Human-Centered Design for Collaborative Innovation in Knowledge-based Economies

Tiago Filipe Pereira da Silva and João Paulo Coelho Marques

> *"We climbed Maslow's hierarchy a little bit and we are now focused more and more on human-centered design which involves designing behaviors and personalities into products."*
>
> David Kelley
> IDEO Founder and Professor
> Stanford University

This research explores a university-industry collaboration based on the case study of an innovation project based on Stanford University's ME310 Design Innovation program. The Porto Design Factory and IKEA Industry joined forces to tackle a problem using what has come to be called a human-centered design approach. The case study provides an understanding of outcomes that reveal the potential of using a human-centered design approach to solve technical problems while enhancing customer experience. It also identifies the benefits that each institution gained by collaborating. The outcomes show that companies benefit from building interfaces with external partners, and that universities are relevant players in the innovation ecosystem, satisfying their third mission of being entrepreneurial institutions.

Introduction

Innovation has been understood as a driver for businesses seeking long-term successful performance (Tushman & O'Reilly, 2002). Both industry leaders and academics have contributed to understanding innovation, which has led to today's vision of the concept as a process that allows organizations to adapt to new situations and capitalize on their knowledge (Lundvall & Nielsen, 2007). In the context of a knowledge-based economy (Lundvall & Johnsson, 1994), creating, acquiring, and transforming knowledge are critical capabilities for companies to thrive and be competitive. It is therefore crucial that interfaces with the external environment are created (Kline & Rosenberg, 1986) for companies to develop relationships with suppliers, partners, and clients as all of them may constitute a source of innovative insights.

Companies are not the only players in the innovation ecosystem. Both public and private organizations have a say, including the state, not-for-profit institutions, and universities (Lundvall, 1992). The latter have been important actors in the innovation landscape by embracing their third mission of being proactively entrepreneurial in searching for value creation opportunities (Etzkowitz, 2001). Universities, as a primary source of knowledge generation and transfer, are relevant allies for companies to jointly do research and co-develop new products and services. For this purpose, several techniques have been developed to provide a structure for innovation. One of them, is called "human-centered design" (HCD), which promotes the engagement with users, clients, and stakeholders, thereby enabling the generation and utilisation of knowledge to enhance human lives (Kelley, 2002; Giacomin, 2014).

This research explores a university-industry collaboration between the Porto Design Factory based ~~a~~t the Polytechnic Institute of Porto (PDF), and the IKEA Industry, which was created to co-develop a project for the ME310, a "Product and Service Innovation" post-graduate course. The main goal of the paper is to explore the collaborative project's development as driven by the problem-solving HCD approach, through the use of a case study.

The article is divided into six sections. After the Introduction, the second section focuses on reviewing the relevant literature to provide theoretical background for this work, followed by explaining the research methodology. The fourth section presents the HCD case, and the fifth shows the results and adds discussion. Finally, the study concludes that the HCD approach can be relevant to guide and actively engage stakeholders when used as an innovation project management tool.

Literature Review

Innovation and Knowledge Production

Innovation has been an important topic over the years, with considerable economic, social, political, and technological impact. The economist Joseph Schumpeter (1934) was a key figure in revealing the importance that innovation has in economic growth, and how it transforms knowledge into new products.

External sources of innovation have been considered important inputs for company innovation processes (von Hippel, 1988; Antonelli & Fassio, 2015). Therefore, a need exists for organizations to have "doors" or interfaces whereby they can collect external information to make it economically useful (Caraça et al., 2009).

Universities have played a key role in national and regional economies and in recent years have been increasing their contribution to social development. The transformation of university cultures and missions has paralleled the global trend of economic development, where R&D's once central role in the whole process has now become a secondary focus. This has given way to today's vision of both extensive and open cross-organization collaboration. The so-called "entrepreneurial university" (Etzkowitz, 2001) is now seen as a relevant stakeholder capable of generating and transforming knowledge into innovative outputs, which can leverage industry capabilities in collaborative partnerships.

