Design and Technology Education: An International Journal

26.2

Embedding Design Sprint into Industrial Design Education

Ozan Soyupak, Osmaniye Korkut Ata University, Turkey

Abstract

Design Sprint is an intensive and innovation-focused framework based on Design Thinking principles. This study discusses the potential usage of the design sprint framework in industrial design education, and focuses on its strengths and weaknesses as an educational tool. Within this context, the study reports on a design sprint workshop involving twelve industrial design students in their fifth semester. The general process and outcomes of the design sprint workshop are critiqued along with the feedback of participant students. Design sprint in industrial education supports student ability to critique their own design and creative thinking, offers a new usage of prototyping as a testing material, and enables user-designer interaction, but also challenges the students with limited time and intensive workload. Design sprint can be a tool for carrying out multidisciplinary studies, reflecting the activities of professional practice, and accelerating project progress in design education.

Keywords

design sprint; design thinking; design education; educational model; industrial design; human-centred design

Introduction

As the centre of economic activity in the developing world is inevitably shifted from industrial production to knowledge creation and the service industry, innovation has gained a vital role (Brown 2009). This change has also affected the definition and practice of the profession of industrial design, related as it is to industrial production. An up to date definition of industrial design is that it is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences (WDO 2018). Innovation has a significant role in industrial design, and the problem-solving process of industrial design can be encapsulated as questing for innovation. Cox defines creativity briefly as the production of new ideas, and innovation as the successful use of these ideas. Design, on the other hand, creates a link between creativity and innovation, transforms ideas into attractive and practical solutions for users and customers, and in doing so becomes purposeful creativity (Cox 2005).

Nowadays, the problem solving and innovation questing methodology of designers is used in a wide variety of areas. Over time, the definition of industrial design has been updated to include designing beyond the physical product (systems, services, experiences, businesses) and innovation. Systems, services, experiences and businesses are problem areas waiting to be designed. Design thinking is the methodology of the designer in approaching these problems, in solving them, and in the search for innovation, and it has contributed to the evolution of different methodologies. Design sprint is one of the methodologies which derives its roots from design thinking and other approaches and it is both flexible and easily applied to given circumstances (Banfield et al. 2016). Design sprint is a highly condensed approach which is used

in the field of entrepreneurship and which takes its originality from its limited time period and intense workflow. Developing a solution to the problem, taking advantage of other disciplines in the solution development process and creating links between different components are inherent in the design action and design education. The constructivist structure of design thinking methodology has yielded it to be used as a tool for design education. As design sprint is one of the notable frameworks of design thinking, it is worth asking if design sprint can be used in a similar manner. This study examines whether design sprint has a similar kind of potential in design education and discusses ways of implementing an entrepreneurship application in industrial design education. It differs from other studies in the field by adapting Jake Knapp's framework to the industrial design discipline. In order to do that, a design sprint workshop with undergraduate level industrial design students was carried out and the process and results of the workshop analysed. This study has been constructed upon the theoretical basis of design thinking and design sprint, educational applications of design sprint, and the process and outcomes of the design sprint workshop.

Background

In this section, firstly the concept of design thinking is set out, similar methodologies and approaches that focus on innovation are shared and the relationships between them revealed. Then the design sprint framework, which is the subject of this study and an innovation-oriented approach, and the studies conducted using this framework are described. In this way the theoretical framework of the workshop actualized in industrial design education was constituted.

Design Thinking

Two current discourses can be mentioned related to the concept of design thinking. These two discourses are (1) working practises of designers, which is directly related to design, and (2) human centred problem-solving approach for decision makers to solve wicked problems of the real world, which is connected to the fields of management and business (Johansson & Woodilla 2010; Melles 2010). Whilst the first discourse of design thinking expresses the designers' practices and how they think while working and constitutes an academic field with a history of about fifty years, the second one is an innovation and value creation method for better business success and is newer than the first discourse (Hassi & Laakso 2011; Johansson & Woodilla 2010). In the continuation of this study, the term 'design thinking' is used to define the human centred problem-solving approach as explained in the second discourse.

The late 1990s and early 2000s can be seen as the period during which design thinking really emerged; since then its recognition has increased and it has begun to be used beyond the design discipline. IDEO, a Silicon Valley based design firm, was one of the pioneers of this popularization process. Design thinking can be described as a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity (Brown 2008). It is a collaborative, team-based and interdisciplinary learning process of observation, framing, ideation and solution development (Beckman & Barry 2007; Curedale 2013). This process generally starts with a problem or a question instead of an idea (Mueller & Thoring 2012).

The concept of design thinking can be summarized as human-centred approaches, and it has been handled by a variety of institutions that have often named it differently. These approaches used in the new product development and innovation process are as follows:

- Human Centered Design → IDEO Foundation (The Field Guide to Human-Centered Design 2015),
- Design Thinking → D.School ('An Introduction to Design Thinking' n.d.),
- Double Diamond → Design Council (Innovation By Design 2015),
- 3 Gears of Business Design → Rotman School of Management (Fraser 2009).

