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A Design Management and Design Thinking Approach for Developing Smart Product Service System Design: Projects from Online Industrial Design Studio

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Abstract: Industrial design as profession has begun to expand its scope in business practices with the recent developments in design management, design thinking, and technology. However, curricula of industrial design studio remain traditional and mainly focuses on designing products. In fact, design management and design thinking go beyond product design and expand design's scope to establishing business strategies, design innovation and service design by positioning humans and their needs at the center. Besides, the technological shift happened through Industry 4.0 enables to adapt IT hardware into systems, products and services, and make them smart and unified.

To keep up with these paradigm changes and prepare our students to the rapidly changing business environment, we initiated a Smart Product Service System (Smart-PSS) design project with the 3rd-grade students of Bahçeşehir University in the 2019-2020 Spring semester during which online education had just become a part of our lives. In this article, we present three student projects as case studies of Smart-PSSs designed in three stages as system design, product design, and interface design. As a result, students gain a more holistic approach toward the design process, acknowledge the new expansions of industrial design, and its transformative role for businesses.

Keywords: Industrial Design Studio, Smart Product Service System, Design Management, Design Thinking, Online Education.

Introduction

The relationship of design with management and technology has mutually shifted with the rise of knowledge economy. Design management (DM) has been recognized as a strategic business resource by differentiating products, managing design projects more effectively, or building brand value since the 1960s (Farr, 1965; Kotler & Rath, 1984; Cooper & Press, 1995). Recently, incline of the new economy around Industry 4.0 paves the way for technological developments in which creativity and knowledge play a central role. Hence, design management and design thinking have become significant for the creation of new products, services, and business models to gain competitiveness in the commercial global market (Cooper et al., 2009). Within the framework of developments in design thinking, design management, and technology, we

develop and implement an industrial design studio project subject through which our industrial design education meets with these new expansions and prepares future designers to be well-equipped for future opportunities. In the 3rd-grade industrial design studio, we conducted Smart Product Service System (Smart-PSS) design project to develop viable strategies for new businesses, systems, services, and products. This paper presents three case studies of Smart-PSS design projects on different areas of design, such as tourism, health, and entertainment; after giving background information about the shifts in design management and product-service systems.

Design Management and Design Thinking

Design Management Institute (DMI, 2021a) defines the scope and shift of design management activities as follows: "[d]esign management encompasses the ongoing processes, business decisions, and strategies that enable innovation and create effectively-designed products, services, communications, environments, and brands that enhance our quality of life and provide organizational success."

Design thinking is also defined as "a system that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business can convert into consumer value and market opportunity" (Brown, 2008, 86).

DMI (DMI, 2021b) stresses that design management has traditionally used a design thinking approach to develop compelling products and services that resonate with customers, consistently producing financial rewards, and building brand loyalty. More specifically, "thinking of design", "thinking about design" and "thinking through design" address different types of activities within the scope of design thinking and design management (Cooper et al., 2009). While the activity of thinking about design reflects on questions of who can design and what can be designed and shifts its perspective from isolated product to a more system-wide perspective, thinking through design still in its emergence stage and has a much more profound impact on the way of the business itself is being conducted (Cooper et al., 2009). Design thinking has expanded the design activities from product to innovation and business transformation by positioning humans and their needs at the center; and led to create new visions and alternative scenarios that can give rise to new business models, organizations and strategies. Besides, design thinking has helped to raise awareness for design management upon the integration of design activities and processes in an organization at various levels. In the 2009 International DMI Education Conference, efforts in exploring design thinking in design management research generated a contextual framework (Figure 1) that depicts the shift and gradual development of design management from educational and practical perspectives.