Innovation Techniques focusing on Co-Creation

Systematic and successful innovation is only possible if a process is in place to align a company's culture with its extended stakeholders in a way that can affect the outcomes of the process. Several techniques and processes have been developed to provide a structure for engaging in innovation. One example is the stage-gate model (Cooper & Kleinschimdt, 1986), which clarifies the steps between an initial idea and the eventual product launch, and furthers elaborates on post-market monitoring, thus giving a linear view of innovation based on stages of development followed by decision points called "gates". Another approach is based on Lages' (2016) "value creation wheel", which aims to generate value through problem solving in five flexible phases: discover, create, validate, capture, and consolidate value. This approach encourages an innovation team to embrace a certain problem and try to understand it in the initial phase, then to feed that information into the subsequent phases of the process.

The customer development approach (Blank & Dorf, 2012) focuses on the importance of knowing and understanding customers to facilitate the innovation dissemination process. Through the four phases of customer discovery, customer validation, customer creation and company building, innovators and entrepreneurs can adopt a structured process to ensure the distinctiveness of their value proposition to customers and other relevant stakeholders (Bailetti et al., 2020). The lean startup (Ries, 2011) approach is heavily based on the software industry, but has also been considered for extended areas of new product development. It advocates a build-measure-learn feedback loop iterative process, which relies on user feedback to make incremental adjustments and improvements to the solution being built. The above approaches and techniques all imply an increasing concern with lean and agile processes for innovation, with a strong focus on customer and user feedback to improve the new product development process.

Emphasis on the customer is based on the premise that new product development often fails, not for the lack of advanced technology or technical skills, but rather because of a failure to understand users' needs (von Hippel, 2007). The HCD approach has been one of the most followed and adopted approaches by a range of organizations (Schmiedgen et al., 2015). Approaches such as "design thinking" are based on human-centered principles to fully engage with and become immersed in the user environment (Liedtka, 2018).

Human-Centered Design

HCD is a conceptual framework that seeks to holistically understand humans for the purpose of meeting their needs, desires, and aspirations (Uebernickel et al., 2019). According to Giacomin (2014), it aims to stimulate the people involved in a problem to seek solutions by using techniques to communicate, interact, and empathize.

The HCD approach, through insights collected from observation and interaction with potential users or customers, provides important opportunities to target unexplored markets or improve existing products. This means that the outputs of such an approach can lead to both incremental and disruptive innovation. To achieve this, HCD has tools to deeply analyze user research. Several techniques have been created to facilitate the detection of user meanings, desires, and needs, either by verbal or non-verbal means. Some examples are ethnographic interviews (Spradley, 1979), questionnaires, role playing and focus groups (Stewart et al., 2007), participant observation (Spradley, 1980), identifying personas, experiencing prototypes, the customer journey, day-in-the-life analysis, and scenario planning.

IDEO (2015), one of the most relevant players driving the HCD approach, defines it as a three-phased process of inspiration, ideation, and implementation. This process leads the project team to deeply understand a problem by immersion into the context of the study, then to think divergently about multiple possibilities to solve the problem and lastly, to bring the result to those that will benefit from it. Constant throughout for the project makes use of both divergent and convergent thinking, as well as prototyping, the later which allows assumptions to be continuously tested and validated. The goal of the overall process is to achieve a balance between human desirability, business viability, and technological feasibility, in order to ensure successful solutions (IDEO, 2015).

The innovation paradigm’s shift to a human-centered approach may have a unifying role within organizations because rather than each company department working individually on its own goals and objectives, HCD can potentially unite all business dimensions with the same goal. The HCD process relies heavily on gathering different perspectives and promoting multidisciplinary work to enrich the outcomes. It encourages innovation teams to constantly validate their assumptions and continuously improve their understanding of the people involved in and affected by the problem to be solved by “getting beneath the surface” (Brown, 2008).