Despite the varying terminology, there are notable similarities between the different methods and processes shared under the human-centred approach. Starting with empathy, including divergent and convergent stages, being fed by the user, or even including the user in the processes, are all examples of the similarities between them.
There are also methods and processes with similar characteristics which can be grouped within a customer-centred approach while being closer to the business perspective used in innovation seeking and new product development processes:

- Customer Development (Blank & Dorf 2012),
- Lean Start-up, Build-Measure-Learn Feedback Loop (Ries 2011),
- Business Model Generation / Canvas (Osterwalder & Pigneur 2010),
- Running Lean, Lean Canvas (Maurya 2012).

There are many common aspects between human-centred approaches and customer-centred approaches. Both approaches start from potential customers, collect data from them, and involve customers, potential users and other stakeholders in their development processes. In both approaches, ideas and prototypes are developed by revising them with potential user feedback, and they are both based on learning and identify the process as a cycle rather than a linear process. Although they apply similar methods and tools, they use different names in the process. In human-centred approaches, iteration usually takes place at the test stage through the prototype towards the end of the whole process, while in customer-centred approaches, it is called pivoting, and can be implemented earlier, not only in the prototyped idea, but even before the hypothesis is tested (Mueller & Thoring 2012).

The common feature of customer-centred approaches, which distinguish them from human-centred approaches, is the search for the profitability and the profit which is also included in the definition of the enterprises and ventures. In addition to this, there are several other main differences between these two approaches. When it comes to the questing for innovation and new product development process, in general human-centred approaches are focused on innovation, while customer-centred approaches focus on innovation for enterprises, especially for technology start-ups. In human-centred approaches, the idea is built throughout the process, while in customer-centred approaches, there is generally an initial idea and hypotheses are tested in the process. While human-centred approaches use the tools of many different creative disciplines, customer-centred approaches have specialized tools such as canvases. While qualitative evaluation is made in human-centred approaches, qualitative and quantitative evaluation can be made in customer-centred approaches.

In this section, the variously named approaches based on the concept of design thinking have been generalized as human-centred approaches, and approaches with similar features but more of a business perspective have been described as customer-centred approaches. An effort was then made to reveal the similarities and differences between these two approaches. In the next section, design sprint will be addressed, another methodology focused on innovation feeding from the design thinking perspective.

Design Sprint

'Design Sprint' is an intensive methodology and framework that aims for innovation based on design thinking principles. Banfield et al. (2016) state that it evolved from and is comprised of a number of different approaches such as design thinking, agile, etc., and it is a flexible product design framework, not a set of rules, which can be tailor made for different teams and needs. It is a step by step one-week process which can be used by any development team or organization.

Like the customer-centred approaches mentioned above, it is especially popular in the technology start-up ecosystem, probably because of its origin. During their working experiences in Google and Google Venture, Knapp et al. (2016), developers of design sprint, observed that strict deadlines, focusing on individual work, and giving time to prototype are more productive than traditional workshops which consist of noisy brainstorming and group discussion sessions. Design sprint and its core principles developed from these key ideas.

Knapp et al. (2016) define a five-day process for running design sprint as below:

- Day 1 (Monday): Structured discussions to create a path for sprint. At this stage, the long-term goal is established, sprint's challenge map is created and the process continues by obtaining knowledge from the company's experts. Finally, the ambitious but manageable target point of a solution within one week is arrived at.
- Day 2 (Tuesday): With the help of the decisions and target point established on the first day, Day 2 concentrates on solutions using structured ideation and sketching methods.
- Day 3 (Wednesday): Decision making day for the creation of a prototype and its testing based on one of the solutions created on Day 2. The team then creates a storyboard which is also a step by step plan of the prototype.
- Day 4 (Thursday): Prototyping day. The team creates 'fake' and realistic prototypes for testing the following day.
- Day 5 (Friday): Decisions and hypotheses of the team are tested via prototypes with real people.

This is a very quick timebox approach and an essential practice for organizations which are serious about innovation but have no time to do user studies (Banfield et al. 2016; Mikkonen 2013). Due to the whole process and its stages being defined in a timebox, the need for preliminary preparation and data are necessities for design sprint.

Although it is presented as a general approach and framework for innovation, it can be said that its suitability depends on the particular case. Mikkonen (2013) states that it is more suitable for generating concepts from imaginable topics, such as user interfaces or mobile

devices, generally the subjects of technology start-ups. Banfield et al. (2016) indicate that it can be less helpful if the product is well defined, if there is an additional research need, or if a business opportunity is not clear. This is supported by the fact that design sprint starts with discussions and the sharing of knowledge between organizations and consists of testing and revising a hypothesis.

