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Content

Design Provocations

Teaching design to management students. Challenges and risks toward a new integrative pedagogy.

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Abstract

The impact that design is having on managerial culture and practice is progressively influencing the pedagogy and the learning path related to engineering courses. After the era of the "Project-Based Learning" paradigm (PBL) the attention of teachers and scholars is nowadays shifting on Strategic Design and Design Thinking pedagogy. How the basic principles of Design Thinking can be transferred in those educational contexts where an increasing interdependence between design and management is occurring? What are the main learning takes away that management engineering students are more able to absorb and what the difficulties to face in a strategic design studio? What "design tools" mainly enhance creative leaps in a project? To address that questions an exploratory inquiry on 54 students involved in a Strategic Design course placed in a Management Engineering Master Degree has been run. Results derived through the use of descriptive statistics show that management engineering students from a Strategic Design studio mainly grasp – as major takes away - the framing/reframing logics, the visual thinking abilities and the knowledge to explore user experience and context. Moreover framing/reframing the design problem represents even the most difficult capability to learn jointly with the visual representation of business idea and the impulse to propose new solutions. Finally – according to the results - students consider developmental tools as customer journey, service blueprint and offering map – placed in the middle-final part of the creative process - more oriented to create creative leaps and to search for alternative solutions.

Author keywords

PBL; Design teaching; Design Thinking; Strategic design studio

Introduction

In the field of engineering education different changes and landslides occurred.

After stressing analytical capabilities to tackle with complex problems according to deterministic and sophisticated analysis project management and design related logics have been introduced. The more the innovation pervades engineering and management studies the more analytical skills – oriented to create deepened *status-quo* pictures – risk to be a limited asset. Engineering project and project management need holistic thinking, proposition capabilities, abilities to come outside the project field in order to grasp possible stimuli and insights.

A vast literature saw in Project-Based Learning (PBL) a first source to enrich engineering culture (Blumenfeld et al., 1991; Thomas, 2000; Stepien and Gallagher, 1993). Be trained in a project environment means to set goals, to decide the path, to accept risk and serendipity, to embrace complexity and ambiguity, to play with non-school like situations that can be prototyped and tested in real setting. This literature – mainly placed in 80ies and 90ies – was specifically oriented to the "hard engineering" domains – as mechanics, chemistry, ICT – in order to improve the proposition capabilities and the project management abilities.

Nowadays the success of new engineering fields – not typically linked to the "hard sciences" – as management engineering and the emergence of new paradigms of teaching derived by the design culture – as Design Thinking for instance - are posing new challenges and questions about new forms of pedagogies in design (Glen et al., 2015).

Specifically teaching design in management engineering or wider managerial contexts, cannot replicate the same assumptions and logics of PBL for different reasons and emerging factors.

First, management and design both share a typical attention to the final user. Through marketing from one side, through the Human-Centred approach by the other, they both share a common point of view in identifying the final receiver of the solution to a specific problem (Veryzer and Borja de Mozota, 2005).

Moreover, management studies are abandoning the old managerial patterns and certainties (…) in favour of a less paradigmatic view that deals with ambiguous problems, with the stating of hypothesis about what user consider or not value, with principles such as learning from failure, or testing assumptions and business hypothesis through "minimum viable products" (Ries, 2011).

This field that comes under the hat of entrepreneurship – if related to the creation of new ventures – or under the hat of intrapreneurship – if linked to the creation of spin-off and new business in incumbent companies - is approaching managerial culture to design domain.

Finally Design Thinking is a new paradigm that embeds new principles and practice to drive innovation in product-service, but even in organizational behaviours and people mindset (Cross, 2011; Elsbach and Stigliani, 2018).

So, which kind of design pedagogy principles can serve the learning of management engineering students? What are the main learning points and difficulties that management engineering students face in experiencing a strategic design course? Which design skills they consider as complementary to the ones they already handle? And finally, which tools they consider as more fertile to provide creative insights?

To address that questions – in order to lay the foundations of a new design pedagogy specifically oriented to management students – an exploratory on field research has been run. Foundational questions about the learning take away, the main difficulties faced, the complementary skills and the logics to employ design tools have been submitted to 54 students in a Strategic Design studio placed within the Management Engineering Master Degree at Politecnico di Milano.

Descriptive statistics have been used to generate results and discuss insights.

Findings show what are the main learning points, the difficulties faced and the tools that enabled creative leaps in the project.

