INDUSTRIAL DESIGN STUDENTS' EXPERIENCES OF INTERDISCIPLINARY TEAMWORK

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ABSTRACT

INDUSTRIAL DESIGN STUDENTS' EXPERIENCES OF INTERDISCIPLINARY TEAMWORK

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Collaboration with the people from different disciplines has become an essential part of the contemporary industrial design practice. Along with the current trend of interdisciplinary teamwork in professional life, recently new interdisciplinary programs have emerged in university education. Despite the increased importance of interdisciplinarity for industrial design discipline, little is known about the perspectives of industrial design students on interdisciplinary teamwork. This thesis examines this gap by exploring the Interdisciplinary Design Studio (IDS), organized by the METU Design Factory, with the aim of understanding the industrial design students' perspectives on working with different disciplines. The fieldwork of the thesis consists of two sets of interviews conducted with the industrial design students, pre-studio interviews and after studio interviews, and participant observation that was done during the IDS. Based on the fieldwork findings, this thesis offers four main conclusions. First, the industrial design students are aware of the importance of interdisciplinary teamwork for the industrial design practice and they are open for interdisciplinary collaborations. Second, experiencing an interdisciplinary collaboration during undergraduate education prepares the industrial design students for the professional life. Third, while collaborating in an interdisciplinary team, industrial design students feel responsible for explaining and introducing the industrial design profession to others. In doing so, they also think reflexively about their own profession and their self-confidence as future industrial designers is boosted. Lastly, the experience of interdisciplinary collaboration changes the industrial design

students' perspectives on working with other disciplines towards integrationist interdisciplinarity.

Keywords: interdisciplinary design education, interdisciplinary teamwork, industrial design students

ÖZ

ENDÜSTRİ ÜRÜNLERİ TASARIMI ÖĞRENCİLERİNİN DİSİPLİNLER ARASI TAKIM ÇALIŞMASI DENEYİMLERİ

Demir, Özümcan
Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü
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Farklı disiplinlerden insanlarla birlikte çalışmak günümüz endüstriyel tasarım pratiğinin önemli bir parçası haline gelmiştir. Profesyonel hayatta artan disiplinler arası takım çalışmalarına paralel olarak son zamanlarda üniversite eğitiminde de disiplinler arası programlar ortaya çıkmıştır. Disiplinler arası çalışmaların endüstriyel tasarım disiplini için artan önemine karşın, endüstri ürünleri tasarımı öğrencilerinin disiplinler arası takım çalışmasına bakış açısıyla ilgili bilinenler kısıtlıdır. Bu tez, literatürdeki bu eksikliğin üzerine eğilerek, ODTÜ Tasarım Fabrikası tarafından organize edilen Disiplinler Arası Tasarım Stüdyosu'nu inceleyerek endüstri ürünleri tasarımı öğrencilerinin farklı disiplinlerle beraber çalışmaya karşı olan bakış açılarını anlamayı amaçlamıştır. Tezin alan çalışması, stüdyo öncesi ve sonrası olmak üzere endüstri ürünleri tasarımı öğrencileri ile yapılan iki set görüşme ve stüdyo süresince yapılan katılımcı gözlemlerden oluşmaktadır. Alan çalışması bulgularına dayanarak dört sonuç çıkarılmıştır. Öncelikle, endüstri ürünleri tasarımı öğrencileri disiplinler arası takım çalışmasının endüstriyel tasarım pratiği için öneminin farkındadırlar ve disiplinler arası işbirliklerine açıklardır. İkinci olarak, disiplinler arası takım çalışmasını eğitim sırasında deneyimlemek bu öğrencileri profesyonel çalışma hayatına hazırlamaktadır. Üçüncü olarak, disiplinler arası bir takımla işbirliği sırasında endüstri ürünleri tasarımı öğrencileri kendi mesleklerini anlatma ve tanıtma sorumluluğu hissetmektedirler. Bunu yaparken bir yandan da kendi meslekleri hakkında değerlendirme yapma fırsatı bulmakta ve sonuç olarak geleceğin endüstri ürünleri tasarımcıları olarak özgüvenleri artmaktadır. Son olarak, disiplinler arası

işbirliği deneyimi endüstri ürünleri tasarımı öğrencilerinin disiplinler arası takım çalışmasına bakış açılarını bütünleştirici disiplinler arası çalışma anlayışına doğru değiştirmektedir.

Anahtar Kelimeler: disiplinler arası tasarım eğitimi, disiplinler arası takım çalışması, endüstriyel tasarım öğrencileri

Just do your best.
It's the only way to keep that last bit of sanity.

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CHAPTER 1

INTRODUCTION

1.1 Background

Industrial production was central to the 20th century manufacturing, with manual workers being the main asset of that time. As advancing technologies and globalization changed production practices, knowledge workers have become the main actors of the 21st century (Drucker, 1999; Karoly, 2004). Existing technologies are now capable of completing routine cognitive work and manual labor, thus human power has been mostly replaced by computers. In today's competitive job market, employees are expected to engage in tasks that computers cannot do. Therefore, 21st century jobs require a different skill set, including expert thinking and complex communication (Levy & Murnane, 2004). In the last two decades, people have been dealing with complex problems such as climate change, public health and social issues, which can be solved only by the contribution of different disciplines. Dede (2010) argues that in knowledge-based economies, which require teamwork of people from different areas of expertise, collaborative skills have become one of the crucial skills of the 21st century.

Like any other discipline, the field of industrial design is facing a change. Hollington (1998, cited in Julier, 2010, p. 242) drew attention to the increased importance of collaboration in design practice in the late 1990s by stating that the era of the individual star designer is over. Erlhoff and Marshall (2008) also discuss how design practice, once perceived as individual activity, has become a collaborative act, and claim that having collaborative skills has become success criteria for contemporary designers. As Yee, Jefferies and Tan (2013) point out, the new generation of designers is taking more responsibility in todays' world challenges. Recently, designers design not only products but also services and experiences. With the expansion in the scope of

industrial design profession, it is inevitable that the industrial design discipline interacts with other disciplines. Today most of the design teams include experts from other disciplines besides design. Teamwork and collaboration have become the most important skills that the new generation of designers should have.

In order to find solutions to the complex problems of today, the practice of industrial design has undergone deep changes leading to increased interdisciplinary collaboration. In parallel with the changes in professional practice, industrial design education also evolves and integrates interdisciplinary projects in undergraduate curriculum. Following that trend, several universities has developed interdisciplinary programs and courses that bring the students from different disciplines together to work on a project.