There are some recent studies comparing design thinking and design sprint, which can be helpful to understand the concept better. Figueiredo & Fleury (2019) compare design thinking and design sprint, reporting their relative advantages and disadvantages:

- Design Thinking builds something totally new; understands the context in depth and then creates a solution; has a 'learn by sharing' character; uses prototypes with a more general character that can simply be for describing a possible solution; stems from the will to look at the needs users are facing and help them in finding a solution; and involves processes that can last hours, days, months or even years.
- Design Sprint creates a workable solution; develops MVP (most viable product) quickly; has a 'learning by doing' character; simulates working prototypes; comes from an internal company challenge; and has a defined duration of 5 business days, from Monday to Friday.
- Figueiredo Correio and Fleury (2019) also compare design sprint and design thinking, then summarize the advantages of design sprint in three points:
- Owing to the one week long, well-defined and clearly structured nature, it has a low experimentation barrier.
- By involving executives, especially at the decision stages, solutions can be compatible with the company's plan.
- As with the lean approach, focusing on the priorities and testing with real users, its orientation is incremental innovation.

Design sprint, which is a customized framework based on the design thinking approach, can be appropriate for various needs. It may not be correct to compare design thinking and design sprints directly since they are not equivalent or contrary to each other. However, this comparison is still required in order to position the concepts relative to one another. In the next section, studies which use design sprint, especially in the field of education, will be discussed.

Educational Usage of Design Sprint

In order to have a solid discussion on how to use design sprint in the industrial design education process, related studies which have actualized design sprint in educational environments and characteristics of industrial design education need to be examined.

In the search for related studies, only a limited number of studies and examples were found. The reason for that may be the newness of the design sprint framework. The majority of examples reached were related to computer science education. Ferreira and Canedo (2019) conducted a study investigating how design sprint can be adapted to Information Technology undergraduate education. Following their case studies, they claim that the process needs a longer time period and they state their intention to test it over a full academic semester

(Ferreira and Canedo 2019). Larusdottir et al. (2019) emphasize the disregard of Human Computer Interaction (HCI) and User Centered Design (UCD) in the field of education when considering their methods and practical usage. After their two-week intensive UCD summer course, Larusdottir et al. (2019) observed that the main problems of the students were time management and user involvement. Raubenolt's study was not actualized in the education environment but obtained similar results. After implementing design sprint and conducting a survey with participants, Raubenolt (2016) suggested that the design sprint process requires more time especially for prototyping and sharing with the team the summary of the problem and educational material before team members can be prepared for the process.

In industrial design education, studio/project-based approaches have been quite common. The studio is a simulation of the professional working environment and the content of the studio methodology consists of several steps of the design process, such as sketching, conceptual design, final jury, etc. (Oxman 1999). In the studio approach, students are expected to experience design processes as they would in their future professional life. Overbeeke et al. (2004) describe projects and assignments in design studios as the doors which lead students to the path of a designer's knowledge, skills and attitudes. Cross (2001) emphasizes the intellectual culture of design itself, and the idea of design education nourishing it. In this respect, contemporary tendencies and changes in design culture reflect upon design education. New approaches related with design evolve over time and design education walks arm in arm with these new approaches. For design thinking, it has been the same. Wrigley & Straker (2017) point out the nexus between the process of design thinking and the five themes of design thinking courses, which are 1) theories, methods and philosophies, 2) product focus, 3) design management, 4) business management, and 5) professional development. So the effect of design sprint upon education will inevitably be seen due to the nature of design.

Thomas and Shin (2016) apply a similar method to design sprint in industrial design education, giving it a similar title, Educational Design Sprint. However, Google's design sprint did not have any particular starting point of process setup, stating that they realized it later. The Educational Design Sprint of Thomas and Shin (2016) is a 3-5-week process consisting of 7-9 lessons. They also compare corporate design process with the design sprint process, finding that design sprint has fast phases with not much market or user research, and fewer iteration phases than design process. They mention that their intention was not to identify which design process is superior and they point out that there are many lessons for students to learn by exploring product development with different approaches.

There is another study which aims to integrate design sprint with research carried out in the Netherlands in the domain of health and wellbeing. Action Design Research (ADR), which is a combination of Action Research (AR) and Design Research (DR) proposed by Sein et al. (2011), is an approach to design IT artefacts in a problem inspired and action oriented setting which starts with a practical problem in an organization (Keijzer-Broers & Reuver 2016).

Keijzer-Broers and Reuver (2016) integrate design sprint to ADR process for a quick launch into the design process, because of the budget and time constraints in ADR projects.

Considerable potential has been seen in the application of the design sprint concept to design education, in terms of improving students' problem-solving capability and addressing the lack of case studies actualized within the scope of design education.

Methodological Approach

The aim of this study is to find out how the design sprint framework, which is one of the structured questing innovation tools, can be used in industrial design education, and to reveal which aspects of it work and which are ineffective. It was considered worthwhile to investigate how industrial design education, which aims to add professional skill to students via the experience of different methodologies in new product development and problem-solving processes, will interact with design sprint. Since this study searches for the impacts of design sprint approach on industrial design education, participants of the education system, in this case students, were involved in the research process. Within the scope of this study, a design sprint intervention was made in the area of industrial design education, following Jake Knapp's framework. This intervention took the form of a workshop and its impacts were evaluated in the light of the data obtained.