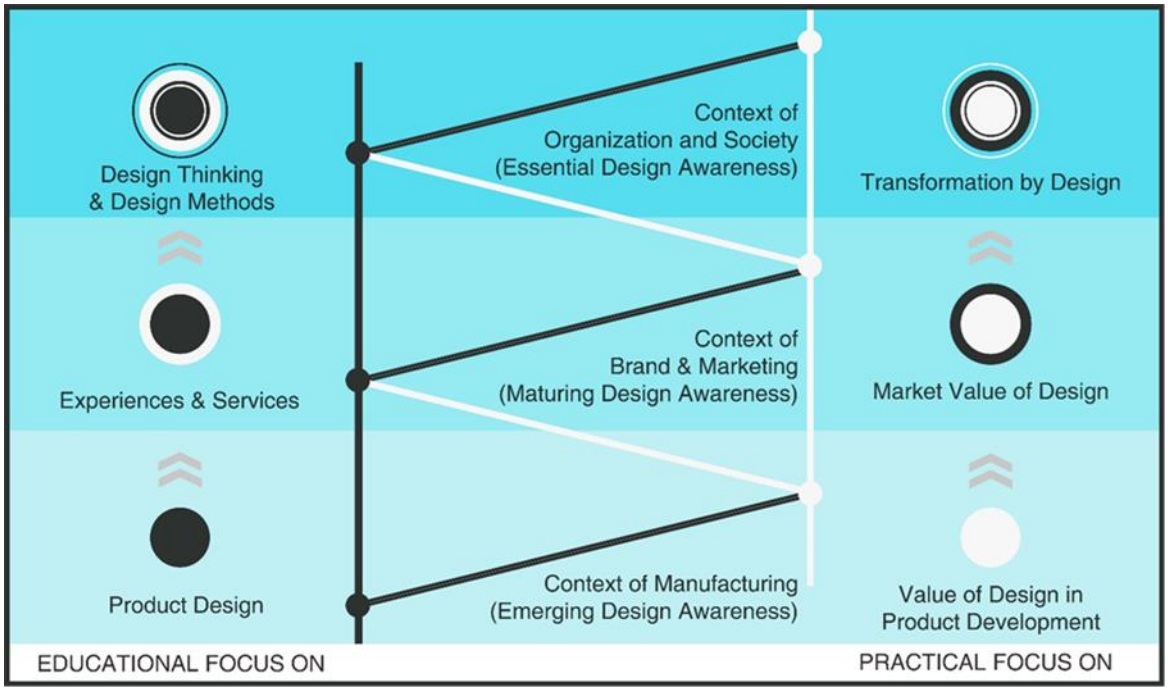

Figure 1: Integration of product design, experience and service design and design thinking in design management research (Adapted from Cooper et. al., 2009).

In the first stage (Figure 1), the implementation of design thinking in design management has initially emerged within the context of manufacturing organizations where researchers mainly focused on classic design management approaches based on product design, technology and brand. The main issues related to design management from the practical perspective can be explained as the integration of design into management processes, the value of design in product development, and the role of the designer in enhancing the communication between engineers and marketers. In developing regions and countries -such as West Europe, Asia, Russia, Turkey- and in some companies from these countries, research and practice on design management from the product design perspective are still relevant (e.g. Manzakoğlu and Er, 2018). In the second context, the research and education of design management still play a role in product design within the manufacturing context, but marketing and branding broaden the scope in terms of defining a specific target group. Western Europe and North America, and the companies of these countries such as BMW, Apple, Starbucks can be the examples of this context where experience and service design solutions are predominantly shaped around tangible products. The third and new context for the practice and research of design management embraces the organization and society, and design thinking usually focuses on the characteristics of a problem independent from a tangible product. Design thinking and design methods can be established in an organization either in marketing, design, or manufacturing with the aim of solving human-centered problems by generating scenarios and new business strategies. This thinking through design approach has been developing with the contribution of North American business schools, Design Councils of UK and Netherland, and the academic programs of EU addressing a wide range of issues from strategy to social change (Cooper et. al., 2009). In our 3rd-grade studio course, we introduced design thinking methodology to our students for them to develop new business strategies and generate scenarios around human-centered problems while keeping tangible product design aspect of the traditional industrial design education. In parallel with the paradigm shift experienced in design management with the influence of thinking through design; another shift experienced in the technology side also

empowered design and expand both its scope and practice.