1.2 Aim and Scope of the Study

In 2015, Middle East Technical University (METU) established an interdisciplinary research and education center, METU Design Factory (known as Centre for Technology, Design and Innovation at the time of the fieldwork of this thesis). This center aims to bring together faculty members and students from different departments to collaborate in interdisciplinary projects. Interdisciplinary Design Studio (IDS) was the first educational event of the METU Design Factory. It was designed as an extracurricular activity that took four weeks by the contribution of faculty members from various disciplines. It brought students from the Department of Industrial Design, Department of Architecture, Department of Metallurgical and Materials Engineering, Department of Mechanical Engineering, Department of Electrical and Electronics Engineering, Department of Industrial Engineering, and Department of Business Administration together to collaboratively work in interdisciplinary teams to develop solutions for emergency situations.

This thesis investigates the first event of the METU Design Factory, Interdisciplinary Design Studio (IDS) with the aim of understanding the industrial design students' perspectives on working with other disciplines in an interdisciplinary design project. IDS offered a good setting for this research as the students from different departments collaboratively worked on a project in interdisciplinary teams in an observable setting.

As it was the first event of the METU Design Factory, there were nothing to affect students' assumptions and opinions prior to IDS. Therefore, it was possible to explore the experience of industrial design students during an interdisciplinary collaboration and compare their perspectives on collaborating with different disciplines before and after attending an interdisciplinary design studio.

1.3 Research Questions

To fulfill the above mentioned aim, the following research questions will be answered in this study. The sub-questions will help the researcher to find answers for the key research question.

Key research question:

- How and to what extent does the experience of interdisciplinary teamwork affect the industrial design students' perspectives on working with other disciplines and interdisciplinarity?

Sub-questions:

- What are the industrial design students' motivations to participate in the IDS?
- What are the industrial design students' assumptions about and expectations from interdisciplinary teamwork? How do they describe the relations they are going to have with the students from other disciplines during the IDS?
- To what extent and in what ways does the experience the industrial design students had during the IDS overlap with their prior expectations and assumptions?

1.4 Significance of the Study

In the last two decades, interdisciplinary design programs and courses have emerged with the aim of preparing students to collaborate with different disciplines in the professional life. Recently, a considerable body of literature has grown up around the theme of interdisciplinary design education. Yet, these studies are mostly in the form of reports that aim to guide the people who would like to establish a similar program or course. Although, there are some studies that investigate the perspectives of the

tutors and engineering students, very little attention has been paid to the experience and perspective of industrial design students. Considering that design has become an integrative element of the interdisciplinary programs, understanding the perspective of industrial design students towards interdisciplinary collaboration is significant. This study aims to contribute to this growing area of research by exploring industrial design students' perspectives on working with other disciplines. The findings of this study have important implications for design practice.

1.5 Structure of the Thesis

This thesis is structured into six chapters.

Chapter 1, *Introduction*, provides a brief introduction on interdisciplinarity in industrial design discipline, and presents the aim of the study and the research questions. Finally, introduces the structure of the thesis chapter by chapter.

Chapter 2, *Literature Review*, provides a comprehensive overview of the literature. It includes the review of different disciplinary frameworks with the emphasis on interdisciplinarity, and continues with the presentation of the current trends in contemporary industrial design practice and industrial design education. After reviewing the extant research on interdisciplinary design, it discusses the contribution of this thesis to the literature.

Chapter 3, *Methodology*, begins by introducing the adopted research approach, which is aligned with constructivist epistemology. It presents the research process, including the data collection methods, which comprises two sets of semi structured interviews and participant observation and data analysis method, which is template analysis. The chapter also gives detailed information about the context of the study and the research participants.

Chapter 4, *Analysis I: Pre-Studio Interviews*, presents and discusses the results of pre-studio interviews, which aim to understand the motivations of industrial design students to participate in an interdisciplinary design studio, to illustrate their assumptions and opinions about other disciplines and finally, to understand their expectations from the IDS.

Chapter 5, *Analysis II: After Studio Interviews*, presents and discusses the results of after studio interviews in comparison with the pre-studio interviews. The chapter provides insights on how and to what extent collaborating in an interdisciplinary team changed the industrial design students' perspectives on interdisciplinarity and to what extent and in what ways the experience they had during the IDS was in parallel with their assumptions.

Chapter 6, *Conclusions*, presents the overall conclusions of the research, discusses the limitations of the study and concludes with the recommendations for further research.

CHAPTER 2

LITERATURE REVIEW

This literature review will cover the points of disciplinary frameworks, changes in both industrial design practice and industrial design education, and introduce interdisciplinary programs and courses in education. First, disciplinary frameworks are presented in order to create a common ground for the forthcoming discussions. Later, the implications and applications of these frameworks in design practice are discussed. Then, integrationist understanding of interdisciplinarity, which this thesis is aligned with is explained. After, presenting the current changes in industrial design practice and the new skills that the 21st century designers need to develop are discussed. Finally, how the industrial design education is affected by the recent changes are presented and the interdisciplinary programs are introduced. The chapter concludes with highlighting the knowledge gap in the field of study and underlining the significance of present research.

2.1 Disciplinary Frameworks

Many professionals today work with different disciplines. In light of current changes in professional practices, it is required to define disciplinary frameworks to fully understand how these affect contemporary work relations. In 1970, Eric Jantsch presented disciplinary framework in a hierarchical order based on the required level of cooperation and coordination. Having disciplinarity at the base, the hierarchy proceeds with multidisciplinarity, pluridisciplinarity, crossdisciplinarity, interdisciplinarity and transdisciplinarity. Each step requires more disciplinary interaction than the previous one (Jantsch, 1970). Although the term pluridisciplinarity has not been widely accepted as other disciplinary terms, almost 50 years after Jantsch's presentation, we are still using this framework to explain collaborations between different disciplines. In this section, first, disciplinary framework including disciplinarity,

multidisciplinarity, crossdisciplinarity, interdisciplinarity and transdisciplinarity is defined. Then, how this framework may be applied to design practice is discussed following the design-specific framework of Dykes, Rodgers and Smyth (2009).

2.1.1 Disciplinarity

The meaning of disciplinary terms changes with the prefixes (multi-, cross-, inter-, trans-) coming before the word disciplinary. In order to understand what those terms mean, the concept of discipline needs to be defined. Discipline refers to a particular field of study. As Repko (2012) puts it: "Each discipline has its own defining elements – phenomena, assumptions, epistemology, concepts, theories, and methods – that distinguish it from other disciplines." (p. 4). The members of a certain discipline should have a sufficient knowledge in that domain, have a sense of belonging to the disciplinary community, and have understanding of the elements that distinguish that discipline from another (Harfield, 2008). In order to participate in other forms of collaborations one needs to be specialized in at least one discipline.