Thus, the innovation paradigm’s shift to a human-centered approach may open an opportunity to fill the gap in knowledge about HCD, which has raised questions about how collaborative projects driven by the HCD problem-solving process can be used in real case studies.

Research Methodology

To fill this gap, our investigation for this paper analyzed a collaborative university-industry project using the HCD process. The specific objectives were 1) to gain an understanding of the benefits of HCD in the context of university-industry collaboration, 2) to explore the outcomes of the project, and 3) to discover the relevance of HCD for achieving those outcomes.

The project was promoted by IKEA Industry Portugal, PDF, and Warsaw University of Technology (WUT) for their ME310 Product and Service Innovation post-graduate course.

Many data sources were considered in order to develop this case study, including student documentation, photos, reports, and five interviews. Semi-structured interviews and informal conversations were the main methods used to collect insights from the participants involved in various phases of the project. The interviewees included the IKEA Industry Portugal head of innovation, and their corporate liaison responsible for periodically establishing contact with the team of students, the PDF’s director, and two Portuguese members of the student team.

From the IKEA Industry head of innovation and the corporate liaison, we collected information about the company’s current innovation process, and how the ME310 course and HCD changed it. The information also included other aspects related to the project, such as company expectations, challenges, and difficulties felt, along with outcome relevance.

The interview with the PDF’s director provided insights toward understanding the university’s point of view regarding collaboration, like benefits and difficulties, value proposition both to the company and students, as well as the importance of taking an HCD approach for educating future professionals. The student interviews provided the overview of their first-person experience in embracing a challenge and solving it using HCD, and the intricacies and relevance of HCD in acquiring competencies for future work.

The interviews were conducted during the last quarter of 2019 and took 40 minutes per person on average, with the researcher making an audio recording and writing notes to allow further content analysis.

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Case Study: ME310 Project

Case Context

The case studied was a joint project between IKEA Industry and Porto Design Factory (Polytechnic Institute of Porto) developed in the academic year 2017/18.

IKEA Industry is the industrial branch of the globally known Swedish brand IKEA, which has been a pioneer in the furniture industry. IKEA has presented innovative solutions, a well-performing business model, and delivers an interesting customer experience. Its strategy is to position itself as a strong, international, and open company.

In 2014, the industry group defined its guidelines, "IKEA Group Manufacturing Strategy Now: 2020", which highlighted the importance for the company of establishing active relationships with suppliers, industrial networks, and the academic world. The goal was to extend the company's manufacturing competence, along with embracing diversity and new knowledge. Heading the work in the project presented was IKEA Industry Portugal, with its team located in northern Portugal.

PDF is a transversal unit of the Polytechnic Institute of Porto, which is positioned as a global platform based on interdisciplinary work, applied research, and industrial collaboration. Over the years, many students have attended its educational courses, with a strong emphasis on problem-solving methodologies, such as HCD and design thinking, as well as collaborations with industrial partners. One of these programs is ME310, which was originated at Stanford University (Carleton, 2019).

ME310 is a year-long course in which students work in international and interdisciplinary teams to solve real-world problems provided by industry sponsors. Each team addresses a given problem statement and at the end of the course journey, students are responsible for having designed and built a functioning prototype. Students are challenged to question, embrace ambiguity, and learn by doing, as the course uses a project-based learning methodology (Carleton, 2019).

The journey is composed of several milestones, which are based on an iterative prototyping process (Figure 1) that is driven by the HCD approach. Students are expected to use practical tools and techniques from the design thinking toolkit (Uebernickel et al., 2019).

The macro-cycle visual represents the different phases of the ME310 program during its first three quarters. It shows the various prototypes and concept adaptations from the beginning of the project until the final proof of concept. Each iteration of the prototype should be the result of research and user testing, as an effective way to make constant improvements.

