or else rethinking and innovating their educational curricula. The critical issue is that innovation cannot be mandated neither may it happen overnight; especially in the HEI setting, where resistance to change is particularly severe. Consequently, it is naïve to expect that the change in the educational curricular offer will occur naturally and spontaneously, and indeed, a catalyst for change and innovation within HEI would be most welcome. The present paper posits that the Design Thinking methodology may serve as an engine for innovation in educational curricula. Moreover, it is proposed that the combination of such methodology with outcome based education and principles of constructive alignment constitutes a powerful tool for efficient program planning.

The present article is organized by starting with the description of the Design Thinking methodology and the identification of its different phases¹. After that, the next section addresses the set of factors that are specific to HEI and that have to

¹It is important to highlight that most examples of academic work in higher education regarding the use of Design Thinking methodology are related to the process of course redesign and improving students’ involvement in the teaching-learning process [2], [3]. However, the present paper argues that curricular development must take into account the process of change within HEI as a whole, that is, the organizational change processes that HEI have to undergo in order to adapt to the rapidly changing environment. Consequently, the main argument is that Design Thinking applied to program planning can be used to help HEI organizational change and curricular innovation.

be taken into account when adapting Design Thinking to curricular development. Lastly, links between outcome based education and constructive alignment principles are established with the Design Thinking methodology, opening new venues for more efficient program planning and for the promotion of innovation within HEI.

II. DESIGN THINKING METHODOLOGY

A. Theoretical framework

For engineers, it is natural to associate the tasks involved in design with the exercise of engineering; however, the processes used by engineers are identical to those used in other professions, as graphical- and industrial-designers, architects or project-managers. Among such processes for helping design professionals, it is critical to highlight the importance of the ideation phase—the fashion through which such professionals think and generate potential solutions. The point is that if the ideation process is independent from its implementation at a concrete level (engineering, architecture, etc.), it is forceful to conclude that such ideation has an unifying essence and nature. It was the discovery of such transversal nature of the way of thinking of design professionals that has justified the development, in late 1960s, of what is known today as the Theory of Design, the scientific domain that discusses the way of thinking of designers.

Having its origin at the heart of technical areas, in the 2000s, the Theory of Design has become a mature and independent discipline with its own tools and methods [4]–[6], directed at the analysis and potentiation of ideation processes. The step towards the transposition of these methods in favor of the search of a solution for innovation improvement, within business settings, developed as a natural process of evolution from the design of ideation to the design of innovation, and from a technical to a managerial setting. Among those responsible for that which has become known as Design Thinking is Roger Martin, from the Rotman School of Management, a pioneer in the development and concrete application of such methodology in order to help promote innovation within business contexts [7]–[11].

Today, Design Thinking is a general jargon, almost a cliché, which is applicable to any area in order to describe a methodology that potentiates innovation. It is possible to establish relationships between Design Thinking and specific methodologies of science of education and social sciences areas, namely, Kolb's [12] model of experiential learning, or, the analysis of organizational behavior, in the form of Argyris et al. [13], or, of Lewin's organizational change model [14], just to mention a few examples.

B. Stages

The different stages of the Design Thinking methodology may differ in terms of the terminology used by different authors [2], [15]. However, for the purpose of organizational change, three essential stages are considered:

- Immersion in the “market” in order to find the common understanding basis that a designer and the clients may

identify as a *shared belief*, enabling the discernment of the direction and orientation from where the market is coming from and towards which it wants to move²;

- Framing / reframing in face of the problem until a solution is reached, at a potential level (“good enough for now and safe enough to try”, as is voiced by the Transition Movement);
- Testing in order to verify the effectiveness of the solution. If it fails, it is important to detect it as soon as possible (rapid prototyping).

Fig. 1, adapted from Gharajedaghi [16], represents graphically the stages of Design Thinking until a solution is reached.