This study is based on the design sprint workshop held at the end of the fall semester of 2019 in the Industrial Design Department of Al-Zahra University in Iran where the researcher was a guest lecturer for a limited time. Volunteering participants of the study were 12 students who were in their fifth semester of an eight-semester undergraduate level industrial design course. Since the university specialized in the education of women, all participants were female. The participant students were classmates, so they were familiar with each other, but they first met the researcher during the workshop. In this study, the researcher served as the executive. The researcher has had experience in running Design Thinking courses and workshops with both undergraduate level and graduate level students from the industrial design and other disciplines. Thus, the researcher was able to evaluate the required adjustments during the workshop.

A variety of qualitative data collection tools were used in this study. Throughout the design sprint workshop, the researcher made detailed observations on the process of participant students. Carr & Kemmis (1986) stress the essential requirement of understanding other actors in the transformation process in an action, so in addition to observation, participants were asked to keep a diary at the end of each workshop day and share it with the researcher at the end of the process to comprehensively report on their workshop experience. 'Diary', as a kind of writing method, preserves the reflections of its owner, helps to recapture and intensify the experience, supports learning, and also gives clues about the owner's insight (Walker 1985). Thus, diaries in the design sprint workshop provided a closer look from the participants' point of view. Finally, after the design sprint process, feedback was received from the participants with the help of a questionnaire containing open-ended questions. Applying different data gathering techniques in this study helped to get detailed information about the process and to create data triangulation which is defined by Yin (2016) as a way of strengthening the credibility of a study by finding convergence on outcomes. As Creswell (2009) explains, following the collection of data, a group of themes emerges from the process from which research results can be drawn.

Design Sprint Workshop with ID Students

The structured step by step framework that Jake Knapp created was used as a reference, and some revisions were made while planning and running the workshop. First of all, the design sprint, which originally required a 5-day period, was shortened to 3.5 days due to time constraints at the case study university: On the first day, the understand and define stages; on the second day, the sketch and decide stages; on the third day, the prototype stage; and on the last half day, the testing stage was actualized via relevant methods (Table 1).

Table 1: Structure of The Workshop

Day	Design sprint workshop structure	What was done at this stage?	It was done by…
1	Understand stage	Determination of the starting point	dot voting between the variety of products of students
		Creation of imaginary company	writing sticky notes about the company and then dot voting between them
		Asking the experts	role playing as if students were the experts in the company
		Capturing ideas	writing sticky notes with “How might we” questions
		Determination of goals and questions	writing variety of goals and questions on sticky notes and dot voting between them
		Persona creating instead of mapping	writing characteristics of users
	Define stage	Define the target users and target problems	dot voting between “How might we” questions which were organized into groups
2	Sketch stage	Lighting talks	giving information about other companies, market and relevant other products and concepts
		Sketching the ideas	four step sketching: 1) notes, 2) ideation, 3) crazy 8s, 4) solution sketches
	Decide stage	Art museum	sticking sketches to the wall
		Heat map	using multiple votes for the exciting ideas on the sketches on the wall
		Speed critique	explanation of the ideas by facilitator
		Straw poll	selection of projects using only one vote
		Supervote	grouping the highest voted projects into two and working with both projects instead of CEO vote
3	Prototype stage	Making prototype	developing prototypes by using appropriate tools, advancing from storyboards, division of tasks and creating the prototype model by only one person and trying it.
3.5	Validate stage	Testing the prototype	interviewing 5 users for each product

Before running the workshop, the researcher prepared a presentation that included theoretical knowledge about design sprint and its stages. Thus, at the beginning of each stage, it was possible to share the relevant theoretical information about that stage with the participants. In design sprint, the first requirement is a starting point. For this purpose, the students were asked to bring products they use in their daily lives to create a starting point for the process and to facilitate the processes that require preliminary research such as the usage scenario and market of the product. Products brought and shared by students ranged from glasses, a smart wristband, a thermos, and a computer mouse, to a french press. There were both low- and high-tech products. Using the dot voting method, which is often used in the design sprint process, the product/subject to constitute the starting point of the study was determined democratically (Figure 1). More than half of the students chose a thermos.

Figure 1: Design sprint object selection process.

As this study was carried out in the educational environment, the first step was to create an imaginary company. Participant students were asked to think of themselves as the staff of a company that produces thermoses, and one of the students was assigned as the facilitator of the workshop. Role playing activities and other stages of design sprint were realized through this company and its features. In addition to this change to the design sprint method, at the end of the second day, a revision was made before the prototyping stage. Since the company was artificial and there was no CEO to supervote, ideas with the highest number of votes were grouped into two themes. Then the student group was divided into two parts and both teams were asked to prototype their projects according to the themes. During this process, students were sometimes overwhelmed by the duration of the phase and occasionally the facilitator student needed support. At such times, additional time was given to the students and the researcher gave the required support to the facilitator. Apart from these necessary revisions, as far as possible, the nature of design sprint was adhered to.