The article is divided into five main parts. Following, the theoretical background expresses how the consolidated PBL paradigm needs a refresh in light of the emerging factors that relate with the strict occurring integration between design and managerial culture. The methodology follows, expressing how the research design has been conceived. Later, results analysis shows the areas of inquiry and the main derived data. A discussion follows where the traits of the foundation of new pedagogy for design for management are depicted. Conclusion at the end shows the main remarks for future avenues in research about design teaching and the article limits.

Theoretical background

Literature about Project Based Learning (PBL) has been consolidated clarifying the teaching strategy and the main learning logics. Specifically, PBL is considered a comprehensive approach to classroom teaching and learning that is conceived to engage students in investigation of authentic and novel problems (Blumenfeld et al., 1991; Barron et al., 1998). In PBL, the project is the central teaching strategy where students encounter and learn the central concepts of the discipline via the project (Thomas, 2000). The definition of the project (for students) must "be crafted in order to make a connection between activities and the underlying conceptual knowledge that one might hope to foster" (Blumenfeld et al., 1991). This is usually done with a "driving question" or an ill-defined problem (Stepien and Gallagher, 1993). Projects indeed involve students in a constructive investigation process, where this is considered as a goal directed process that involves inquiry, knowledge building, and resolution. Investigations include design, decision-making, problem-finding, problem-solving, discovery, or model-building processes. But, in order to be considered as a PBL activity, the central activities of the project must involve the transformation and construction of knowledge. The main literature considers projects as student-driven to some significant degree, where students challenge concepts as autonomy, choice, unsupervised work time, and responsibility. In order to improve the knowledge acquisition, literature states that projects have to be realistic, not school-like, embodying characteristics that give them a

feeling of authenticity. On the other hand, literature highlighted other learning impacting factors that include the topic, the given tasks, the roles that students play, the context within which they work, the collaborators who work with students on the project, the products that are produced, the audience for the project's products, or the criteria by which the products or performances are judged. Finally factors that affect motivation have been widely investigated: the interest and value students attribute to the problem and elements in projects; tasks should be varied and include novel elements, the problem has to be authentic and challenging, moreover projects need a closure sense, so that concepts should be materialized in form of artifacts (Malone & Lepper, 2005). Looking at the academic journal nature – as *Journal of Engineering Education, Higher Education Research and Development, Australasian Journal of Engineering* – that dedicated much emphasis to PBL and to the key reported messages, PBL literature seems to mainly address engineering students and the engineering schools educational needs mainly related to the "hard engineering sciences" such as civil, mechanical, chemistry, ICT. After years of engineering teaching mainly centered on developing analytical skills and problem solving mostly related to clear cut domains, some scholars pinpointed a relative failure of such capabilities in facing ambiguous problems, or in exiting from Euclidean rationale in approaching holistic problems (Dym, Clive L., et al., 2005).

Specifically, the main rationale of the introduction of PBL in hard engineering courses consisted in instilling proposition and design capabilities in students whose habits in learning related with analytical problem, given clear constraints, orientation to reach unique solution even for wide scale problems.

Nevertheless, while the main academic contributions about PBL dated 80ies and 90ies, recently design teaching is attracting scholars and expert attention, partially integrating, strengthening or replacing PBL pedagogies (Dym, Clive L., et al., 2005). Specifically, Design Thinking – in academic research debate as in teaching – is becoming a paradigmatic approach oriented to purse innovation combining creative abilities with intuitive ones, deepening the empathy with the user, enabling discussion and consensus through visual thinking, replacing deduction and inductive reasoning with abduction, leveraging specifically "how might be" questions and "what-if" (Martin, 2009; Brown, 2008; Liedtka, 2011; Liedtka and Ogilvie, 2011).

After the fertile experience at Stanford – with the D.School – where students enrolled in all the degrees and Masters can be engaged in single or bundled courses to increase their "designerly way of knowing" (Cross, 2001; 2006), different highly ranked Management Schools (as INSEAD, MIP-Politecnico di Milano, Antwerp, Saint Gallen, Harvard Business School) are integrating in MBAs programs design related entire streams, labs or single courses. In a recent theoretical work, Glen et al. (2015) - investigating Design Thinking teaching in business schools - reflect the more general movement in education away from an over-dependence on passive teaching approaches, towards more active problem-based learning. These authors reinforce the benefits of Design Thinking teaching for management students pinpointing how it fosters the ability to work through the innovation process, the ability to work with multidimensional contexts and solutions associated with active engagement in real-world situations, the learning through using specific tools, the development of interpersonal skills relating to team working. If the integration of design related contents through design teaching techniques and pedagogies is assumed to

enrich and strengthen the cultural background and the soft skills of management students, there continue to be a poor understanding about the main "take away" and the difficulties students face, joint to the benefits and the limits that the "tools based learning" embedded in DT pedagogy, presents.