2.1.2 Multidisciplinarity

In Jantsch's hierarchical order, multidisciplinarity is placed at the lowest level as a number of disciplines exist concurrently without having any cooperation between them (Jantsch, 1970). Repko (2012, p. 17) uses the metaphor of the bowl of fruit to clarify the concept of multidisciplinarity. Similar to a bowl of fruit full of different fruits, disciplines stand close to each other during multidisciplinary collaboration. Yet, as individual fruits do not lose their own characteristics and taste in a fruit salad, disciplines do not lose the elements that distinguish them from other disciplines. In multidisciplinary teams, different disciplines bring their own disciplinary perspective, knowledge and methods to approach a common problem (Repko, 2012; Stokols, Hall, Taylor, & Moser, 2008; Holley, 2009). Although insights from different disciplines are brought together, there is no attempt for integration.

2.1.3 Crossdisciplinarity

In crossdisciplinarity, one dominant discipline collaborates with others in order to achieve a greater understanding of a problem within its own domain. Holley (2009)

argues that the aim of crossdisciplinary collaboration is not to create a new paradigm, but rather solving a specific problem. Similar to multidisciplinarity, there is lack of integration between disciplines. The dominant discipline borrows the relevant tools and concepts from other disciplines to utilize in solving the problem in question. Newell and Green (1982) criticize the nature of crossdisciplinary collaboration by stating that the contributing disciplines become passive actors in the collaboration and fall under the hegemony of one discipline.

2.1.4 Interdisciplinarity

Interdisciplinarity has become a popular term used along with other catchphrases like innovation, technology and collaboration. In some cases, it is used as an umbrella term covering other disciplinary terms like multidisciplinary, crossdisciplinary and transdisciplinary. However, there are three aspects of interdisciplinarity that differentiate it from others (Holley, 2009).

Integration. Integration is an important characteristic of interdisciplinary collaboration. Both multidisciplinarity and interdisciplinarity include different disciplinary perspectives. But, unlike multidisciplinarity, where disciplines do not directly interact, interdisciplinarity combines different disciplinary theories, concepts and methods while approaching to a problem (Repko, 2012). Referring back to Repko's bowl of fruit metaphor for multidisciplinarity, it is argued that interdisciplinarity can be compared to a smoothie, which is well-blended, so that individual flavors of the fruits are no longer recognizable (2012). In a smoothie, carefully selected fruits are blended according to a recipe and as a result, something new is created. Likewise, in interdisciplinarity, disciplines relevant to the problem are selected, and their insights are integrated to achieve something new.

Shared problem. During interdisciplinary collaboration people work on a shared problem, which cuts across disciplinary boundaries. Klein and Newell (1997) define interdisciplinary studies as follows:

> [Interdisciplinary studies is] a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession… [and] draws on disciplinary

> perspectives and integrates their insights through construction of a more comprehensive perspective. (p. 3)

This definition highlights the nature of interdisciplinary problems. Working on a shared problem that cannot be solved by a single discipline distinguishes interdisciplinarity from other disciplinary terms.

Active engagement. People from different fields are actively engaged during an interdisciplinary collaboration. As discussed earlier, in crossdisciplinary collaboration there is one dominant discipline, which consults others to find a solution to a problem within its own domain. In comparison, interdisciplinarity builds up on the efforts of different disciplines to find a solution to a shared problem. As the problem or topic does not belong to one specific domain, there is an active engagement of different disciplines (Holley, 2009).

This section reviewed three key aspects of interdisciplinarity: the process of integration, focus on a shared problem and active engagement of disciplines. How to distinguish interdisciplinarity from the other forms of disciplinary works was presented to reach a clear understanding of the term.

2.1.5 Transdisciplinarity

Dykes et al. (2009) present transdisciplinarity as "the most complex form of collaboration", as it deals with real world problems like sustainability, global health and human genetics (p. 105). Due to the nature of the problems dealt with, transdisciplinary work requires collaboration among different stakeholders including disciplinary experts and professional practitioners (Repko, 2012; Holley, 2009). People from different disciplines synthesize their discipline-specific concepts, theories and methods to achieve a shared understanding of a complex real world problem (Stokols et al., 2008). Similar to interdisciplinary collaboration, integrative process is in the center of transdisciplinary work. Once the disciplinary perspectives and methods blend into each other, the "uniform conception of the world" is created, where it is impossible to spot the distinctive elements of each discipline any more (Holley, 2009). Whereas interdisciplinarity and transdisciplinarity have some common characteristics, transdisciplinarity requires "multilevel coordination of entire education/innovation

system" and thus is placed higher in Jantsch's hierarchical order (Jantsch, 1970). In other words, transdisciplinarity tries to find solutions to mega and more complex problems. Therefore, it not only works across different disciplines as interdisciplinarity, but also goes beyond all disciplines (Repko, 2012).

2.2 Design-specific Disciplinary Frameworks

Much of the current literature on disciplinary frameworks pay particular attention to collaboration among scientists working on social, environmental or health problems (Stokols et al., 2008; National Academy of Sciences, 2005). However, very little is known about collaborative framework in design practice. In contemporary design practice, where professional boundaries are blurred, the ability of collaboration with different disciplines has become an important skill. Dykes et al. (2009) emphasize the importance of creating design specific collaborative framework to understand and facilitate new forms of design practice. They elaborate on existing disciplinary frameworks from the perspective of designers. New disciplinary frameworks for creative design practice are defined with reference to the works of the professional designers. In this section, the terms disciplinary design, multidisciplinary design, crossdisciplinary design, interdisciplinary design and transdisciplinary design, introduced by Dykes et al. (2009), will be explained.

2.2.1 Disciplinary Design

Disciplinary design requires skills, knowledge, concepts and methods from a single domain. Each domain has its own area of focus. While industrial designers focus on product development, architects deal with built environment (Dykes et al., 2009). A disciplinary designer is the one who develops expertise in only one design field. The way in-house product designers work is a good example of disciplinary design practice. They bring their domain-specific knowledge and skills acquired during undergraduate education and advance them as they gain more experience in one domain. At the end they become specialists in the area they work in.