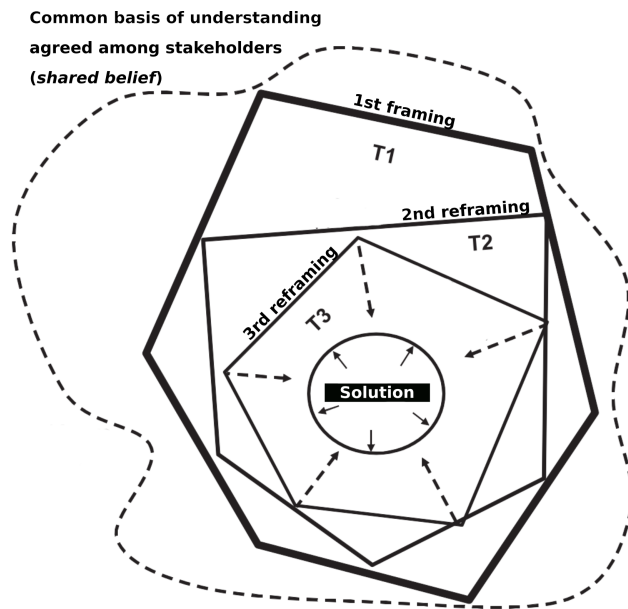


Fig. 1. Diagrammatic representation of the successive steps of the methodology of Design Thinking. It starts with the acquisition (through immersion) of the common basis of understanding—forcefully wide-band and all embracing—and then “funneling” it through successive levels of framing and reframing (T1, T2, T3), until the designer (as the stakeholders’ voice) reaches the desired solution [16].

The external dotted line in Fig. 1 represents the solution’s domain, agreed upon between the designer and the stakeholders or clients, established from the set of identifiable shared beliefs; undoubtedly, this is a crucial step in the Design Thinking process. The bold lines (T1, T2 and T3), represent the successive efforts to tackle the problem, through the process of framing / reframing, until a sub-domain is reached where the final solution may be found. The testing of such solution is not explicitly represented; however, it may be implicit throughout the successive framing / reframing phases that have had the aim of purging the false positives.

²Market is the space where exchanges happen, that is, where goods and services exchange hands; clients are those towards which such goods and services are directed. At the concrete level of the higher education program planning, clients are the stakeholders, taken as a whole; students, industry (as future potential employers), civil society, teachers, administrators (together with the whole academic community).

This Design Thinking methodology is indeed appealing; especially the fact that an ideal uniting the stakeholders is being searched and, as such, it is a guarantee of involving everyone in the discussion and identification of a set of shared beliefs. Also the process of framing / reframing that is followed by the testing and rapid checking of the solution's validity emerges as a naturally needed step, in particular in complex and multidimensional problems, which involve a large number of clients or stakeholders. It is worth emphasizing that the Design Thinking methodology is contrary to prescribed solutions and, because failure and the need to reframe are natural, it constitutes an opportunity for unaffected collaboration between stakeholders.

However, taking into account the fact that the Design Thinking methodology has been developed for business settings and for corporations interested in boosting their innovation capacity, may such methodology be considered adequate to the HEI setting? This is the question that will be answered in the following section.

III. DESIGN THINKING IN HEI

It is paradoxical that HEI have as their mission the promotion of independent thought, innovation and entrepreneurship, whilst such entities are, from an organizational perspective, extremely conservative institutions [17]. The organizational culture of HEI is indeed unique, being the result of the specificities and idiosyncrasies of research and teaching activities, which have traditionally benefited from wide levels of autonomy. Such autonomy is extensive to the departments and it is common to see stressful relationships and tense conflicts with (among others) the management bodies, as the departments are entrenched in the defense of their own interests.

In an entrenched environment, hostile to changes, small steps—small changes and substitutions—can be achieved through a process of continual improvement, as has been established in the approach of Quality Management Systems [18]. However, faster and more radical changes require explicit leadership and touch sensitive issues, therefore begging the handling with extra care. Social science researchers, as Argyris et al. [13], have for long verified that the imposition of changes in apparently balanced organizations with a top-down approach (from top management), which raise problems of coercion and threats, invariably result in dysfunctional group dynamics, which, in turn, rapidly slide into power games, falseness and simulation in compliance with the norms. To avoid these situations Argyris et al. remind us that change must start from the organization interior and not as an external imposition, from the outside. These authors refer to the importance of starting with questioning the present balance and the current objectives; and then to communicate new objectives and unite the different stakeholders around such objectives. Only then, they argue, the organization is ready to accept change.