Therefore, given a lack of evidence in last contributions about design teaching in non-design educational contexts, the article aims to fill that gap running a quantitative on-field analysis.

Methodology

This paper is based on the results of a survey conducted on students enrolled in Management Engineering Master Degree at Politecnico di Milano, specifically related to "Design management, entrepreneurship and innovation" stream. In particular, the empirical study was conducted during the 15 ECTS credits course "Design Management Lab" that represents the final studio. The course' challenge consists to develop an innovative project, with a brief provided by a company, using both managerial and design theories and tools oriented to create novel solution of product-service. The brief in this course is provided by NTT Data that asked students to find novel applications through design about a new sensoring technology.

The Design Management Lab taken in this study is a journey aimed at developing capabilities and skills to handle design-driven innovation, to manage design-related tradeoffs, to mold scenarios of innovation and configure new product-service systems and business models, focusing in particular on three main learning outcomes:

- trends and scenario board: where students are evaluated for their capability to identify technology, social and cultural changing factors that affect the framing, the completion and the reframing of the strategic brief;

- user analysis board: where students are evaluated for the depth of articulating user needs/characteristics/attitudes and the capability to represent and visualize "personas" according to concise and appealing frames;

- new business ideas development: where students are assessed on their capability to identify promising business lines and embedding that ideas in compelling storytelling.

The learning outcomes are reached through lectures on themes from both Managerial and Design fields, presentations and explanations of the most important design tools needed to address the course and a project conducted in teams, where students have to properly manage the previous presented contents.

A questionnaire characterized by 4 main areas of inquiry has been submitted at the end of the entire course to 54 students composed by 32 males and 22 females.

Given the aim of the study the investigated areas were:

- primary learning take-away of the students;
- complementary skills to management engineering background of the students;
- the level of difficulties associated to the different phases of the project development;
- the contribution of the design tools adopted in generating creative leaps and overcoming creativity blocks.

Each question was provided with multiple fixed choices, ranging from 3 to 10 possible answers depending on the investigated area.

All the answers were collected in a .xls file in order to create descriptive statistics graph for each area of inquiry (Hays, 1973).

All the results were collected through histograms and were discussed by a team of two researchers and two Professors. After a first-hand discussion the research team invited two external researchers in order to freeze insights and provide further comments to the statistics results.

Results analysis

The analysis has been developed submitting a multiple choices questionnaire to the descripted sample of students. The approach used for posing and than scaling the responses is the *likert scale* approach; the scale is articulated in a range from 1 to 5 as parameters of evaluation, where the lowest represents the poor presence of the investigated aspect and the highest stands for the high presence of it. For each area of inquiry analysed through one dedicated question, only the results of those answers/graphs which present a valuable variance from most significant values (4-5) and lowest ones are commented. The full script of the questionnaire is attached in Annex to this paper.

Regarding the first area of inquiry, that relates with the main "learning takeaway" the 63% (34) of students highly evaluate the aspect of *deepening what user experiences in real context* (figure 1). Therefore, the 64% (35) of students assess positively the process of *reframing the problem by searching for an alternative view.* Moreover, one of the crucial take away consists in *visual representing and communicating new ideas* highly evaluated from the 76% (41) of students (figure 1).