Product Service Systems

Industrial design is no more limited to the design of a product, or product-service systems. But, with the advancements in technology and the internet being "everywhere", previous Product Service Systems (PSSs) turns into Smart-PSSs with an addition of small IT hardware to the products. This hardware makes the system smart, since it enables the system to gather, process, and generate data (Rijsdijk and Hultink, 2009).

In the previous product-oriented paradigm of industrial design, designers and companies accustomed to managing the system and product design in different processes of PSSs. However, on the consumers' side, there is no difference between these two and they perceive the experience as a whole. The articulation of IT hardware in the Smart-PSSs not only interweaves the system and product into each other but also led to create a consistent user experience. Moreover, the new system targets individual consumers more often and increases the value offered to them, which is also the main aim of human-centered design and design thinking. Hence, from design and technology perspectives, the focus of industrial design and designers has shifted from new product development to Smart-PSS designs in which industrial designers and students need to equip a more holistic approach to design (Valencia Cardona et al., 2013).

The contribution of design thinking to design management research and industrial design education that possesses the shift from product design to service design, and to business system design was recognized as an invaluable framework for industrial design studio practices. Many guidelines and methods have been offered to designers for managing the PSSs processes (Crul et.al., 2009; Tukker, 2015) through which designers are expected to pursue an iterative process mainly influenced by producer user interactions (Diehl and Christiaans, 2015). Throughout the iterative stages of the PSS design process, designers are found to have been struggled in achieving cognitive jumps from abstract (service) to solid (product) level (Valencia et al., 2014). Thus, they offer designers to focus on a single stage at a time such as system, product, and service design. Following a similar approach, we structured design studio project around Smart-PSS subject and divide the design process under three sections for them to focus one part of the project at a time.

Industrial Design Studio Projects of Smart-PSSs

As full-time instructors of Bahçeşehir University, in the 2019-2020 Spring semester, we initiated a Smart-PSSs project in the 3rd-grade industrial design studio with twenty-two students. In the curriculum, eight hours in a week is dedicated to design studio course and they are divided into two days, Tuesday and Friday from 8:30 am to 12:30 pm, allowing to give two critics to each student in a week. Unlike previous face-to-face studio courses, the Smart-PSSs project was initiated in an online education program due to the Covid19 pandemic outbreak which brought mainly challenges, but also opportunities in terms of setting up a communication network between students and lecturers. While experiencing online education for the first time in Adobe Connect software, we also set up a WhatsApp group with the students to enhance communication and respond to their questions readily. Hence, we achieved high level of communication with students that allows us not only to follow up their three stage Smart-PSSs process closely, but also provide a base ground for sharing design ideas and technology sources collaboratively.

Although, the focus of the project is to generate complex and integrated Smart-PSSs through design thinking with the aim of solving human-centered problems by generating scenarios and new business strategies (Cooper et al., 2009), we divided the design project into three stages as system design, product design and interface design (Table 1) to manage the process effectively (Valencia et al., 2014). At the first stage, students are expected to define a daily life problem focusing on human needs and to

propose a system solution around a wearable product by specifying all the stakeholders in the system and relations between them. We strictly advised them not to concentrate on the product or details of it by means of usage and manufacturing; however, they need to conduct research about IoT and smart technologies that will enable their system to work. The research effort on technology was focused on learning the existing technology of smart wearable products in the market such as smart rings, necklaces, bracelets, and glasses. They searched different types and sizes of Bluetooth chips, NFC modules, wireless charging batteries, vibration sensors, micro USB ports, amplifiers according to the requirements of their project concept. Selecting the appropriate components enables them to comprehend the interior dimensions and scales of their product. The second stage centralized the product and the students' decisions on the usage, dimensions, and production details within the limits of today's technological capabilities. At the last stage, they designed the graphics and the flow of the mobile phone application that supports the Smart-PSS and the interface of the wearable, if there is a screen attached to it. which the product design stage had an impact on system design, or interface design had an impact on system and product design stages, and led to revisions. It was apparent that before the final submissions all three submissions of system, product, and interface design need to be revised repeatedly.

Within this paper, we introduce three of the nineteen submissions Smart-PSSs projects by referring them Project A, B, and C in accordance with the Student A, B, and C, respectively. By selecting those projects, our aim was to cover diverse topics as much as possible.