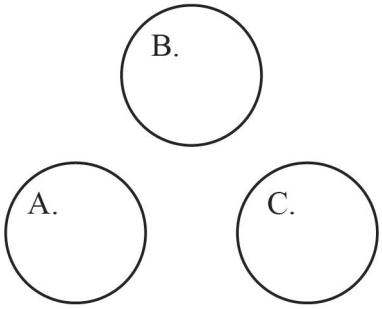

Figure 2.1 Disciplinary Design (Dykes et al., 2009)

2.2.2 Multidisciplinary Design

Dykes et al. (2009) suggest two versions of multidisciplinary designer. In the first case, designers communicate with other domains to gain a new understanding of their problem. Multidisciplinary work allows designers to see how other disciplines relate to their own domain. This type of multidisciplinary design practice requires deep knowledge in one field and sufficient understanding of others. In the second version, multidisciplinary designers have expert knowledge in more than one field. Being specialist in more than one domain, these designers can perform fluid employment between the design disciplines. Most of the design consultancy firms are multidisciplinary. As they work in a broad range of sectors, ranging from transportation to household appliances, they either involve other stakeholders or develop necessary expertise in different fields.

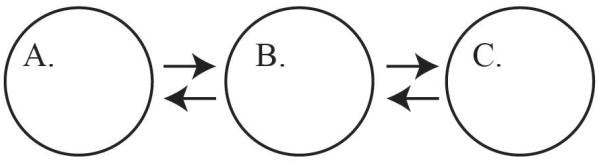

Figure 2.2 Multidisciplinary Design (Dykes et al., 2009)

2.2.3 Crossdisciplinary Design

Unlike multidisciplinary design, where disciplines merely communicate with each other, in crossdisciplinary design temporary intersections and active interactions occur between different disciplines in order to solve a problem. Design is the dominant discipline in crossdisciplinary design and designers collaborate with outer stakeholders in a problem-focused manner. The concept is defined by the designers, but when expert knowledge is required to develop the specific aspects of the product, the designer may seek the knowledge of other domains. A design team consulting an engineer's expertise to solve a mechanical problem of a product is an example of crossdisciplinary design (Leinss, 2007).

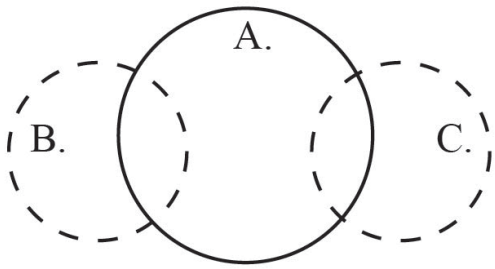

Figure 2.3 Crossdisciplinary Design (Dykes et al., 2009)

2.2.4 Interdisciplinary Design

Interdisciplinary design teams include at least two different disciplines, design being the dominant one. Whereas each discipline brings their own expertise, knowledge and methods, designers dominate others to solve a shared problem (Leinss, 2007). During interdisciplinary collaboration, team members approach to the design project more holistically as each discipline can see how their own expertise is integrated with other aspects of the project (Corkery, Roche, Watson, & Zehner, 2007). Being predominant over others, design discipline takes an important role in integration. Dykes et al. (2009) define interdisciplinary designers as the ones who have expertise in more than one field. Interdisciplinary designers are able to combine specialist knowledge of different

domains at an expert level. This integration might create a new genre of design at the intersections such as interaction design.

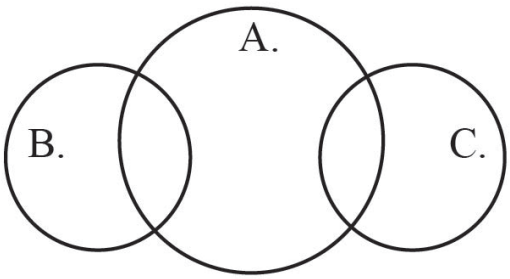

Figure 2.4 Interdisciplinary Design (Dykes et al., 2009)

2.2.5 Transdisciplinary Design

Transdisciplinary design consists of more than two disciplines but none of which is predominant. During transdisciplinary design practice, all disciplines come together around a context to share their own expertise, but the end-result is totally hybrid. Dykes et al. (2009) discuss that being combined through a context, disciplines are able to explore new questions. The designed object, after all, does not represent the design practice alone but it represents the combination of all contributing disciplines. Due to the complex nature of transdisciplinary collaboration, focusing on real-world problems, such as public healthcare and environmental issues, and requiring coordination of a larger system, the examples of transdisciplinary design practice are relatively rare when compared to other types of disciplinary design practice.

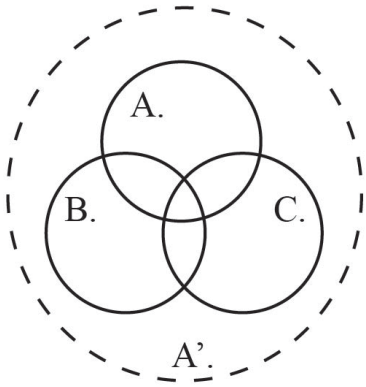

Figure 2.5 Transdisciplinary Design (Dykes et al., 2009)

2.3 Integrationist Understanding of Interdisciplinarity

As it is presented above, designers of new generation are experiencing different work practices that include collaboration with other disciplines. Design-specific collaborative framework is useful to analyze how collaboration may lead to new forms of design practice. Despite the variety in collaborative framework, ranging from disciplinary to transdisciplinary, in contemporary design practice interdisciplinary collaboration takes a larger place than others. Whereas disciplinary design practice provides specialist knowledge to the designers, it becomes inadequate to solve complex problems that goes beyond the expertise of one domain. Multidisciplinary and crossdisciplinary design practices, on the other hand, include other disciplinary experts, yet the integration of different disciplines is missing. Although transdisciplinary collaboration is presented as the ultimate degree of coordination (Jantsch, 1970), due to organizational and operational difficulties it is not as common as interdisciplinary collaboration. This thesis focuses on interdisciplinary collaboration between industrial design students and the students from other disciplines.

Both Chettiparamb (2007) and Huutoniemi et al. (2010) demonstrate in their detailed literature reviews that interdisciplinarity can be classified in various ways. It can be categorized according to research goals and questions, motives, level of interaction or

epistemological approaches. Repko (2012), on the other hand, simply identifies two conceptions of interdisciplinary studies based on level of integration: generalist and integrationist. Generalist interdisciplinarians argue that interdisciplinarity occurs when there is a dialog or interaction between two or more disciplines. They undervalue or deny the importance of integration and focus on mere interaction. According to integrationist interdisciplinarians, integration is the core of interdisciplinary work. It addresses complex problems by synthesizing, combining and blending the ideas, data and information, methods, tools, concepts, and/or theories from two or more disciplines (Repko, 2012).