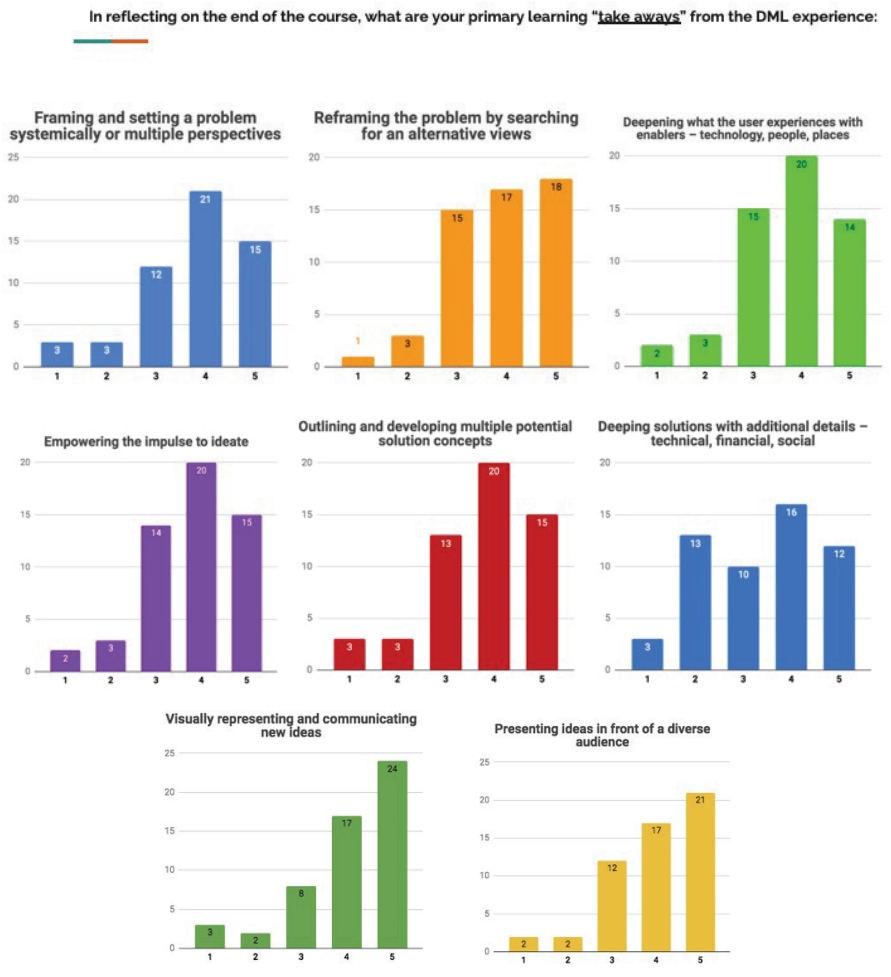

Figure 1. Primary learning takeaway during the course.

Concerning the second area of inquiry, that relates with the "skills considered as complementary to the management engineering background" as happened in the first area of inquiry, the 76% (41) of the sample highly evaluates the process of *reframing the problem by searching for an alternative view.* It means they consider one of the main pillars of Design Thinking (Dorst, 2011) as one of the complementary add on their management background. The 72% (39) of the sample of students, instead, highly assess the skill of *visually representing and communicating new ideas* (figure 2). In addition, one of the crucial skills seem to consist in *empowering the impulse to ideate* highly evaluated as crucial by the 72% (39) of the sample of students (figure 2).