Translating these teachings into the HEI context and taking into account the teachers and departments autonomy, it

is important that all stakeholders may contribute and work together in order to achieve a common basis of understanding and an unifying ideal. This has to be the first step in order to prepare an organization for change and for the creation of the conditions for innovation to happen.

As was explained in the section above, the methodology of Design Thinking has precisely as point of departure the search for a unifying ideal; that is, a basis over which it is possible to raise the solution's domain and the processes of framing and reframing or testing. It is possible to argue, therefore, that although such methodology has been applied (and tested) in business contexts, the methodology of Design Thinking is adequate also to HEI settings. Such use is justified by the need to innovate, keeping up with the transformations in society, and, more importantly, directly addressing the rigid and entrenched nature of the relationships that occur in such organizations and the need to dismount such deadlocks³.

However, the dangers related to the dismounting of an organization's blockages are not negligible, being fair the alert to the incommensurability risk; that is, there is a very unfavorable ratio between the efforts of implementing a Design Thinking methodology versus its potential outcomes. Indeed, the stages of the Design Thinking touch sensitive issues related to the structures that are already installed and, consequently, they potentially create conflicts, which are the result of the exchange in opinions among experts from the different areas, who meet in order to find an open field of common understanding; this implies that such efforts might not always reach a safe harbor. As it is natural to avoid conflict [17], the success is not guaranteed. Examples of unsuccessful implementations have been reported, in particular in cases when it is tried to extrapolate the positive results of small group changes to large organizational settings [19], [20]. However, as Geoghegan e Pangaro [20] refer, it is precisely in order to promote the need for cross pollination that may be the crucial point in implementing Design Thinking as a solution for innovation; and, moreover, as an opportunity to rehabilitate the interest in organizational change on behalf of institutions that have been traumatized by the failures of misaligned and misled previous change processes.

Regardless of the difficulties in the transformation processes of HEI being an overwhelming challenge [17], the paradigm change towards student-centered learning—particularly, outcome based education and constructive alignment principles—constitutes a powerful support and ally. As discussed in the following section, such change in educational paradigm enables an articulation that is explicit and objective between individual course outcomes and the broad aims of the curriculum program, allowing a common basis of understanding that is critical for the launching of a process of change.

³In the terminology of Lewin [14], to unfreeze an organization before making it move.

IV. OUTCOME BASED EDUCATION AND CONSTRUCTIVE ALIGNMENT PRINCIPLES DURING PROGRAM PLANNING

In the classical version of the teaching-learning process the teacher establishes the programmatic contents of her or his course, uses such contents in order to evaluate the corresponding knowledge acquisition by her or his students and it is assumed that, in a process of synthesis, the student is able to reach an adequate level of new skills. However, under this traditional approach, there is no explicit specification, neither evaluation, of the skills as such. It is the responsibility of the student to undergo the referred above synthesis when such need arises. This paradigm is referred to as teacher-centered model of education [21], and it is an example of the conventional autonomy that is commonly understood as being dear to higher education settings; in this concrete case it is the autonomy of the student to proceed with the skills' synthesis. A drawback of such paradigm is the lack of evidences related to the offerings of skills by the educational program, creating, consequently, problems of accountability.

Through the change in favor of a student-centered educational paradigm such lack of accountability is solved; curriculum programs establish learning objectives and these, in turn, determine a list of skills/ outcomes to be delivered by program courses, that students need to acquire. This need to declare expected skills and to present evidence of students' attaining the declared skills defines *outcome based education* [22]. The effort needed to align learning objectives, course contents and skills evaluation defines *constructive alignment* [23]. Outcome based education and constructive alignment can be used to implement association between program skills and specific course skills, which, in turn, relate to course programmatic contents. Obvious advantages of such a process are [21] the identification of overlaps in courses skills and contents, facilitating the process of program planning, and improved involvement of the group of stakeholders in the phase of discussing curriculum changes. Fig. 2 exemplifies the way program learning objectives/ outcomes, courses learning objectives/ outcomes and course contents align to deliver a balanced and effective program plan.