This thesis is aligned with the integrationist understanding of interdisciplinarity for a number of reasons. First, the very nature of design practice requires integration of various concerns and insights to create new ideas (Kim, Jin & Lee, 2011). Similarly, Kleinsmann et al. (2012) define knowledge sharing and knowledge integration as the essential processes in collaborative design. Second, during interdisciplinary projects design students are expected to have not only design-specific skills and knowledge but also integrative skills that enable them to acquire external knowledge and understand other disciplines (Corkery et al., 2007). The studies presented so far highlight the importance of integration in the design process. As integration is a critical element in design practice, integrationist interdisciplinarity is a more relevant conception for the design context. Moreover, the case study explored in this thesis, the Interdisciplinary Design Studio (IDS), "brings together interdisciplinary student teams from design, engineering, and business disciplines to develop innovative product ideas and prototypes through extracurricular program." (METU Design Factory, 2016), and thus aims to achieve integration of design, engineering and business disciplines. The organization and motives of IDS also lead to the use of integrationist interdisciplinarity to discuss the collaboration between students from different disciplines.

2.4 Contemporary Industrial Design Practice

In the last two decades there have been significant transformations in industrial design profession. In 2015, International Council of Societies of Industrial Design (ICSID) launched a campaign called "Renew ID" and invited all members to redefine industrial design. With the contributions coming from industrial design community, at 29th

General Assembly in South Korea, ICSID changed its name to World Design Organization (WDO) and introduced a new definition of industrial design as follows:

> Industrial design 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 (ICSID, 2016).

Buchanan (2001) argues that not being settled on a single definition is the strength of design as it advances the practice. He also emphasizes the importance of definitions by stating that "[Definitions] allow an investigator or a group of individuals to clarify the direction of their work and move ahead." (p.8). When considered from this point of view, the new definition of industrial design tells a lot about current and envisioned design practice.

Design as a process. Defining industrial design primarily as a *strategic problem-solving process* rather than defining it with its potential outcomes implies that industrial design is a systematic activity that has certain phases. IDEO, a leading design firm, presents design thinking as a method applied during the design process. In their field guide they introduced design thinking as three phased process: inspiration, ideation and implementation (Ideo.org, 2015). During inspiration phase extensive user research takes place in order to define a problem. Ideation requires divergent thinking during which lots of ideas are generated. In implementation phase the idea is brought to life with the help of external partnerships. Each phase requires different skills and expertise. Thus designers need to collaborate with other fields during different phases of design process including user research, idea generation and execution (Buchanan,2001; Kiernan & Ledwith, 2014; Yang, You & Chen, 2005).

Design-driven innovation. In the ICSID's new definition of industrial design, there is an emphasis on innovation and business success (2016). Design used to be involved in innovation process in later stages. However, today design contributes to innovation from the very beginning, idea generation, till the end, implementation (Acklin, 2010). As other members of innovation process understand the value of design in approaching different problems, design methods such as design thinking are also accepted as useful tools in different domains (Cooper, Junginger, Lockwood, 2009). Design methods and tools provide common ground for design-driven innovation and help finding solutions

to problems of real people. McDonagh and Thomas (2013) argue that the collaborations between designers, engineers and managers starting from early stages is crucial for achieving business success.

New areas of design. Industrial design discipline traditionally focuses on aesthetics and functionality of physical products (Brown & Wyatt, 2010; McDonagh & Thomas, 2013). Yet, contemporary design practice goes beyond product design and includes "systems, services and experiences" (ICSID, 2016). Today there is a shift from product-oriented design to experience-oriented design. Buchanan (2001) argues that unless they contribute to the human experience, visual symbols and products have no value. As designers consider human experience more holistically, the boundaries between different design disciplines have been blurred and new areas of design have emerged, such as interaction design, service design and system design (Dykes et al., 2009; Kiernan & Ledwith, 2014). Yee et al. (2013) illustrate how design practice has changed by presenting the stories of designers and design companies working at intersections of different design disciplines. They categorize the new practices into six different categories: products/design futures, design art, design of services, social design, design research and strategy/design/innovation. As this example illustrates, today designers define new problems and approach those problems from different perspectives. With the broadened scope of design, the problems dealt with become more complex and require different expertise.

This section has reviewed the current changes in industrial design practice following the renewed definition of industrial design by ICSID (2016). The key characteristics of contemporary design practice can be listed as follows: being process oriented, driving innovation and having a broader scope. First, contemporary design is presented as a process having systematic stages, all of which requiring different skills and knowledge. Second, designers are taking more active roles in innovation, and design methods and tools are used collaboratively by the innovation team. Lastly, the scope of industrial design is no longer limited to physical products but include services, systems and experiences. As a result, new areas of design practice have emerged at the intersection of traditional design disciplines. Collectively, these changes outline a critical role for collaboration. Dykes et al. (2009) argues that collaboration have

become commonplace in contemporary design practice. Considering all of these characteristics, it seems that new generation of designers need different skills to embrace current changes.

2.5 Skillset of 21st Century Designers

As discussed earlier, design is defined as a process consisting of different activities and requiring different skills. By referring to the design process, Lawson (2005) proposes a model of designing that outlines the way of thinking, the activities to perform and the skills to have during different phases. His model of designing includes 'formulating', 'moving', 'representing', 'evaluating' and 'reflecting'.

Formulating. At the beginning of a design process designers need to find problems and explore them in detail. Once the problems are found and explored, designer reformulate the ill-structured problems. At that phase, designers need to have abilities to develop scenarios considering different stakeholders and their roles. Then, in order to process further, designers create frames that defines the borders of the problems in hand, so that they can direct the thinking process.

Moving. The main focus of the design activity is creating solutions for the problems. Designers need to have skills to develop solutions. It mostly starts with the ideation phase, during which the designers develop initial solutions aiming for quantity rather than quality. Once the design solutions to be focused on are chosen using the frames, detailed design solutions are developed. As design problems are not well-defined, problems could change during the design process as well as solutions. Therefore, designers need to be comfortable with ambiguity.

Representing. During the process of design, designers need to communicate their ideas using textual information, models, sketches, prototypes and computer models. In order to represent the design solutions and the final design, designers develop skills to work with different mediums of design representation. By making models, sketching, writing or computer modelling, designer not only communicate their ideas to others but also have a chance to explore different solutions, experiment with form and materials, and develop new ideas.

Evaluating. Although generating ideas are valuable during the design process, designers need to have abilities to decide when to stop by evaluating the design solutions according to certain criteria. Yet, it is important not to make early judgements about the design solutions in order not to hinder creativity.

Reflecting. While evaluating the work, designers reflect on the understanding of the problem and the proposed design solution. In addition to that, designers need to be able to reflect on the process and evaluate themselves, their actions and decisions. By doing that, they could develop their own 'guiding principles', which they refer to every time they work on a new design problem. Guiding principles affect the way designers approach to a problem, the solutions they explore and the solutions they develop. Designers need to have skills to put their own understanding and worldview to the project they are working on.