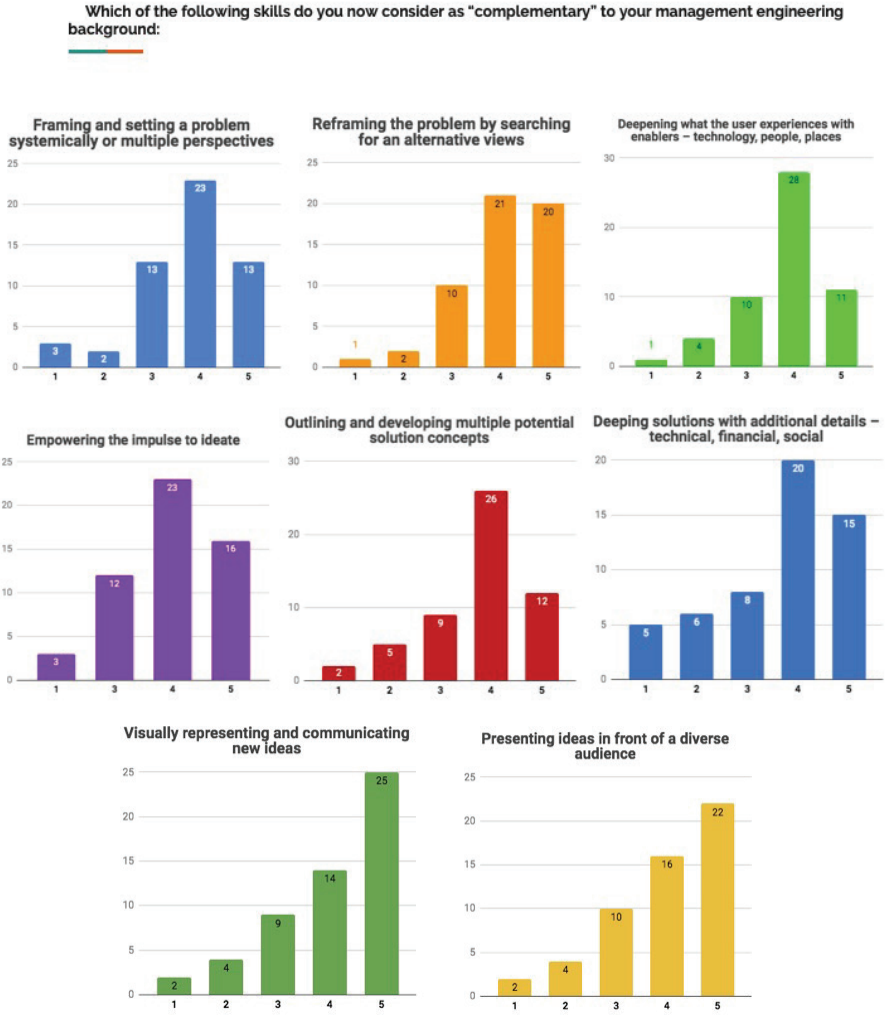

Figure 2. Complementary skills to management engineering background

About the third area of inquiry that analyses the "grade of difficulties associated to the single phase of the project development", 74% (40) of students perceived as very critical the *framing and reframing* phase; only the 33% (18) of the sample evaluate as critical *the scenario and use case development phase.* The *strategic design* is perceived as critical from the 53% (29) of students (figure 3).

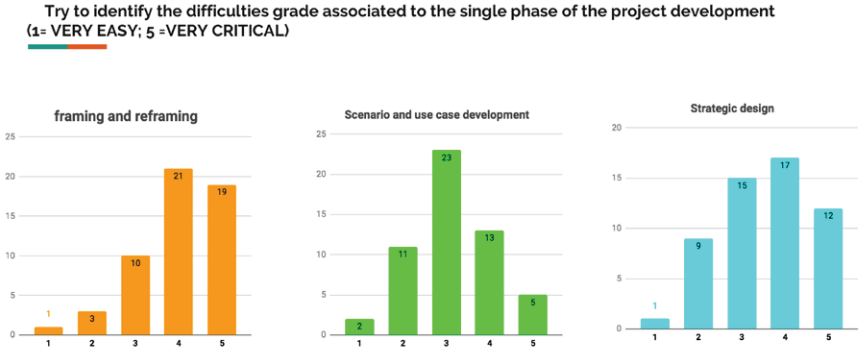

Figure 3. Grade of difficulties of the different phases of course and design process

Regarding the fourth and last area of inquiry, that relates with "how much each of the adopted design tools contributed to generating creative leaps and overcoming creativity blocks" a high percentage of students highly evaluate those design tools adopted for developing the solutions: *scenario building* (67% -36), *customer journey* (70% -38), *offering map* (80% -43), and *service blueprint* (63% -34).