Limitations of the workshop

Prior to discussing the results of the workshop and the potential of the design sprint framework in industrial design education, major constraints of the study need to be considered. First, depending on the duration of the workshop, the allotted time of the stages in design sprint framework was reduced. Especially in the prototyping stage, the combination of the students' performance in the usage of design tools, lack of required equipment and space, and shortening time affected the process. In addition to the challenge of creating testable prototypes in a limited time, the participating students focus on small details and being unable to create high fidelity 3D prototypes in such a short period ended up using 2D presentations of the products as testable prototypes. The sprint was actualized through an imaginary company. Thus, on the contrary to running a design sprint in an existing company, the participants of the workshop could not get the required data beforehand. In addition to that, dealing with an imaginary company and being run in an educational environment in a very fast phase caused a lack of a specialist's evaluation on the stages of the design sprint.

Results

The imaginary company, created by participants after the dot voting of subject/ artefact, was named TAF. A fictional company history was outlined: TAF was founded fifty years ago for the production of traditional teapots in Iran, then extended its product portfolio to other metal kitchen appliances and was currently looking for new products and solutions for global markets (Figure 2).

Figure 2: Fiction of TAF.

Firstly, students made selections between the alternatives of goals and problem areas of the company and “How might we” questions by dot-voting (Figure 3). The highest rated goals of the company were:

1. Using new technology in our product in raising the time keeping
2. Using new material and becoming ‘smart’
3. Using new designing and producing methods.

Questions that students wanted to find answers to in the sprint were:

1. Which materials could be more suitable in terms of production and usage?
2. How can design be pure and minimal?
3. How can we increase the usage of our product?

“How might we (HMW)” questions which got the highest votes of students out of 51 alternatives were:

1. HMW make self-heating and portable ruhi dishes?
2. HMW omit metals from our products?
3. HMW make less waste?

Figure 3: HMW questions.

Once the target users and target problems were defined by the students, the sketching stage was carried out by considering the outcomes of the previous stages. Students drew their ideas anonymously, using the same kind of paper and pencil. Students created solutions and voted on the ideas. Since this workshop was actualized in an educational environment and there was no CEO to decide which ideas to pursue, the highest voted ideas were grouped under two themes and the participants were split into two different teams. Two different thermoses for TAF were designed by two different groups according to the criteria they set at the beginning of the design sprint. The groups visualized the usage scenarios of their products during the prototyping stage and created photorealistic renderings. In addition, they integrated the thermos, a physical product, with digital solutions such as mobile applications and created examples for the interfaces of these digital solutions.

The first group concentrated on mountain hikers and climbers and developed a thermos with the requirements of this user group (Figure 4). Possible features of the mountain hikers' thermos were identified as easy to hold and carry, chargeable self-heating, easy to clean, easy to find thanks to neon colours etc.

Figure 4: Thermos for mountain hikers and climbers developed by the first group.

The second group aimed to facilitate the use of the thermos for a more general market and developed solutions for this (Figure 5). Stability problem and tilting, having no idea about the temperature of the liquid in the product, possible negative experiences of visually impaired people, and losing the product and being unable to find it were problems that they tried to solve.

Figure 5: Thermos for all developed by the second group.

Since the developed solutions were mostly physical artefacts and due to time constraints, presentation posters in A3 size paper and marketing materials consisting of photorealistic visuals were created in the prototyping stage for the testing stage. These marketing materials were product pages in shopping sites such as Amazon or flyers (Figure 6). Each group tested their products with 5 people.

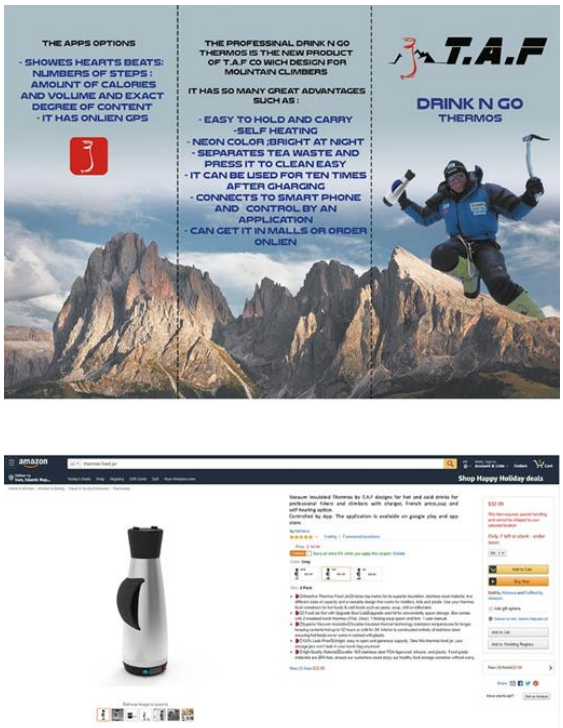

Figure 6: Amazon page of the product and flyer.