Despite the fact that the change of paradigm towards a student-centered educational model—towards outcome based education and constructive alignment—is consigned in European Union's higher education objectives since the year 2000, the reality is that this transition has been slow to take place. Resistance is related to the conservative culture, which has been already referred above, of the HEI setting, but it is also related to the subtle nature of the fundamental educational concepts, which, in practice, are presented in a jargon that may be not very familiar to teachers.

To exemplify such difficulties, there is a list of definitions that are presented in Felder and Brent's communication (in the Appendix A of [24]), which enable the contrasting between educational objectives and educational outcomes, both at the level of the individual courses and at the program level. Such

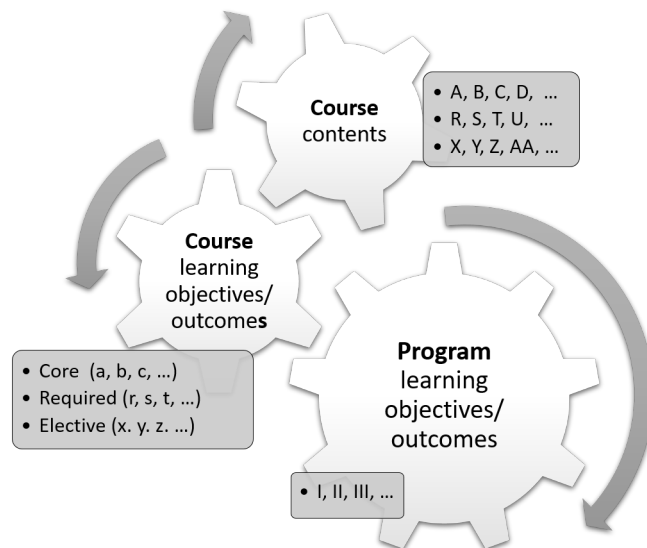


Fig. 2. Achieving course content, course learning objectives/ outcomes and program learning objectives/ outcomes alignment.

definitions are used as criteria of ABET [25], a certification entity that evaluates the implementation of the student-centered learning approach.

- Program Educational Objectives: comprehensive declarations that define the way that the program curricula aims at fulfilling its educational mission and reach the needs of its group of stakeholders.
- Program Outcomes: more specific declarations related to the knowledge, skills and attitudes that the graduates will achieve as evidence of having reached the fulfillment of the educational objectives.
- Course Outcomes: at the course level, the knowledge, skills and attitudes that the student acquires upon completion of the course.
- Course Learning Objectives: at the course level, declarations of actions, on behalf of the students, that may serve as evidence of the acquisition of knowledge, skills and attitudes.

From the analysis of these definitions it is clear that (i) the focus is (not only in knowledge contents but equally) in the skills and attitudes, (ii) the linking of the learning outcomes at the course and at the program level. Felder and Brent [24] introduce a distinction between core and elective courses, with the former covering some or the totality of the program's outcomes and the latter responsible for the modulation of the course in relation to the student's individual options and choices. In this paper we further distinguish between program core and required courses, with the latter covering transversal knowledge acquisition (e.g., mathematics, physics or chemistry).

This section highlighted the importance of outcome based education and constructive alignment principles during program planning. But how can the Design Thinking methodology

be articulated with these principles uniting all stakeholders around a shared belief and leading to effective and innovative program plans?

V. RETHINKING PROGRAM PLANNING THROUGH DESIGN THINKING

In order to answer the question that has closed the last section it is relevant to consider Fig. 3.

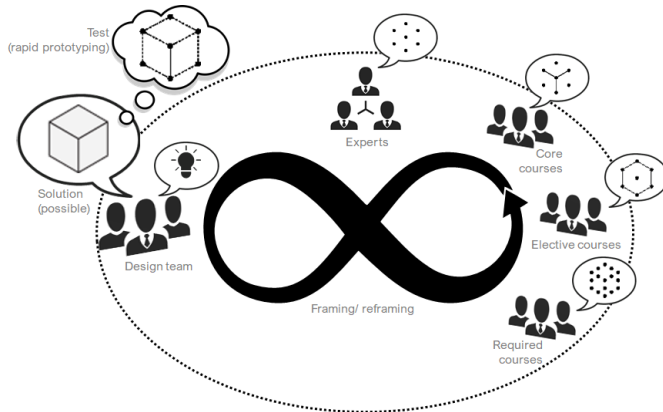


Fig. 3. Diagram that supports the explanation of the articulation between the methodology of Design Thinking, outcome based education and constructive alignment, when addressing the process of program planning. It represents the design team, the stakeholders, the unifying ideal and the processes of framing/reframing and testing [26].