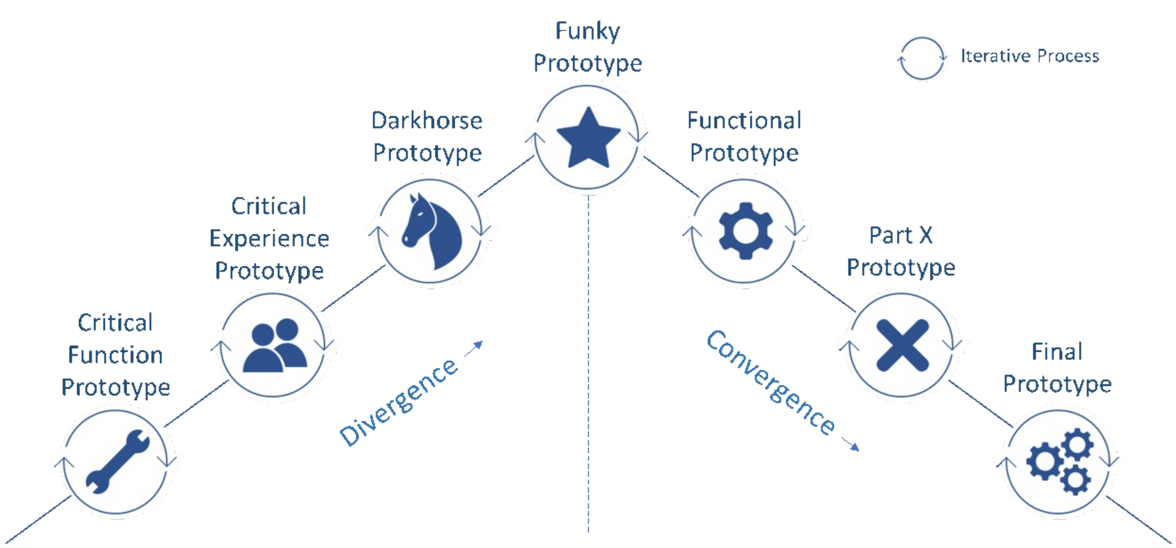

Figure 1. ME310 Macro-cycle. Adapted from Uebernickel et al. (2019).

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The iterative process is ensured by the micro-cycle or the Stanford design innovation process mentioned both by Uebernickel and colleagues (2019), and by Wiesche and colleagues (2018). This process is composed of five different steps that have similarities with other design thinking models: 1) (re)define the problem, 2) Find needs and benchmark, 3) brainstorm, 4) prototype, and 5) test.

That was the five-step process behind the project's progress in which the team constantly collected information about the problem and the stakeholders involved, thereby turning those insights into product iterations. The project management followed each of the steps and the sequential prototyping deliveries of the macro-cycle.

Project Outcomes

In the 2017/18 edition of the course, IKEA Industry joined as a corporate partner for the third year in a row, challenging a team of six students, three from PDF and three from Warsaw University of Technology, with different backgrounds from engineering, physics, design and biotech. Here is the briefing students had to work on and solve: "Eliminate drilling from the mass manufacturing of wood furniture".

IKEA Industry Portugal provided a workforce to observe the project and to get involved in it more closely in an extended way through its innovation team with the help of a corporate liaison.

The project started with the student team working on redefining the problem, exploring each word of the briefing individually and conducting research to understand the impact of the drilling process at issue. To holistically understand the problem the team needed broader knowledge of the factory, manufacturing process, materials, worker flow, and working conditions. This included research on the internet and in specialized publications to gain a broad vision of the design context. An initial drawing of the stakeholders' map provided an understanding of which people and organizations were involved in the complex industrial arrangement and who could influence or be influenced by the given problem.

After gaining a broad understanding of the context, both the Portuguese and Polish students were able to visit an IKEA Industry factory. Doing field research allowed the students not only to observe the manufacturing process to better understand the business, but also to connect with workers on the ground and speak with managers to gather various perspectives of the problem through conducting interviews.