Since the process was analysed via student feedback collected by questionnaire, diaries and observation, many positive and negative inferences could be made. The questionnaire aimed to evaluate design sprint practice in the educational context by asking students the following open-ended questions:

1. What did you learn from the Design Sprint Process?
2. How could it be improved?
3. Is there any negative aspect in this process?
4. Are there any similarities or differences between your previous processes and Design Sprint?

Diaries reflected the experience of the students. Observations helped to analyse the impacts of the design sprint intervention. After analysing the questionnaires, diaries and observations, it can be said that the positive themes were: democratic characteristic of the process, being able to be a decision maker in an educational assignment, having group work but being able to work individually within the group, visualizing every action, ease of finding a starting point, self-confidence coming from the anonymity of the sketches, understanding the relations between industrial design and other disciplines, understanding the importance of prototyping and testing, not having homework, and having an organized process. The intensity of the process, and lack of time at the prototype stage were the two main negative themes.

It is a common method to have a master-apprentice relationship in design education and the students' work is criticized, verified or falsified by the advisors so that students can continue the development process of the projects according to the comments of their advisors. In the design sprint framework, the project development process continued in a more democratic way via a structured process and tools, and the testing of the idea to be verified or falsified was left to the testing stage. The students said that the design decisions they made were not labelled as wrong by an educator in the process, and this made them feel more comfortable. One of the students stated:

> *It was almost one of the first times that I could choose what I like and which way I want to proceed, a professor didn't take part and no one was making my decision.*

Similar to the decision-making aspect, in traditional studios, students have no power over others' projects and have no chance to follow their design decisions besides group critiques and juries. Thus, progress in the project is actualized only within the student's own perspective. In the design sprint workshop, everyone was able to follow all ideas and vote to improve them. This gave the students freedom in all phases. One of the students even admitted, "I really loved voting for our decisions."

In addition, some stages of the process such as prototyping, provided opportunities for dealing with activities that they liked and were interested in, and this was another point emphasized positively by students. At the prototyping stage, students had the opportunity to share work according to the subjects they are more interested in, such as graphic work, copywriting or 3D modelling. Facilitating the decision-making processes via tools and methods such as dot voting, and making group work more productive, by 'Working Together Alone' compared to brainstorming, etc., were other points positively evaluated by students. One of the students explained it in the following way:

> *Honestly, I like giving ideas alone, I'm not saying that I don't like work in a group and it's not efficient. I'm saying that I like to imagine and sketch it by myself then have my friends' suggestions to improve it.*

Anonymity of the process made students comfortable:

> *The other one is that the whole class had to use the same colour for writing and they mustn't write their names, so they can write with comfort and there will be no bias. No one is better or worse than anyone else.*

It has been stated as a positive aspect of design sprint process by many students that the project development process in traditional design studios and design education consists of intense work which continues outside the studio as homework, while design sprint workshop, on the contrary, involves no homework assignments, the whole process being done in the studio environment during the day.

As the negative aspect of the design sprint process, most of the students mentioned the problem of time limitation. Design sprint is already an intensive process, and as the current study was carried out in a university where the researcher was working as a guest lecturer, the study duration was, by practical necessity, shortened further to just 3.5 days. At almost every stage, time extension was given according to the demands of the students. For example, the solution sketching stage was planned as 90 minutes, but extended to 120 minutes. Many students have stated that the process was very intense and that if they had had more time, they could have done much better. In addition, the students stated that they were more energetic in the morning hours, thus they could concentrate better on the problem, and their fatigue increased in the afternoon studies. One of the participant students who found the process intensive and exhausting mentioned that despite this negative aspect she was willing to repeat the process:

> *To be honest at the end of the last week I was so happy that it was over and I get to have some rest (of course not because of your class but because of the crazy timings) but now when I look back at the experience I wish that your class and that whole week could happen again, like once or even twice in a every month actually! That's how much I enjoyed it. I'm still in shock and I can't believe how much work we've done and how much I've learnt during the past week.*

Another important point of the design sprint process that distinguishes it from the traditional design studios, is that instead of a jury consisting of studio executives, their design decisions were verified or falsified by potential user interviews and testing (Figure 7). It was a substantial achievement for students that they directly experienced that some of their decisions and assumptions were perceived differently by potential users.

Having an organized structure, design sprint practice helped students to complete the task, and the multidirectional, democratic structure of the design sprint approach positively affected the project development process.

Figure 7: Potential user interviews and testing.

Discussion

There are significant similarities between the results of this study, actualized for the purpose of how to use design sprint framework in industrial design education, and previous studies. As Figueiredo and Fleury (2019) state, the well-defined and structured nature of the framework eased the experimentation. The fact that the researcher had already had experience as an educator in industrial design can be said to have had a facilitating effect. Thanks to this experience, it was possible to restructure and tailor the process according to immediate needs and reactions, by manipulating the duration of some of the phases and supporting the students if they faltered at any point in the process.