Fig. 3 represents a design team and the different stakeholders that are involved in the process of program planning; namely, experts (representing the perspectives of employers, alumni, students, civil society, school administrators⁴), and teachers that represent courses that are core, required or elective. The methodology of Design Thinking assumes an immersion in the market, represented by the dotted line linking the design team, experts and teachers. The high relevance of the contributions from the experts is that from the “market immersion” it is possible to identify the direction towards which the curricular development should follow, represented by the ideogram $\{ \cdot \cdot \cdot \}$. It is important that this direction is accepted by the different parts involved in the process, and this search for consensus is represented in the different courses—and between the different teachers of such courses—by the ideograms $\{ \cdot \cdot \cdot \}$, $\{ \cdot \cdot \cdot \}$, $\{ \cdot \cdot \cdot \}$, which, though they are not identical, they nevertheless have some elements in common. These elements in common, therefore, represent the basis of a shared understanding or a unifying ideal. Such common elements can be equally interpreted as the essential outcomes of the curricular program, which are translated as knowledge, skills and attitudes, according to the definition mentioned above by Felder and Brent [24].

The next step consists in finding a way to reach the delineated outcomes. The definitions presented by Felder and Brent

⁴Each group expert in its own experience of the educational program; and, expert in understanding the value of the program, courses and course contents for those it represents.

point towards the distinction between groups of courses, so that for the core courses there has to be a direct correspondence between such core course’s outcomes and the outcomes of the program taken as a whole, regarding the knowledge, skills and attitudes that are promoted. In Fig. 3, such alignment is represented by the ideogram $\{ \cdot \cdot \cdot \}$, which, symbolically, unites the central point and three other points. However, the core courses are supported by the required courses (e.g., mathematics, physics and chemistry)—ideogram $\{ \cdot \cdot \cdot \}$ —, and it is justifiable the existence of the elective courses—ideogram $\{ \cdot \cdot \cdot \}$ —which, regardless of the fact of not contributing to the core outcomes of the program, are a relevant complement as they modulate the educational offer.

The integration of the knowledge, skills and attitudes from the various courses of the program does not lead to a unique solution. It is the responsibility of the design team, in an iterative process of framing and reframing—ideogram $\{ \infty \}$ —, to find the desired solution, which integrates the contributions from the different parts of the process. Such solution is represented in Fig. 3 by the ideogram $\{ \text{cube} \}$, a cube. In Fig. 3 it is also represented the “draft” version of a cube, $\{ \text{dashed cube} \}$, which identifies the testing phase; this means that intercalary and intermediate results from the successive iterations are needed before reaching the final cube.

The interpretation of Fig. 3 shows how to implement the methodology of Design Thinking considering all stakeholders, from the initial program planning stage of agreeing upon a shared belief to the finding of a solution, where the elements in Fig. 2—learning objectives/ outcomes and contents—are aligned to deliver a balanced program plan. Taking into account what has already been said about the importance of uniting the stakeholders around a common ideal and regarding the validation achieved through the framing/ reframing and testing phases, it is believed that articulating Design Thinking, outcomes based education and constructive alignment principles enables efficient program planning easing innovation in HEI.

VI. CONCLUSION

The accumulated past experience, by the authors, in several processes of curriculum evaluation and curriculum restructuring point towards overall disappointing results and frankly low efficiency. It has been such direct experience that has triggered renovated efforts to rethink the whole curriculum design process. Although the currently proposed Design Thinking methodology has not been directly tested in a real case, with the present communication the association of Design Thinking, outcome based education and principles of constructive alignment enabled the production of an intellectual artifact useful for the development of innovative program plans in higher education. As a form of validation of such integrated approach, the reality of HEI has been considered as being adequately addressed by the proposed artifact when taking into account its essential elements and the need achieve HEI organizational change for curricular innovation.

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