A first glimpse at the project provided a clearer understanding of the real impact a solution to the given challenge could have. IKEA's business model relies on reducing the costs of production to enable lower prices and thus increase demand. This is the rationale behind having a close-to-perfect assembly line, with efficient timing, as a way to offer customers better deals. Complementing the information from the other sources, weekly meetings with a corporate liaison from the technical department's equipment team provided students with insightful revelations regarding the factory's production line and machinery.

To summarize the findings and reorient the project towards its human factors and impact, the team chose the tool Persona, which describes archetypes of users, giving them a name, a visual representation, and typically also quotes, as described by Wiesche and colleagues (2018). It allowed the students to collect information on the initially established needs, ambitions, and desires of the stakeholders. The three identified stakeholders had different roles in the project: the factory worker on the ground, factory manager, and customer.

After "getting out of the building", as the teaching team encouraged the student team to do, it was time to create a prototype. By the end of the quarter, the team had to design and build two prototypes: a critical function prototype (CFP), and a critical experience prototype (CEP). It was necessary to be hands-on and to start exploring concepts more than only thinking about final solutions. The prototypes were designed with exploration and divergence in mind, and to test assumptions regarding the problem faced. They were meant to be developed relatively crudely and rapidly, with a minimum allocation of resources possible.

The winter quarter was a key part of the whole project, when divergence reached its peak and important decisions were made to narrow choices and select the final proof of concept corresponding to the initial challenge. Research on primary and secondary sources was conducted throughout the project. The student team needed to constantly go back and forth between them in the research process because new knowledge brought with it new perspectives. At this stage, it was necessary to explore the problem more deeply and to slowly start envisioning the project's future. The team collected findings from the visits and external contributions, and then started to work on framing its new understanding of the context.

By targeting the housing issues in big cities, the team assumed that furniture needs to be multifunctional and serve many different purposes, and that it should be adapted to small spaces, occupying less room or being storable when not used. It should thus be capable of being assembled and dismantled repeatedly, providing the same quality from the first to the last use.

The first deliverable of the quarter was a dark horse prototype. Reaching the peak of divergent thinking, the dark horse was an opportunity to test farfetched concepts, which were the ones least likely to be successful.

The team decided to explore two different concepts: furniture made of living materials and origami furniture. The "living furniture" relied on fast growing plants that would be shaped into a bench or table and could be turned into garden furniture. Such furniture offers a sustainable and environmentally friendly solution for people's homes, while not needing any special skills or tools for assembly. The origami furniture was thought to respond to a need for versatile furniture that could have different applications, offering customization options through modularity, and the ability to be stored easily when not used.

The team tested the initial prototypes that were carried out with nine users, who engaged the prototypes, assembling and dismantling them while the team recorded the event on video, noted how long the engagement lasted, watched user behavior, and collected various observations. At the end of the test, some questions were asked regarding what the user felt during the experience and their general opinion about the furniture concept.

The convergent phase of the project had begun with a funky prototype. To reorient every member of the team, the students decided to redefine the persona for whom they were building the solution. An earlier question remained open: was the solution for the factory worker on the ground, the manager, or the final customer? However, it was now clear that the target should be the end customer because the vision of making everyday life better is for customers who also create the product demand. Understanding the pain points and needs of the persons involved, the team then defined origami furniture as the main concept to explore in future prototypes.

The spring quarter constituted the sprint towards building the final proof-of-concept, which was ultimately to be delivered to the company. One of the students during this time said, "At that point we were entering a phase of the project when things started to become extremely technical". The student team was able to contact several external specialists for finetuning the prototype, adapting it to the current manufacturing process and materials, and generating a potential business model to channel the product.

By exploring the "origami furniture" concept further, the team was able to understand how this would be beneficial for a range of different IKEA products, such as cabinets and other square-shaped pieces, where the solution, named LÄNK Technology (Figure 2), could be applied. The students developed a way to avoid traditional furniture junctions that rely on matching joints, screws, and other materials, by embedding a flexible fiber inside the furniture that would connect all pieces during assembly and disassembly.