The model of Lawson (2005) illustrates how designers think during the design process and outlines the skills designers should have. He argues that the most important skill of the designers is the ability of combining "rational and imaginative thinking" (p.138). Whereas this model lists the essential skills that the designers should have, along with the changes in the design practice, skills that designers should have also changed. Inns (2007), after presenting creativity, synthesis and technical knowledge as the core skills, described six emergent roles for the 21st century designer, which are negotiator of value, facilitator of thinking, visualizer of the intangible, navigator of complexity, mediator of stakeholders and coordinator of exploration.

Negotiator of value. During the decision making processes the designer has a role in negotiating decisions by considering different dimensions of value, including economic, ecological and ethical dimensions.

Facilitator of thinking. As the methods and tools of the design discipline has been used in different fields, designers have a new role to integrate different people to the design project. In order to do so, designers need to develop facilitation skills to empower and encourage the thinking of other people.

Visualizer of the intangible. Visualizing the design solutions has already been an essential role of the designers. Yet, with the extended scope of the design, designers need to visualize the systems, experiences and networks in addition to the physical products. In order to overcome the challenge of communicating their ideas to others, designers need to develop new visualizing, modelling and prototyping skills.

Navigator of complexity. Todays' interdisciplinary world includes complex systems and ambiguity. Designers play a role in helping people to understand those complexity, whereas the complexity makes them reflexively think about their own roles.

Mediator of stakeholders. Contemporary design problems include multiple stakeholders. Designers have a role of mediator between the stakeholders and ensure that the design solution meets the different needs and expectations of those stakeholders.

Coordinator of exploration. As the competitiveness have become an important part of the design practice, creating innovative ideas becomes critical. Designers need to coordinate exploration of new technical and contextual sources to encourage creativity during the idea generation.

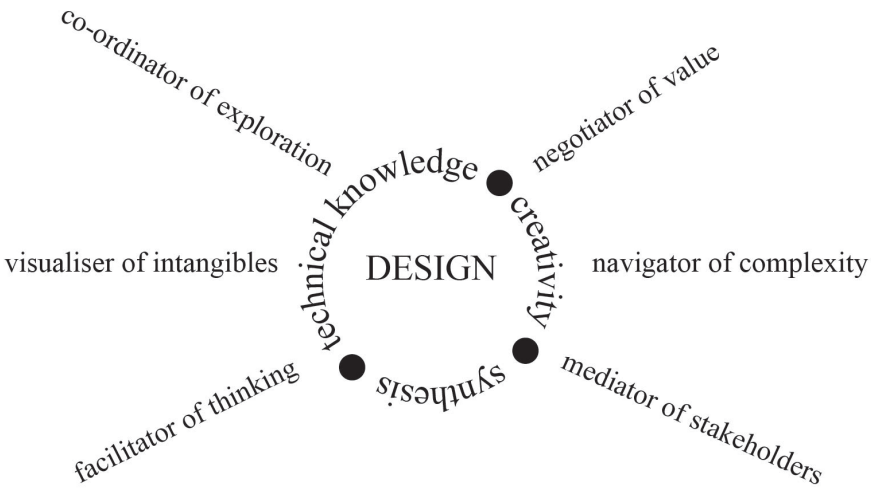

Figure 2.6 Emergent Roles for the 21st Century Designer (Adapted from Inns, 2007)

Similarly, Press and Cooper (2003) define the skills and roles of the new designer of 21st century. According to them designers need to fulfill different roles including intelligent maker, knowledge worker, sustainable entrepreneur, and active citizen. Each role requires different skills and knowledge:

Intelligent maker. Either working with physical materials or virtual spaces, designers are intelligent makers. In order to make something, they need to know how things work in detail and understand the experience of it. In addition to craft knowledge, creative problem solving and reflective thinking skills are essential to make things work.

Knowledge worker. As most of the 21st century workers, designers are also knowledge workers. Life-long learning is an important aspect of knowledge work. Designers need to be active learners. Since acquiring and sharing knowledge is a social process, designers are also required to have good networking and communication skills.

Sustainable entrepreneur. In order to be involved in innovative and entrepreneurial activities, designers need to understand business, management and marketing. Moreover, they should understand and perform sustainable business practice, so that they can become sustainable entrepreneurs.

Active citizen. Designers should empathize with the people to understand their needs and desires. Once they gain the necessary understanding, designers as social initiators, initiate a change starting from their own community. Yet, the impact is not limited to local. Their impact can change the world.

Both Inns's (2007) and Press and Coopers' (2003) interpretation of the roles of new designers show that today designers are expected to be well-rounded professionals. Exploring designers' relationship with different stakeholders, Raijmakers et al. (2012) also conclude that being able to flexibly play different roles results in designers' playing a key role in organizing different stakeholders. As design process involves a diverse group of people, designers should develop collaborative skills in addition to design skills. Brown and Wyatt (2010) argue that in order to work in an interdisciplinary context, designers should develop "T-shaped" knowledge. The

vertical axis of the "T" represents the depth of skills and knowledge in one domain. Using their discipline-based expertise, designers can make remarkable contributions to the projects. The top of the "T", on the other hand, represents the ability to understand and cooperate with other disciplines. Brown and Wyatt (2010) emphasize the importance of being a T-shaped person by stating that it is the skill that IDEO looks for while recruiting new designers.

A study conducted with product design graduates also confirmed that designers are expected to undertake a variety of roles in industry (Kiernan & Ledwith, 2014). The same graduates believe that design education should prepare students for the professional life. Gaining a flexible and transferable skill set during design education, graduates can adapt to different design roles in industry (Kiernan &Ledwith, 2014). Similarly, Britton et al. (2015) states that teaching students collaborative skills during undergraduate education would prepare them for the professional life.

This section has demonstrated the changes in skills that new generation of designers expected to have. All of the studies reviewed here support the hypothesis that design education should evolve in parallel with the changes in design profession. The next section describes the changes in design education.

2.6 Changes in Industrial Design Education

Yang et al. (2005) agree that changes in industrial design profession should lead to significant transformations in design education. However, they identify a gap between what is taught at the design schools and what is expected at the professional life. The areas that they draw attention to can be categorize under three themes: emerging new technologies, expanded focus of design, and interdisciplinary teamwork.

Emerging new technologies. New technologies such as computer-aided modelling tools, digital sketching and 3D printing both changed the contemporary design practice and design education. Most of the activities in design process that used to be done manually like sketching, model making and technical drawing, now can be done by computers. Yang et al. (2005) propose that design education should educate students as continuous learners, so that they can adapt to rapidly changing technologies and tools. Moreover, internet also changed the teaching and learning activities. Online

learning has become an emerging trend in design education (see for example Ganser, Kennel, Kunz, 2010; Bassanino, Fernando & Wu, 2014; Toh, Miller & Simpson, 2015).