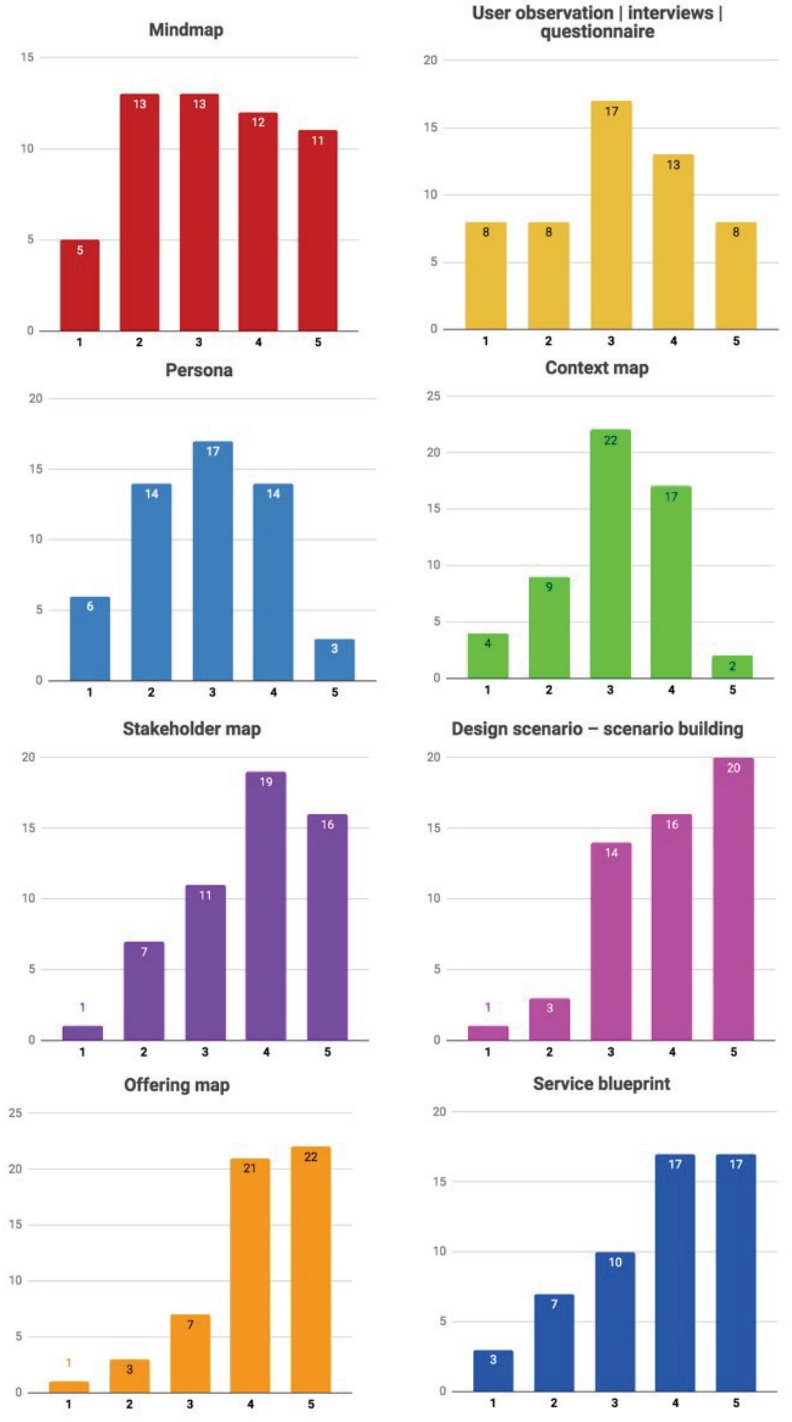

Figure 4. Grade that the adopted design tools contributed to generating creative leaps and overcoming creativity blocks

Discussion

The results analysis tends to partially confirm established acquisitions that the main design teaching literature stated; on the other hand, new insights about teaching design in non-design students can be derived.

First, the inquiry about the main "learning takes away" tends to pinpoint what non-design students –specifically management engineering students – tend to appreciate by design culture and Design Thinking.

The highest acquisition is about visual representation. This acquisition seems to be in line with all the literature from the outside of design domain that sees in design a way of visual thinking that enables strategic reflexions and the searching for a common view (Gorb, 1990; Osterwalder and Pigneur, 2010).

Moreover, the other highly appreciated learning point that leverages "reframing the problem by searching for alternative view" tend to suggest that management engineering students – used to face management problems with data analytics and deepening – saw in design culture a way to treat design problem area with other lens. More than going in depth, design is confirmed to be appreciated for the principles to tackle the problem from other angles, to add alternative perspectives, to play with metaphors in order to loosen the strong constraints of the problem and suggest possible weak links that could be promising (Dorst, 2011).

The other learning area – relating to the user experience – reveals instead a specific aspect related to design teaching that enriches some specific knowledge that management engineering student usually handle. Specifically marketing teaching is used to transfer some constructs and models about user analysis. Actually, design adds to a systematic view of the user gained through marketing management peculiar aspects related to the user that deal with the user behaviour, with the use contexts and with some soft aspects that relate with the user lifestyles. Even here some graphic user representations embedded in mood board expressing the user lifestyle, the objects that surrounds her life, the storytelling through "personas", intended as a visual portrait that holds the personal life and the personal belongings in a canvas – provide the soft side of the user analytics that marketing for a long time neglected (Carson, 2001).

