



Design for Innovation and Education



POLITECNICO
MILANO 1863

Design Methods and Processes

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Abstract

This paper contains considerations on the skills and knowledge required to carry out design for innovation. The main concepts comprised by designing for innovation are presented in a brief introduction¹². The focus is then shifted towards two university programs that allowed me to develop skills for design and an analysis on the skills I still need to develop is brought on. Moreover, the learning approach adopted at Politecnico di Milano is discussed. Finally, a new design for the Master's program is presented through three main proposals.

Designing for Innovation

Progress is what man has always been striving for. Technological advances are key to human beings living a more accessible and comfortable life. Many great men have come up with genius inventions, however not all have succeeded in making value out of them. Innovation is a process that responds to the needs of the market, possibly driven by a technological advance. Delivering innovation relies on several steps that comprise research, product development and testing, ultimately leading to the creation of value, especially for society. These steps make up design for innovation.

Designing starts from the presentation of a situation and of problems related to it. Planning is crucial to better understand available team resources and skills and to determine all project activities that need to be carried out. Joining resources and activities through a responsibility assignment matrix is useful to define each team member's focus. An in-depth analysis is to be performed to identify stakeholders, their needs and consequent requirements. After this thorough study, a brief – a clear statement on the task to be undertaken – may be formulated. Starting from the requirements, brainstorming possible solutions for each one and analyzing the compatibility with the others makes up the creative solution-centered design phase. Once ideas are laid out, performance metrics are chosen so as to evaluate the ideas and choose the best ones. Finally, best solutions are tested to validate their effectiveness and one is adopted.

Design tools support the design process all the way through and knowing how to use the appropriate ones can increase both the efficiency of the design process and the quality of the final solution. Being able to use these tools and to carry out the design process requires skills and knowledge which cannot be taught in a standard fashion: one must embrace them through experience.

IDEA League Challenge Program

Throughout the IDEA League Challenge Program, I was exposed for the first time to challenges related to entrepreneurship, innovation and social responsibility, together with a group of students from top European universities.

¹Gaetano Cascini, *Design Methods and Processes Tutorials*, ASP Spring School 2019.

²Pascal Le Masson, *Innovating today - why design theory matters*, ASP Spring School 2019.

During the first meeting the group of us were faced with the challenge of dealing with conflicting stakeholders in a railway renovation project. We were introduced to the problem by a professor from TU Delft expert in the field of conflict management and by an engineer working for the Dutch government. Their explanations and insights on the problem allowed us to understand how to identify the stakeholders of the project and how to analyze their needs. Moreover, many considerations were made about the strategies one can adopt when dealing with a situation where several actors have different and perhaps conflicting needs. The outcome consisted in a solution that would have had almost all the stakeholders to agree.

A few months later, we shifted our attention to social responsibility and had to find a way to integrate Syrian refugees in the local community. We were introduced to design thinking and we learned to express and keep track of our ideas through the intensive use of post-its and of graphical representations. Furthermore, we had the opportunity to interview refugees asking them first about their needs and then for opinions on our prototype solutions. Being able to come up with a few different solutions and receiving feedback on them is one of the ways suggested to select the best solution and give birth to a minimum viable product for further testing and eventual launch on the market.

During the third meeting we understood the meaning of the value of a solution. We were assigned to different fields where Artificial Intelligence will sooner or later make a disruptive change. We discussed about the possible changes that AI will bring and focused our attention on the impacts on man's life from an ethical perspective. We learned about the double diamond model of design thinking which we used to explore several possibilities. To evaluate a solution, we thought about the long-term effect it could have on users, or more generally on society, measuring qualitatively and quantitatively the value that it would create. Adequately assessing value is one of the fundamental skills required to design a solution.

In conclusion, this university program allowed me to learn about the basics of designing, from studying the setting and the actors of the main problem one is tackling, to methods that can be used to design, validate and present a solution. Thanks to this program I was able to grasp the concept of exploring problems and solutions, which is the basis of the double diamond model, and I now always apply the learned methods in other projects.

Erasmus Program

In 2017 I was given the fantastic opportunity to experience learning in a different context by spending a semester abroad at UCL University College London through the Erasmus program. Being able to carry out my studies and work on new challenging projects in London allowed me to discover and experiment a diverse approach to computer science, which profoundly shaped some aspects of myself as an engineer.

One of the most important skills when it comes to designing a solution is being able to proactively listen to others' ideas so as to build on top of them. Once an idea is laid out, all team members should give their contribution making it the best it can get. This approach was particularly stressed in London: when in the design phase of a computer science project we would write our ideas down and let others jot notes about them collectively or in a round-robin fashion.

Furthermore, London is well known for being multicultural and nowadays teams are usually multiethnic, especially in large companies and in research. Being able to understand others' behavior, possibly driven by culture, can really make a difference in establishing synergy among the group. Empathy, or emotional intelligence more generally, is the most important skill when it comes to team working and building a solution together. Finally, being able to put yourself not only in your team members' shoes, but also in those of whom you are designing a solution for, is key to delivering something of great value truly responding to the needs of your customer.

Further Practicing to Improve Skills and Develop New Ones

As an engineer, I have learned a problem-based approach, which consists in a thorough study of available data and assumptions, in conducting extensive research and in having profound theoretical knowledge about the problem-related topic, and finally in using known techniques and algorithms to find an appropriate solution. Surely, this allows for a good exploitation of known working methods, however it is probably not enough for delivering innovation. There are some desirable skills for designing that unfortunately I lack, but that I can develop.