The final concept was submitted to for user validation conducted with 20 randomly picked people, some who were familiar with IKEA furniture assembly and some who were not. The aim was to test the experience of assembling a LÄNK cube and an EKET cube, which are easy-assemble solutions already existing in IKEA's product catalogue. The test consisted of measuring the time taken to assemble and dismantle the cubes, and involved collecting qualitative data from the answers to predefined questions. Users found the solution intuitive and the prototype cube easy to manipulate. Bearing in mind the limitations of only working with a prototype, it was possible to infer that the technology was potentially interesting as an easy-assemble solution without the use of tools.

In the final documentation delivered to the company, the students conducted an extensive exploration of the differences between the production techniques used by IKEA Industry (BoS —board on style, and BoF —board on frame) and the ones needed for LÄNK technology. Together with a corporate liaison specialized in the factory's equipment and assembly process, the team tried to present a process requiring the minimum

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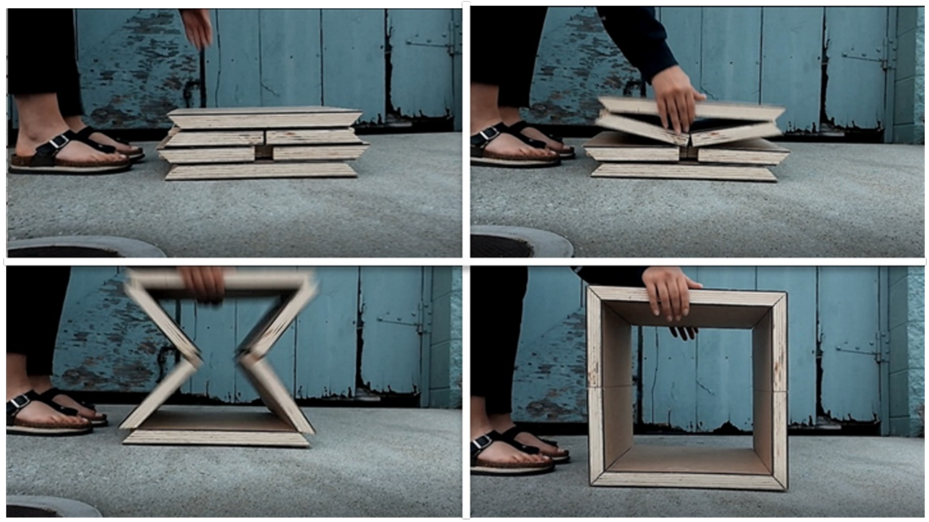

Figure 2. Assembling the cube with LÄNK Technology. Source: Project documentation.

changes possible to the current assembly line in order to increase the chances of implementation.

Both the student team and company representatives were aware that the proof of concept had some limitations and a lot of room for improvement. However, as stated by the head of the Innovation Department at IKEA Industry Portugal, the goal was to bring to the table new insights, radical approaches to product innovation, and challenging views of IKEA's business, manufacturing process, and products as a way to enrich internal knowledge and capabilities.

What had begun as an industrial challenge using university-industry collaboration, thus led to a solution that could potentially disrupt how consumers interact with their furniture. This was made possible by constantly engaging with multiple stakeholders, building empathy, finding customer pains and needs, and iteratively improving the concept.

Results and Discussion

Benefits of University-Industry Collaboration

The ME310 program allows a university to fulfil its primary mission: to teach. With today's competitiveness in higher education, universities must search for value propositions to attract students. Since universities teach and train students to gain competitive skills and experiences for the job market, practical exposure to the problems industry faces, along with immersion in industrial environments constitute a learning opportunity (Santoro and Gopalakrishnan, 2000). Throughout the project we studied, not only were the students able to face a technical problem at IKEA Industry, but they could also deeply explore it by making several visits to the Portuguese facilities. To enrich their experience, the team also visited IKEA Industry Poland, the factories of Portuguese competitors, and even those of other industries, as a way to engage stakeholders. The knowledge they accrued was supplemented with employee interviews, which brought greater understanding of the problem and learning experience. As corroborated by Mora-Valentin (2000), the value proposition of experiential learning at university is enhanced by partnering with relevant and well-known companies that might be appealing for students to work with in their future careers.