Project A – A smart tracker for Resort Hotel Customers

Student A designed a Smart-PSS for Resort hotels where family members enjoy their own time even though they go on vacation together. Especially, when it is the matter of children, parents need to know their whereabouts, like kids' club, swimming pool, etc. without sacrificing their own activities. This was the main problem definition at the beginning stage of the project and to overcome finding their

Table 1. Smart-PSS Design Stages and their duration periods

Smart PSSs Design Stages	***Duration periods of the stages***
1. System Design	6 classes (3 weeks)
2. Product Design	6 classes (3 weeks)
3. Interface Design	3 classes (1,5 week)
4. Final Submission	1 class
	Total: 16 classes (8 weeks)

Table 1 shows how we distributed the total eight weeks of time dedicated to the Smart-PSS into three stages; namely the system, the product and the feedback. In this process each student had a chance to experience these different scopes of industrial design individually.

Throughout eight weeks-time project duration, we experienced an iterative design process in

kids' location. Since GPS is not that accurate in multi-story buildings such as resorts; Student A offered a wearable tracker, which works with Bluetooth transmitters, for the kids. Student A planned to place Bluetooth devices at the entrances and exits of the interior places and some certain outdoor places such as pools, beach, and sports fields. Thus, parents can locate their children with an application that

Figure 2. System Poster of Project A

they have downloaded when they check in to the resort if they want to benefit from the system (Figure 2).

In the second stage (Figure 3), while Student A was working on the product, he realized that he could expand the concept for every customer in

Figure 3. Product Design Poster of Project A

the resort since sometimes couples and friends can wonder about the whereabouts of each other while they are doing different activities. Besides, people tend to carry fewer things on vacation. Sometimes even the room key and towel cards become extra stuff, they can be forgotten or lost. People are also used to wear colorful wrist tags in resorts that inform the workers about their accommodation type such as half-board, full-board or all-inclusive. On the other hand, the resort management and workers are defined as stakeholders in the system. Thus, Student A decided to combine the room key, towel cards, and the tracker in the waterproof colorful wristband that contains a Bluetooth and NFC module, a battery, and a wireless charger. The receptionist gives a wristband to each customer when they check- in. Customers are asked to download the application and pair the wristband with their phones. At the end of the vacation, they leave the wristbands at the reception desk where they can be cleaned and recharged.

At the third stage (Figure 4), while designing the application, Student A also evaluated the communication between the hotel management and the customer. He added features like booking reservations from restaurants and sending notifications about some events like concerts, etc. In the final design of the application there were three main menus by which customer can track his/her accompanied ones; lock/unlock room; and notified about special events, track towels and sunbeds, and make reservations.

Project B

Student B designed a Smart-PSS for doctors that can be referred to as a new generation pager. She identified the problem as the doctor just seeing the incoming caller ID from the pager and needing to make a call to learn about the emergency. In order to enhance communication, Student B proposed a wearable earpiece (smart pager) for doctors that offers the opportunity to communicate instantly with the nurse who is making the emergency call, and to learn about the patient's condition and location. The doctor also can reject the call if s/he is already busy with another patient. In the system design stage, Student B also considered the earpiece to work as the headphones of the smartphone; thus, being used by the doctor in his/her free time.

Figure 4. Interface Design Poster of Project A

In the product design stage, Student B concentrated more on the pager usage habit of doctors and conducted research with the users. She revealed that users attach their pagers to their belts or suitcases and some of them mentioned they might need a loudspeaker when their hands are busy and/or the pager is not in reach. Taking user research data as a basis for product design, Student B decided to add a loudspeaker working with a magnetic signal receiver/uploader to the earpiece. Also, the final hook-like form of the wearable is suitable to wear on the ear and to attach to their belongings. However, Student B limited the product's usage to only work-related calls.

At the last stage, she designed the application interface through which the volume of the in-ear and loudspeaker can be adjusted, and the emergency situations and locations of the patients are shared. Lastly, she added a message board to be used amongst the doctors of the hospital to increase the communication between them. Student B's system, product, and interface design submissions are as follows (Figure 5).