The second inquiry area deals with the skills that students considered as complementary to their "native" background centred on managerial sciences. Here if reframing abilities and the visual representation are confirmed to be additive and complementary to their previous knowledge ground, a focal attention stems from *"the impulse to ideate"* that they highlight as a complementary. This finding shows how management engineering domain – without design courses – risks to create future managers with strong capabilities to create meaningful analytical frames but characterized by poor proposition capabilities. In other words, management engineering students are able to create a full picture – made by data and insights - of an innovation or strategic problem – the problem space area (Dorst and Cross, 2011) - but they seem to be stuck when they should propose exit avenues by the problem-space depicting some promising solutions – the solution space area (Dorst and Cross, 2001) to say.

In this sense visual representation and visual thinking act as a crucial support in the process of decision making: the capability of visualize data and knolwdge in different phases of the project has been adopted by management engineering students to depict solutions in form of visual synthesis derived by the complex process of analysis. Thus, visual thinking stands as a link between the problem space area and the solution space one (Dorst and Cross, 2011).

Here, going beyond the finding itself, it seems that the integration of design in management background acts as a sort of cure for the "paralysis by analysis" paradox that usually managers experience in facing problems that provide the creation of novel goods or processes (Langley, 1995).

By the third area of inquiry – instead – it results that the framing and reframing phase have been "suffered" as the most critical phase. This finding does not seem to be counterintuitive. As anticipated management engineering background tends to split a problem in sub-areas and to accommodate a possible solution for each problematic sub-area. This is quite opposite to what happen in design thinking and culture where the problem is seen in its ambiguity, working on the border, emphasising the holistic soul of it. Moreover, reframing an innovation problem means even in certain moments to provide weak interpretation or suggesting with the alternative perspective of the problem itself possible avenues to solution. As recommended in literature there are overlapping areas and moments between the problem-space and the solution-space (Dorst and Cross, 2011). On the other hand, there's something to say about managerial culture that is going completely in the direction of Design Thinking. The advent and the raising attention in the entrepreneurship are contributing to approaching progressively managerial culture to design thinking. As in Design Thinking, as matter of fact, even entrepreneurship follows some abductive reasoning, develops propositions in terms of "what-if", tends to reframe the problems fixing some assumptions and advancing operative hypothesis to test, until leveraging on the building of Minimum Viable Products that mimic the prototyping rules very common in design domain (Ries, 2011). This enrichment of the managerial culture made by the entrepreneurship domain– in other words – tends to approach further management to design. After all, a common ground that pertains the relationship between Design Thinking and lean entrepreneurship is growing faster (Nielsen and Stovang, 2015).

Lastly the findings related to the contribution of design tools to creative leaps tend to suggest some novel insights respect to the consolidated literature.

Design Thinking is taught through the employment of tools of different nature: tools to instil creativity, representation tools, development tools, (Stickdorn et al. 2010). It's quite surprising that according to the findings shown above the tools acknowledged as more effective for generating creative leaps have been tools placed in the late developmental phase and not in the framing/reframing phase, at the beginning of the entire creative process.

Some hints can be advanced. First, iterative logics of Design Thinking imposes to search creative leaps not just at the beginning, but since the beginning to the end and vice versa, in a recursive loop. It means that they fully absorbed the

iteration logics to arrive at the end of the process to question and reconsider the first assumptions.

Moreover - even accepting the fact that the major concentration of design tools lies in the solutioning part of the DT process and not in the "problem context" arena – design teaching could reconsider the use of tools loosening some taxonomies and some phase allocation that tend to inhibit the real potentialities. In other words, the same design tools can be employed according to different ends. Leaving apart the scenario building map where the aim to represent future course of action is almost fixed, tools as a customer journey or a service blueprint can be leveraged to represent "as is" situation searching for insights or to represent a "to be" situation. The conducted study strengthens the point that design tools can be versatile and that its use can be suggested by the contingencies and by the on-going evaluation. After a first round where a not satisfactory creative result has been reached, making iteration does not means to repeat everything again – one more time – but contrarily to change the way tools are used and insights generated.

This is coupled even with an additional aspect: when a new experience or a new product-service is represented in detail insights about new changes - that can be incremental or even radical - emerge. Developmental tools – pinpointing detailed aspects – can generate doubts, questions and cues useful even for restarting a reframing phase. Moreover, the results suggest that fundamentally the creative leaps can be generated seeing at the user experience and/or to the structure of the offering (in form of bundle structure or process).