The ME310 program also provides a privileged learning environment for all individuals involved in the project. Under the auspices of university teaching (Santoro & Gopalakrishnan, 2000), it is a way of exposing students to industrial environments, knowledge and facilities of corporate partners, which can also lead to employment opportunities for university graduates (Lee & Win, 2004), as well as (Santoro & Betts, 2002). From a company's perspective, the course may also be a way of discovering talent and creating a relationship with potential future employees (Ankrah et al., 2013). This indeed happened in this case of our study, as one of the students was hired by IKEA Industry at the end of the ME310 project.

While the project was running, several workers from IKEA Industry were able to follow the student team's progress and to directly benefit from it. Professional training is thus a valuable outcome of such partnerships (Santoro & Chakrabarti, 1999), which can directly impact the people who are in contact with both the team and the innovation process. As the corporate liaison stated, "I started including prototyping early in my upcoming projects because I saw how the team did it and the importance of immediate validation. That had few costs for us and allowed me to test first before reaching suppliers of that service."

The participation of a company in the ME310 program also provides an opportunity to gain international exposure and for networking with other universities and companies. For example, PDF is presently involved in two different international networks: DFGN (Design Factory Global Network), and SUGAR. This way it collaborates with several companies that come together for community events, projects, and public presentations. According to George and colleagues (2002), this may give a boost for initiating other inter-organizational projects that may generate relevant impacts on a company's future.

Project Outcomes

The knowledge created and collected during the project was materialized in prototypes. This is commonly a major outcome of collaborative projects between universities and industry, as suggested by Santoro and Gopalakrishnan (2000). The ME310 project generated more than ten prototypes, some with several different iterations, and each with its own specific validation tests. This constitutes a relevant deliverable for IKEA Industry as a first step for future developments. In the words of the corporate liaison, "the outcomes of the project were delivered to the PDC in Poland, where they collect innovative concepts to further explore when needed". All of the documentation that supported the prototypes may also be viewed as a source of inspiration and knowledge concerning possible R&D paths, as well as technical information for replicating the prototypes.

The final proof of concept or of any concept explored during the project can potentially lead to business opportunities for the company to introduce new products or solutions to the market. According to Siegel and colleagues (2003), one motivation for industry to collaborate with universities is to seek to commercialize its technologies for financial gains. LÄNK Technology, as the most recognizable outcome of the project, has become suitable for application in various products that aim to eliminate drilling, thereby enhancing the manufacturing process. This could imply some impact on the company's performance if adopted in the future.

Industry partners tend to see university-industry collaboration as a potential opportunity to gain financial benefits through sales enhancement, or for developing new products that can benefit from serendipitous outcomes (George et al., 2002). This was strongly emphasized by the corporate liaison in our study, who stated that IKEA Industry wanted new insights and perspectives about their business, processes, and products. He noted, "We have a lot of internal knowledge because we've been doing this for ten years now. We understand our process and know our equipment, but we lack a fresh new vision which we knew we could get from ME310". The expectations of the company, however, were not entirely focused on financial benefits from the final proof of concept, but rather there was also a possibility of commercializing university-based technology, which happens in some cases (Siegel et al., 2003).

Role of Human-Centered Design

According to Kivleniece and Quelin (2012), in university-industry collaborations it is common for companies to look for solutions to technical problems. Nevertheless, although the project in our study started with the deeply-rooted technical problem of "eliminating drilling from wood furniture mass manufacturing", the final proof of concept had a stronger focus on the final customer and their needs. This speaks to the HCD approach, which aims to solve everyday problems and puts human desires at the center of the process (Kelly, 2002). For IKEA, to "create a better everyday life for the many", means that "the many" must be taken into consideration in every decision the company makes, including decisions about innovation and new product development.