Project C

Student C originated his idea on the fidgeting habit of tapping fingers on solid surfaces, while thinking about something, keeping up with the music, or just for fun. He evaluated this idea for people who would like to play instruments, anywhere and anytime they want and record it without disturbing others. At the first stage of the project, he planned to offer a wearable band for each finger that can be linked to several notes of the same instrument or different instruments. Users can make the adjustments from the phone application and hear the sound from the speaker of the phone or headphones. The product works with a vibration sensor that transmits each finger tap to notes via Bluetooth technology.

At the second stage, he researched technology and found Piezoelectric sensors that measure changes in pressure or force and convert it to an electrical charge. This technology allowed him to design a smart fingerless glove and place these sensors on the metacarpals. The main components including the battery, main power card, on/off button, and micro-USB port are

Figure 5. Smart-PSS system scenario, wearable product and application interface of Project B

located on the wrist part of the glove. Student C also added some natural sound (rain, forest, birds, etc.) features into the instrument palette.

At the interface design, he acknowledged that not all instrument types are compatible with the finger tap music creation concept. Thus, he limited the instruments, assigned to the smart fingerless glove, as percussions and piano/synthesizers. In the final design, the user can create, play and record his/her own music by tapping fingers and mix them together with the app (Figure 6).

students used design thinking methods to develop new business systems, products, services and interfaces oriented to human needs in daily life. Student A observed the needs/problems of families in big resort hotels such as difficulties in finding the location of family members, carrying towel cards and room cards,…etc. Hence, he designed a smart waterproof colorful wristband to be used as a room key, towel card, and a tracker during the vacation of families or friend groups for improving their experiences. Student B focused on facilitating the pager experiences of doctors

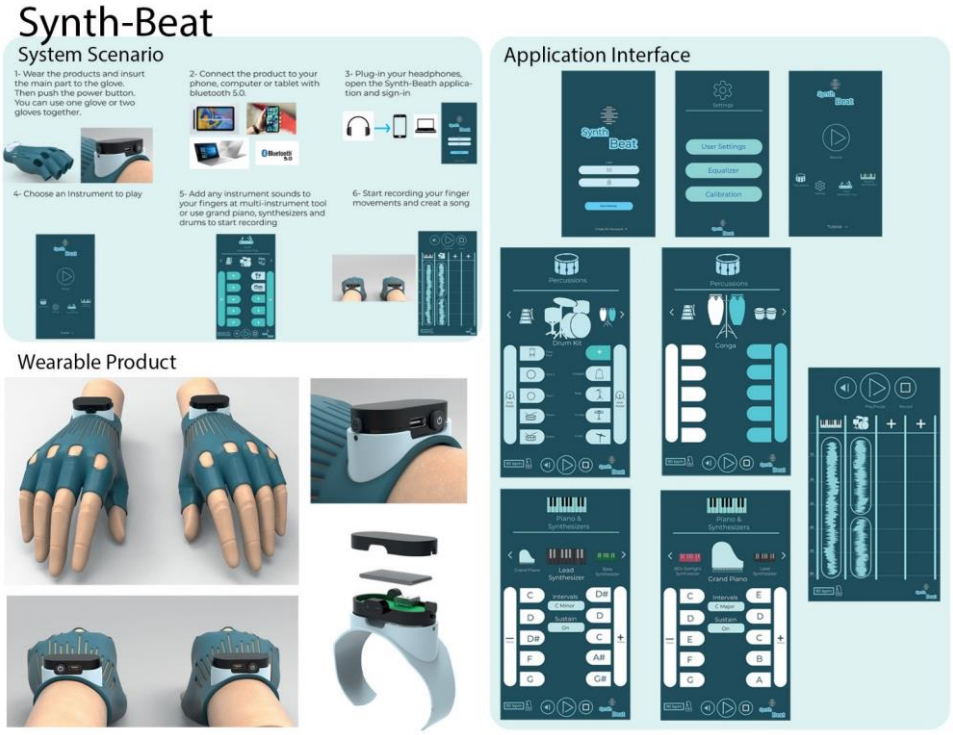

Figure 6. Smart PSS system scenario, wearable product and application interface of Project C.