Conclusion

The article tries to increase the understanding of design teaching in educational environment far – until few years ago – respect to the design culture.

Design teaching is changing overall for different reasons. The old paradigm of PBL is being enriched by different factors that affects both engineering and design education. The raising attention for Design Thinking by engineering and managerial sides is creating novel conditions and pedagogies in design. Design is not anymore, a sort of foreign body respect to the field of engineering and management. Far to be recognized as a limited territory where to learn product semiotics and aesthetics, design is nowadays being acknowledged as a pillar in the theory of innovation able to influence managerial and engineering decision making, the organization culture and behaviour, the people mind-set (Elsbach and Stigliani, 2018; Cross, 2011; Kelley and Kelley, 2013). With the diffusion of design courses and streams in Business Schools and Management studies, design itself seems to change its own original skin. The integration between technological issues – driven by the digital transformation – with the boosting of entrepreneurial issues in management agenda imposes new forms and new lens to teach design in non-design contexts, with an integrative pedagogy model.

The classical scope of design related to objects shifted to service, organizational process, business model (Osterwalder and Pigneur, 2010). The more design enters the classical managerial scopes, the more design is influenced by

constructs and principles related to organizational frame. On the other hand, management teaching is absorbing many logics from design teaching changing the classical pedagogical pillar. The introduction of Lab and Workshop, the inclusion of prototyping and testing logics, the adoption of problem reframing exercise represents the text of an integrated territory where it will be quite difficult – in the short run – distinguishing design from management pedagogy.

Given this increasing integration, next steps in research should explore not the integration happened between two domains, but a new integrative pedagogy and teaching ground made by novel derived principles and practices.

The learning points, the difficulties that management engineering students face to learn design thinking and the complementary skills leveraged to learn design thinking shown in the present article open new insights to explore a hybrid territory that is owned neither by design neither by management.

Lastly, the article is not immune by limits. Some highlighted results can be biased by the kind of design challenge, by the structure of the course, by the tutor mind-sets and teaching abilities. Additional question in future researches could mitigate those biases naturally connected to on field researches in teaching scope.

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ANNEX – Full questionnaire – Questions and answers

Teaching strategic design to management engineering students

This questionnaire aims to better understand how the DML course improved your knowledge and increased your skills through the learning project HITOE. Feel free to answer to the questions below with the maximum sincerity and fairness. Answers are reported with multiple choices.
The data we are collecting will be probably used only for scientific purposes, such as writing academic reports or articles on journals. Thank you in advance for your participation.

1) **In reflecting on the end of the course, what are your primary learning "take aways" from the DML experience:**
Evaluate from 1 to 5 (1= very low; 5 =very high) each of the indicator related to your didactic experience.

- framing and setting a problem systemically or multiple perspectives
- reframing the problem by searching for an alternative views
- deepening what the user experiences with enablers – technology, people, places, ….
- empowering the impulse to ideate
- outlining and developing multiple potential solution concepts
- deeping solutions with additional details – technical, financial, social,
- visually representing and communicating new ideas
- presenting ideas in front of a diverse audience

2) **Which of the following skills do you now consider as "complementary" to your management engineering background:**
Evaluate from 1 to 5 (1= very low; 5 =very high) each of the indicator related to your didactic experience.

- framing and setting a problem systemically or multiple perspectives
- reframing the problem by searching for an alternative views
- deepening what the user experiences with enablers – technology, people, places,
- empowering the impulse to ideate
- outlining and developing multiple potential solution concepts
- deeping solutions with additional details – technical, financial, social,
- visually representing and communicating new ideas

- presenting ideas in front of a diverse audience

3) Try to identify the difficulties grade associated to the single phase of the project development
Evaluate from 1 to 5 (1= VERY EASY; 5 =VERY CRITICAL) each of the indicator related to your didactic experience.

- framing and reframing
- scenario and use case development
- strategic design

4) Please identify how much each of the following design tools contributed to generating creative leaps and overcoming creativity blocks.
Evaluate from 1 to 5 (1= almost useless; 5 =useful and effective) each of the indicator related to your didactic experience.

- Mindmap
- User observation | interviews |questionnaire
- Persona
- Context map
- Stakeholder map
- Design scenario – scenario building
- Offering map
- Service blueprint