For instance, I was never really able to express my creativity to its fullest. When it comes to brainstorming solutions, I have always felt like held back by the idea of possibly saying something wrong or that could be not shared by my team members. On the other hand, I have become aware of how useful it is to lay out every possible idea and consideration even if it is not going to be adopted as part of the delivered solution.

Another design related skill that I have not well developed yet is a strong observation ability. Being open to solutions one never explored and being able to understand if and which filters one is applying when observing is key to designing innovative solutions.

Politecnico di Milano and the Italian Teaching Approach

According to university rankings³, Politecnico di Milano is the best university in Italy for engineering. The teaching-learning approach adopted at my university is quite traditional. All levels of education in Italy tend to put theory first and let students learn the practice on their own - on the job. The underlying philosophy is that if one knows the fundamental theoretical principles on which practice is based, then learning

³for instance, QS World University Rankings.

practice makes a lot more sense, becoming easier and faster, allowing students to be more performant as they are sure of what they are doing. This ultimately leads to often producing sound solutions appropriately supported by theoretical evidence.

I believe the Italian approach does not provide us with all the basic skills needed to design for innovation, to work as a team and to present ideas. It provides us with a strong methodical approach to researching, learning and understanding a topic, which is certainly fundamental when it comes to design for innovation, however it is not enough. More stress should be put on learning by observing, learning by doing and learning by working together with others.

Fortunately, some professors have started introducing *innovative education* to make lectures more dynamic and let students participate more actively. For instance, in a class we were given some challenges to work on without knowing how to solve them. This allowed us to test ourselves in new situations without being afraid of receiving a negative mark. This kind of approach contributes to the development of the skills necessary to face unfamiliar situations being aware of the knowledge one holds, fully expressing creativity with the goal of finding a solution without knowing how. On the other hand, instead, such little practice limited to a closed and relatively comfortable environment, such as the classroom, leads to insecurity as no feedback is given on real-world practical activities. Consequently, one may feel particularly uncomfortable when in an unfamiliar situation, fearing judgment and ending up not feeling qualified enough.

In conclusion, design has always been a topic of study in engineering, however the way it is taught to students should be expanded. In many courses we are required to design a solution to a problem considering assumptions and constraints, however the space of taught and accepted solutions is so limited that one ends up losing all their creativity. Our traditional theoretical-based approach is what distinguishes us, and fortunately this is widely recognized, however perhaps shifting away from traditional methods and exploring more practical-based ones would provide us with the necessary skills that we are lacking.

A Modern Approach

The main problem of Politecnico di Milano is that creativity is being muted, giving students the possibility to express themselves in unfamiliar and new situations only when developing their own dissertation at the end of the last year. Students do not have time to experiment on their own, to find problems and to build their own solutions. They are so overwhelmed by the theoretical background that Politecnico wants to provide them with, that in order to finish their degree in time they cannot dedicate to other tasks. This also leads to many students not having the time to exercise, to go out with friends and to pursue their hobbies, in the worst cases leading to psychological breakdowns and physical repercussions.

The following is a three points proposal for a more innovative Politecnico where

students can develop necessary skills to design for innovation and have more time to acquire these.

1. Distinction of three paths The current Master's degree does not clearly offer students different study plans based on what they would like to do next. Distinguishing three paths can help students focus on and acquire the skills required in the field they will work in after their degree. Students will have to choose one when enrolling. The three paths proposed are: Job, Classic and Research. The first would only last one year and would include the most important courses of the current 2-years Master's. This path would suit all students that are willing to or need to work as soon as possible but want to obtain a Master's degree. Classic would be similar to the current Master's degree, but with slightly less technical courses and more innovation-based ones. This would suit all students who have not yet decided what to do after the end of their studies and want to acquire a more solid knowledge. Finally Research would be made up by the current courses and by new courses to teach how to carry out research in their field, how to study the state of the art and other necessary skills. Students of this path would have more time to experiment on their own and to understand what they want to focus their future research on. All three would have a dissertation, with some differences: Job would have a real-world project to be developed in collaboration with a company, possibly the one that will hire the student once graduated; Classic would have the current style dissertation; Research would have the students publish a research paper as part of their thesis.

2. Introduction of mandatory courses on design thinking and innovation We shall never forget that we are not technicians but engineers. What we learn in ASP and in similar programs can be taught to all students through courses during the year. This would allow all students to have basic design skills, resulting in a shorter gap among them when working in a university or job project and in an approach more solution/user-centered rather than problem-centered.

3. Introduction of a mandatory internship in partner institutions Partnering up with institutions and companies, especially with startups, would allow students to have work experience before graduating by working as interns. Students would definitely be more prepared to face real-world situations by acquiring skills through direct experience on the job. Their creativity would be stimulated in a different context from university, allowing them to fully express their potential.

Other solutions may include the introduction of oral examinations to allow students to practice their presentation skills, and of coursework letting them practice during the semester, possibly rewarding them with extra points. The participation to hackathons and business games should be incentivized as it allows students to express themselves and stimulate their creativity in a controlled environment.

Conclusions

Nowadays there are some skills that engineers cannot lack when it comes to working together as a team, delivering an innovative solution and presenting an idea. The university I attend certainly teaches us how to carry out research giving us an appropriate theoretical background through technical courses. However, without the participation to extra-curricular courses such as ASP and IDEA League Challenge Program, I would not have developed all, or at least some, of the necessary skills to design for innovation.

Giving more time to students to learn about design thinking and innovation would surely reduce the size of theoretical knowledge they acquire from Politecnico. However, it would probably result in more prepared engineers for the role they will play as makers and would increase their level of self confidence when facing unfamiliar tasks.