Conclusion:

The industrial design studio curriculum represented in this paper has been delicately shaped around the contemporary concepts of design thinking and design management for developing Smart-PSSs. In addition to traditional industrial design studio education, our aim is to integrate the expanded scope of design management encompassing business strategies, services, and innovation (DMI, 2021a) to the new smart technologies with the help of design thinking that mainly positions humans and their needs at the center. Therefore, in hospitals and developed a smart pager that can be worn on the ear to listen and respond to emergency calls and instant messages. Student C has oriented to the needs of amateur musicians and designed a smart fingerless glove to be used to create, play, and record percussions and piano music by tapping fingers on a table. Building a new business system around a human-centered approach and design a product within that system increase the awareness of students towards new expansions of industrial design profession. Experiencing the paradigm shift in industrial design by

developing their own Smart-PSS concept, students gain a holistic approach toward the design process and its transformative role for businesses. Besides, the approach toward the design process was very flexible at the first stage during which students developed new business and system proposals without focusing on a product, instead they focused on humans in daily life. This aspect of the studio project differentiates the Smart-PSS design process from the traditional industrial design studio courses. On the other hand, searching, selecting, and adapting the appropriate technological components into the system and the product are found to be the most struggling issues for the students since they were not supported by IT developers or engineers. In business practices, the innovation process has become an interdisciplinary activity harboring mechanical engineers, industrial designers, user experience designers, IT developers, marketers, …etc. Therefore, for further studies, we suggest establishing an interdisciplinary design studio concept which integrates industrial design, mechanical engineering, and information technology students and lecturers for developing new business strategies, systems, scenarios, and products collaboratively.

References

Brown, T. (2008). Design thinking. Harvard Business Review, 86(6), 85-92.

Cooper, R. & Press, M. (1995). A guide to successful design management: The design agenda. Chichester: John Wiley & Sons.

Cooper, R., Junginger, S., & Lockwood, T. (2009). Design thinking and design management: A research and practice perspective. Design Management Review, 20(2), 46-55.

Crul, M., Diehl, J. C., & Ryan, C. (2009). Design for sustainability-A step-by-step approach. UNEP, Paris.

Diehl, J. C., & Christiaans, H. H. C. M. (2015). Product service system: The future for designers. In Proceedings of the International Design Conference of KSDS and ADADA with CUMULUS (pp.17-18).

DMI [Design Management Institute]. (2021a, March 13). What is Design Management? http://www.dmi.org/?WhatisDMI

DMI [Design Management Institute]. (2021b, March 15). What is Design Thinking? https://www.dmi.org/page/WhatisDesignThink

Farr, M. (1965). Design management: Why is it needed now? Design Journal, 200(8): 38–39.

Kotler, P. & Rath, G. A. (1984). “Design: A powerful but neglected strategic tool. Journal of Business Strategy, 5(2): 16–21.

Manzakoğlu, Bilgen T. & Er, Ö. (2018). Design management capability framework in global value chains: Integrating the functional upgrading theory from OEM to ODM and OBM. The Design Journal, 21(1): 139-161.

Rijsdijk, S. A. & Hultink, E. J. (2009). How today's consumers perceive tomorrow's smart products. Journal of Product Innovation Management, 26(1), 24-42.

Tukker, A. (2015). Product services for a resource-efficient and circular economy–a review. Journal of Cleaner Production, 97, 76-91.

Valencia Cardona, A. M., Mugge, R., Schoormans, J. P., & Schifferstein, H. N. (2013). Characteristics of smart PSSs: Design considerations for value creation. In CADMC 2013: 2nd Cambridge Academic Design Management Conference, Cambridge, UK, 4-5 September 2013.

Valencia Cardona, A. M., Mugge, R., Schoormans, J. P., & Schifferstein, H. N. (2014). Challenges in the design of smart product-service systems (PSSs): Experiences from practitioners. In Proceedings of the 19th DMI: Academic Design Management Conference. Design Management in an Era of Disruption, London, UK, September 2-4, 2014. Design Management Institute.