The team of students we studied was able to extract the most relevant information from the factory and manufacturing process, and to translate that into leveraging a solution that would fit the user's needs. This process was enhanced by the tools and mindset of HCD by creating connections and empathy with the user (Giacomin, 2014; Liedtka, 2018). By understanding the need for a seamless assembly experience with no tools or guides, and by providing the potential for the furniture to be assembled and dismantled several times, not only were the individual user's problems addressed, but an answer to global demographic trends was also given. Hauffe (1998) showed that this is a relevant part of the design and innovation process, which must take into consideration society and its constant growth and development.

The tools of design thinking that put into practice a humanising and user-centered approach are understood as drivers for organizational culture, they may be a trigger for experiential learning, collaboration, risk taking, and learning (Elsbach and Stigliani, 2018). As the corporate liaison said, the project we studied had a relevant impact on his work process as he started to integrate prototyping in IKEA Industry's projects. This allowed IKEA to validate assumptions early, and subcontract services later in the projects.

The HCD process and its tools, which bridged the gap between the design research team and the users, were extremely relevant for the project's outcomes. The importance of continuously searching for validated assumptions and "getting beneath the surface" (Brown, 2008), introduces a new type of product development, since human-centeredness aims to empower human beings and enhance our lives through well-designed technological interfaces (Krippendorff, 2004).

The HCD technique also helped promote deep and diverse relations between IKEA Industry workers, students, engineers, material suppliers, and business specialists, including diversity in points of view, opinions, and knowledge that led to richer outcomes. The fact that the students had various backgrounds, cultures, and skills to interact with the inputs from several different mentors provided a multidisciplinary environment that enriched the project with input and feedback. This follows the vision of Sherwood and colleagues (2004), who state that companies seek variety in research expertise and inputs through university-industry collaboration.

Prototyping is the way through which creative problem-solving happens, which is a core activity of the HCD approach. Prior to this, an ideation process must occur based on previous findings concerning the particular problem to be faced. Divergence and convergence of innovative thinking provide a suitable environment to expand the possibilities for solving a given problem. Inspirational and divergent thinking employed in, for example, the dark horse prototype (Bushnell et al., 2013), offer strategies to enhance and empower the creativity of students. This allowed the problem in our study to be explored outside the usual boundaries.

Conclusion

This paper described how a collaborative project driven by a HCD technique can be used to solve technical problems with a strong focus on the user experience. HCD was used as a tool, within a ME310 project, as a form of relevant guidance to actively engage with innovation project management. It also promoted a collaborative approach to the innovation process by gathering various points-of-view and including an extended project team to enrich its outcomes.

Co-creation in the project led to greater engagement by different stakeholders, each of whom contributed their skills, knowledge and experience. The practical side of the technique was that it deeply embraced divergent and creative thinking, along with convergent and analytical reasoning, which increased the outcome's value.

The project made a relevant contribution to IKEA Industry's innovation portfolio by integrating more knowledge in their database that will feed future new product development efforts and inspire new outcomes. We believe that other customer-focused firms can thus benefit from using the HCD process by allowing the integration of users' insights into their value proposition.

The practical implications of this study for management can be viewed from the perspective of encouraging collaboration between universities and industry, in the sense of stimulating co-creation, and solving companies' problems by involving students and professionals in a mutual learning process.

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Citation: Silva, T.F.P., and Marques, J.P.C. 2020. Human-Centered Design for Collaborative Innovation in Knowledge-based Economies. Technology Innovation Management Review, 10(9): 5-15.

http://doi.org/10.22215/timreview/1385

Keywords: Innovation, New Product Development, University-Industry Collaboration, Human-Centered Design, Design Thinking, Co-creation, Project-based Learning, ME310