Expanded focus of design. As it is discussed earlier, today industrial designers not only design products but also systems of products, interfaces, interactions and services. The variety in design areas leads to a question that whether design education should be generalist or specialist. Although the debate goes on without a conclusion, Kiernan and Ledwith (2014) suggest an integration of specialist and generalist skills in one program. They argue that generalist skills such as communication, problem-solving and design thinking are crucial as they can be applied to any design problem. Once students acquire such skills they can specialize in the area they would choose. Yang et al. (2005), on the other hand, more radically state that instead of focusing on form giving, drawing and model making skills, design education should focus on design process and equip the students with problem solving abilities.

Interdisciplinary teamwork. Interaction and collaboration with other disciplines are essential parts of contemporary design practice. As designers expected to work in variety of roles and with different people, design education need to prepare students for the professional life by teaching them how to operate in interdisciplinary teams. Corkery et al. (2007) propose that students need to develop integrative skills in addition to the specialized skills, so that they would be able to understand different disciplines and be able to use relevant knowledge and tools of those disciplines. Participating in interdisciplinary teamwork, design students could develop technical, social/ cultural and aesthetics aspects of a product in cooperation with other disciplines (Bronet et al., 2003; Yang et al. 2005). Understanding the critical importance of interdisciplinary teamwork, new programs that try to integrate team learning and interdisciplinarity to design curriculum have emerged.

It is evident that the changes in industrial design practice also lead to significant changes in industrial design education. Considering the aspects mentioned above, it can be concluded that contemporary industrial design education, once being more specialist, has proceeded to a more generalist approach. Today, design students are expected to develop life-long learning skills to catch up with developing technologies

and tools, problem solving and design thinking skills to comprehensively approach to any design problem, as well as communication and collaboration skills to be effective team members in interdisciplinary teams.

2.7 Interdisciplinarity and Industrial Design Education

This section follows on from the previous section, which outlined the changes in industrial design education. Along with social, cultural, technological and economic changes that affect industrial design practice, industrial design graduates are expected to have a variety of skills, so that they can successfully play different roles in industry. Interdisciplinary learning can equip student with the necessary cognitive skills. Thus, there is a growing interest in interdisciplinarity in design education. In this section interdisciplinary education in design will be discussed with reference to the contemporary examples.

University education is traditionally disciplinary-based and builds on departmental structures. The main aim is to develop mastery in a particular discipline. Holley (2009), on the other hand, argues that there is an emerging need for active learning, integration and critical analysis skills opposed to specialization. Similarly, Derrick et al. (2011) claim that the changes that disciplines have been facing in the last two decades require an interdisciplinary curriculum, where different disciplines work together. Holley (2009) suggests that interdisciplinary education can offer students the skills that traditional education cannot. She lists the skills that interdisciplinary learning process entails as follows: "learning how to learn, gaining social and emotional maturity, engaging in critical thinking, and being an independent learner". Referring back to the aims of contemporary industrial design education, which entails developing life-long learning skills, problem solving and design thinking skills, communication and collaboration skills, it is possible to detect the similarities with this list. Therefore, integrating team learning and interdisciplinarity to design education has become a new trend. In his review of creativity in business, Cox (2005) sees creative disciplines as a necessary part of interdisciplinary education:

> Creativity needs to be part of technological and scientific learning, and also of management or business studies. On the other hand, those who go on to study

> the creative arts need to appreciate the context in which their skills will be applied (p.29).

He also suggests that higher education should give students the opportunity to work with other disciplines by establishing closer links with industry and creating interdisciplinary courses combining management, engineering and creative disciplines (Cox, 2005). Although in the same year Yang et al. (2005) state that there are only a few design schools that understand the trend of interdisciplinarity and have design students collaborate with business, engineering and social science, after a decade, today lots of innovative interdisciplinary programs have emerged in design education.

One of the earliest examples of interdisciplinary product design course dates back to 1989. At Massachusetts Institute of Technology (MIT) a joint design course was organized between schools of engineering and management (Eppinger, Fine & Ulrich, 1990). In collaboration with the partners from industry, engineering and management students worked on redesign of an existing product. It is important to note that there were no industrial design students participating and the aim was preparing engineering and management students for the professional life. After more than 25 years, industrial design has become an essential part of interdisciplinary design programs, yet most of these programs still focus on equipping engineering students with design skills.

As the creativity and innovative thinking have become important skills for 21st century knowledge workers, interdisciplinary design courses in undergraduate and graduate programs have been integrated in engineering education to help engineering students to develop creative thinking and design thinking skills besides analytical thinking and technical skills (Costantino et al., 2010; See for example: Dym et al., 2005; Gerber, Olson, Komarek, 2012; Siniawski et al., 2016). By developing those skills, engineering students could understand and appreciate design as a profession although they cannot act like professional designers without a full design education. Hirsch et al. (2001) exploring an interdisciplinary design course, during which the students work on conceptual design projects for real clients, states that studying both design and communication prepares engineering students for their future careers. There are also some programs that go beyond building temporary interdisciplinary relations between engineering and industrial design students in form of courses and workshops, and offer

a new pedagogy. Product design engineering programs are examples of that new pedagogy. A considerable amount of literature has been published on the experiences of engineering students during interdisciplinary design programs, yet little attention has been paid to the experience of industrial design students during interdisciplinary collaborations.

On the other hand, a search of literature revealed few studies which explores the experience of both the engineering and design students during an interdisciplinary design project. Goff et al. (2006) compare the performance of interdisciplinary teams consisting of industrial design, architecture, urban studies and engineering students with engineering only teams during a human centered interdisciplinary design project. They conclude that interdisciplinary teams produced higher quality designs compared to engineering only teams. Moreover, they found out that industrial design students' gains from an interdisciplinary design project was not as clear as the engineering students. Whereas engineering students were reported to be positively affected by the interdisciplinary collaboration, industrial design students were reported to be not negatively affected. Self and Baek (2016) investigate the case study of an interdisciplinary course called Design Thinking, which bring together the students from design, engineering and ergonomics disciplines. They compared the learning experience of the students taught by single tutor with the students taught by a team of tutors. Both of these studies are based on quantitative survey data. For that reason, despite of the fact that they provide useful data for validating hypothesis about students' experiences during interdisciplinary design projects, they have failed to address the students' perspectives on interdisciplinary collaboration.