Similar to workshops held by different disciplines before, time problems were frequently encountered throughout the process (Ferreira & Canedo 2019; Larusdottir et al. 2019; Raubenolt 2016). However, this problem was not encountered at every stage of the process. For example, combining the sketch and decide stages in one day, which were defined as two separate days by Knapp et al. (2016), did not cause a big problem. Conversely, especially in the prototyping stage more time was needed. This may be due to the fact that students were still in their fifth semester, and their practice and speed in using related digital tools was still being developed. When similar studies are carried out with seniors, the time problem may decrease. It was very strongly emphasized that the prototyping stage is for testing the solution rather than creating presentation material. However, the instincts of a design student, being a nit-picker and going into every detail, negatively affected the prototyping stage. In addition, the time and effort difference between the creation of a testable prototype of digital solutions and physical solutions was another challenging factor. As Mikkonen (2013) states, the framework is more suitable for imaginable topics such as creating user interfaces or mobile device solutions. To create physical testable prototypes in a limited time may require a more qualified team and workshop facilities, and it might be one of the biggest challenges of adapting this framework to industrial design education.

In this study, the subject of the sprint was determined via dot voting by the participants, and then the data and imaginary company needed in the process were also created by the students. This freedom and the participatory method made it easier for participants to adopt the issue and the problem. However, even if the design sprint process had been planned by acting from an existing company, it may have been easier to provide the data needed beforehand, especially for the initial stage of the process. Thus, for students who started the design process with intensive user and market research in an ideal scenario, this phase may be overcome more easily with the help of concrete data as opposed to imaginary data. In addition to that, due to the fictional nature of the workshop, even though the proposed solutions came closer to the sprint target, they did not fully cover the sprint questions and HMWs.

When comparing the traditional studio approach and the design sprint intervention, it can be said that although the students achieved similar results with the traditional design process, the path they followed was different based on the nature of the design sprint. Being able to improve projects from a collective perspective, not feeling a hierarchy in the educational environment, understanding the connections of industrial design with other disciplines from the first hand and understanding the importance of user testing, feeling of democracy and independence separate design sprint from the traditional studio approach.

The approaches and methodologies used in the questing for innovation process are categorized as customer-centred approaches and human-centred approaches in the literature review section. Design sprint may be included in the category of customer-centred approaches due to its features of being closer to the business perspective and being used for technology start-ups by Knapp et al. (2016). In addition, this framework and the others in the customer-centred approach category can be demonstrated in practice to the senior design students, so they can gain awareness in different problem-solving methodologies. Finally, the design sprint framework in the educational environment ensures that senior students who are trained in different departments can work on the same subject. This experience may be one of the most suitable and memorable simulations of professional life that students are offered.

Conclusion

In this study, the relationship between design sprint and similar approaches focused on innovation has been revealed and how this framework can be used in industrial design education has been examined. A three-and-a-half-day workshop was held with the 5th semester students in the Industrial Design Department of Al-Zahra University in Iran. The most important problem encountered according to the feedback received at the end of the process was the intensity of the process and especially the problem of limited time for the prototyping stage. Realization of the whole development process within working hours, freedom to continue their development processes until the testing stage without being falsified by a higher authority, possibility of dealing with the activities they are more naturally inclined towards, and tools and methods such as dot voting and ‘Working Together Alone’ in the process were considered positively by students. The students themselves determining the subject of the design sprint process and their role-playing an imaginary company are among the revisions made to the design sprint framework. In addition, rather than preparing visual materials for the jury and presentation, using these for testing the developed solution with potential users was a new approach, distinct from the conventional methods used in design education. The positive feedback of participant students emphasized the potential of the design sprint as a catalyst in

the project development process. However, further studies with varying sample groups are needed to verify the potential of the design sprint in design education. This study is carried out to find the effective and ineffective aspects of the application of the design sprint framework in design education. In that sense, the positive and powerful aspects of the design sprint in design education can be counted as challenging but productive nature of the rapid process, dealing with projects solely on work hours, continuous project development, diminishing the hierarchy in the design studio, and providing a chance for students to participate the whole process equally with other actors. In addition to that, the fast-paced essence of the design sprint framework might not always suit all cases in terms of creating testable physical prototypes and need for specialist's opinion and evaluation need to be considered.

It is inevitable for design education to have similarities with the new approaches in design practice because both evolved mutually. It is again inevitable for design education to remain close to other disciplines because their existences are dependent upon each other. In that sense, design sprint can serve as a connector between different disciplines in a new kind of design studio approach or it can be a tool to spread seeds of multidisciplinary work in the minds of students, or it can simply be a tool to accelerate the project process. So, depending on the context, different axes of the design sprint can be put forward in design education, being used within the frame of product focus, design management, business management or professional development. Finally, by benefiting from frameworks such as design sprint, it can be ensured that design education is kept up-to-date and the connection between design and other disciplines can be reinforced.

References

An Introduction to Design Thinking Process Guide (n.d.) https://dschool-old.stanford.edu/sandbox/groups/designresources/wiki/36873/attachments/74b3d/ModeGuideBOOTCAMP2010L.pdf Accessed 13 December 2019.

Banfield, R., Lombardo, C. T., & Wax, T. (2016). *Design Sprint: A Practical Guidebook for Building Great Digital Products*. O'Reilly Media, Inc.

Beckman, S. L., & Barry, M. (2007). Innovation as a learning process: Embedding design thinking. *California Management Review*, 50(1), 25–56.

Blank, S., & Dorf, B. (2012). *The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company*. California: K & S Ranch.

Brown, T. (2008). Design thinking*. Harvard Business Review*, June(6), 84–92. http://0-search.ebscohost.com.divit.library.itu.edu.tr/login.aspx?direct=true&db=edsggo&AN=edsgcl.179770754&lang=tr&site=eds-live Accessed 7 January 2020.

Cox, G. (2005). *Cox Review of Creativity in Business: Building on the UK's Strengths.* TSO.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publication.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science, *Design Issues*, 17(1), 49-55.

Curedale, R. (2013). *Design Thinking Process and Methods Manual*. Topanga: Design Community College.

'Definition of industrial design' (2018). http://wdo.org/about/definition/ Accessed 19 November 2018.

Ferreira, V. G., & Canedo, E. D. (2019). Design Sprint in classroom: Exploring new active learning tools for project-based learning approach. *Journal of Ambient Intelligence and Humanized Computing*, 1, 22.

Figueiredo Correio, L. B., & Fleury, A. L. (2019). Design Sprint versus Design Thinking: A comparative analysis. *GEPROS*, 14(5), 23–47.

Fraser, H. M. A. (2009). Designing business: New models for success. *Design Management Review*, 20(2), 56–65.

Hassi, L., & Laakso, M. (2011). Design Thinking In The Management Discourse: Defining The Elements Of The Concept. *In 18th International Product Development Management Conference.*

Innovation by Design (2015). Design Council.

Johansson, U., & Woodilla, J. (2010). *How to Avoid Throwing the Baby Out with the Bath Water: An Ironic Perspective on Design Thinking,* Lisbon, Portugal: EGOS Colloquium.

Keijzer-Broers, W. J. W., & de Reuver, M. (2016). Applying agile design sprint methods in action design research: Prototyping a health and wellbeing platform. in *International Conference on Design Science Research in Information System and Technology*, 68–80.

Knapp, J., Zeratsky, J., & Kowitz, B. (2016). *Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days.* Simon and Schuster.

Larusdottir, M., Roto, V., Stage, J., Lucero, A., & Šmorgun, I. (2019). Balance talking and doing! Using Google Design Sprint to enhance an intensive UCD course. In *IFIP Conference on Human-Computer Interaction,* Springer. 95-113.

Overbeeke, K., Appleby, R., Reinen, I. J. & Vinke, D. (2004). Nine competencies, six units: Industrial design education at TU/e. In *Proceedings of International Engineering and Product Design Education Conference*, Delft. 3-10.

Maurya, A. (2012). *Running Lean: Iterate from Plan A to a Plan that Works*, Sebastopol, CA: O'Reilly.

Melles, G. (2010). Curriculum design thinking: A new name for old ways of thinking and practice? In *Proceedings of the DTRS8 Conference, Sydney.* 299–308.

Mikkonen, J. (2013). The design sprint. In *IASDR 2013: 5th Intl Congress of the Intl Association of Societies of Design Research*. Tokyo: Shibaura Institute of Technology.

Mueller, R. M., & Thoring, K. (2012). Design Thinking Vs Lean Startup: A Comparison of Two User-driven Innovation Strategies. In *Proceedings of 2012 International Design Management Research Conference.* 151–161. https://doi.org/10.13140/2.1.1834.4647

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers,* John Wiley & Sons.

Oxman, R. (1999). Educating the designerly thinker. *Design Studies*, 20(2), 105–122.

Raubenolt, A. (2016). An analysis of collaborative problem-solving mechanisms in sponsored projects: Applying the 5-day sprint model. *Journal of Research Administration*, 47(2), 94–111.

Ries, E. (2011). *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses,* New York: Crown Business.

Sein, M. K., Henfridsson, O., Purao, S., Rossi, M., & Lindgren, R. (2011). Action design research. *MIS Quarterly*, 35(1), 37-56.

The Field Guide to Human-Centered Design (2015). Canada: IDEO.

Thomas, J., & Shin, S. S. (2016). Implementing design sprints in the education of industrial designers. *Design Principles and Practices*, 10(1), 59–73.

Walker, D. (1985). Writing and reflection, in D. Boud, R. Kneough and D. Walker (Eds), *Reflection: Turning Experience into Learning*, (pp.52-68), Oxon: Routledge.

Wrigley, C. & Straker, K. (2017). Design thinking pedagogy: The educational design ladder. *Innovations in Education and Teaching International*, 54(4), 374-385. doi:10.1080/14703297.2015.1108214

Yin, R. K. (2015). *Qualitative Research from Start to Finish*, Guilford Publications.