There are limited number of qualitative studies that investigates the experience of the students during interdisciplinary design projects. Yim et al. (2014) explore an interdisciplinary and intercultural course named "Design-Engineering Collaborative Product Development" that was offered both at Hongik University and at Aachen University. They apply mixed methods, consisting of both a systematic questionnaire and interviews, both with the students and the instructors. They separately present the issues mentioned by students and the instructors. By combining a quantitative method with qualitative one, they successfully provide an overview of the perspectives of

students and instructors on interdisciplinary and intercultural design studio. Similarly, Björklund et al. (2011) present a detailed report on Aalto University Design Factory (ADF), which offers a collective space to bring together students, researchers, tutors and industrial practitioners to work on collaborative projects. The report includes the history, aim and motivations of ADF to document the operation at ADF in detail, then present the perspectives of ADF community members including staff, researchers, students, tutors to capture the experience and perception of them. In that sense this study provides a comprehensive overview of how ADF is perceived by its community.

Although there is scarcity of empirical studies focusing on the experience of industrial design students during interdisciplinary collaboration, there is a substantial body of literature which focus on the experience of industrial designers working in collaboration with different disciplines. These studies explore different aspects of interdisciplinary collaboration, such as gender implications, developing common language, different modes of relations, conflicts and resolving strategies, perceived image of each other and designers' perspectives. Kaygan (2014) explores interdisciplinary relations between industrial designers and engineers focusing on gender construction. Her study revealed that these relations are constructed around symbolic dualisms of real/arty, objective/subjective, technical/aesthetic and masculine/feminine. Having identified the need for creating shared understanding of design representations, such as idea sketch, prototype etc., among industrial designers and engineering designers during interdisciplinary collaboration, Pei, Campbell and Evans (2010) develop a collaborative design tool that offers a common vocabulary. This study shows that once the shared language is developed, the interaction among the interdisciplinary team advances. Persson and Warrel (2003), studying the relations between industrial designers and engineering designers defined different relational modes: one-way communication, reciprocal communication, interaction and collaboration. Each level requires increased communication, common understanding and interaction than the previous one. They argue that defining the mode of relation helps interdisciplinary design teams to overcome the problems they could face. Kim and Lee (2014) also explore the relations between industrial designers and engineering designers by focusing on causes of conflicts, resolving strategies and perceived image of each group. The qualitative research they conducted provides a good overview of

the relations between industrial designers and engineers. Their exploration shows that industrial designers think engineers are *not creative, conservative* and *unadventurous*, whereas engineering designers think industrial designers are *inflexible, bossy* and *dismissive*. Finally, Feast (2012) investigates professional designers' perspectives on collaborative design work. As the examples presented here illustrate, there is a wide variety of studies on industrial designers' experiences in interdisciplinary teams. Yet, it is not possible to find the same diversity and abundancy in the studies that investigate the experience of industrial design students' experiences in interdisciplinary teams.

2.8 Summary

After introducing the disciplinary framework and explaining the interdisciplinarity in detail, this literature review has demonstrated the recent changes in industrial design practice and correspondingly, the changes in industrial design education. In parallel with those changes in the last two decades, interdisciplinary programs and courses that aim to bring together the students from different disciplines have emerged in both industrial design and engineering education. Extensive research has been carried out on interdisciplinary educational programs. Existing research recognizes the critical role played by design in interdisciplinary collaborations. As the examples presented here illustrate, design tools and methods, such as design thinking and user research, hold an important place in the curriculum of these interdisciplinary programs and courses. So far, however, there has been little discussion about the experience of industrial design students during an interdisciplinary teamwork and their perspectives on interdisciplinarity. Much of the research up to now has been descriptive in nature and describe the interdisciplinary programs in detail to guide future implications (See for example Bronet et al., 2003; Goff et al., 2004; Coupey et al., 2010; Kim et al., 2012; Björklund, Nordström and Clavert, 2013). Although descriptive investigations are useful for developing a curriculum of a new interdisciplinary program, by offering the experiences of past course organizers, they do not necessarily investigate the experience of the students. Moreover, most of the existing studies on interdisciplinary design education, focus on the experience of engineering students and discuss how to integrate design into engineering education (See for example Hirsch et al., 2001; Vere et al., 2010). There are some studies that investigate both the industrial design and

engineering students (See for example, Goff et al., 2006; Self & Baek, 2016), yet these studies are mostly based on quantitative survey data. Reviewing the existing literature, it seems that there is a general scarcity of empirical studies that address the experiences of industrial design students during an educational interdisciplinary teamwork. This study aims to contribute to the growing body of literature on interdisciplinary design education by exploring the experiences of industrial design students and investigating their perspectives on interdisciplinary teamwork. As it clearly presents the industrial design students' motivations to participate, assumptions and opinions about working with other disciplines and expectations from interdisciplinary teamwork; and as it reveals the challenges they faced along with the strategies they employed during an interdisciplinary collaboration, this study has important implications both for industrial design education and industrial design practice.

This chapter has reviewed the relevant literature and highlighted the need for the present research. The next chapter will describe the methods used in this investigation and explain the context of this study, the IDS, in detail.

CHAPTER 3

METHODOLOGY

This thesis aims to understand the industrial design students' perspectives on working with other disciplines in an interdisciplinary design project. In order to do this, the study outlines the motivations of industrial design students to participate in the Interdisciplinary Design Studio (IDS), and explores their assumptions and opinions about other disciplines and interdisciplinarity before attending to the IDS. Moreover, the study investigates to what extent and in what ways the experience that the industrial design students had during the IDS overlaps with their prior expectations and assumptions, and how and to what extent the experience of the IDS affected the industrial design students' perspectives on collaborating with different disciplines. In broader terms, this research explores the experience of the participants from the Department of Industrial Design, throughout the process of an interdisciplinary design project, starting at the application period and ending after the IDS has finished.

This chapter describes the adopted methodology and presents a detailed overview of the research process. First, research approach, which is aligned with constructivist epistemology is explained with the emphasis on the characteristics of qualitative research. Then, the context of the study is described in detail to give insight about the curriculum and the scope of the IDS. Afterwards, research process including data collection and data analysis methods are presented.

3.1 Research Approach

There are different epistemological views that a researcher can adopt. Positivism and constructivism (also be used as social constructivism) are two of the epistemological views that have different focus and methods. According to the positivist epistemology, research is done in order to discover the reality 'out there'. Mostly quantitative methods are employed in order to test a hypothesis and to achieve objective and

repeatable results. In this kind of research, researchers are advised to keep their distance from the subjects, so that objectivity can be ensured (Holloway & Wheeler, 2002). According to the constructivist perspective, on the other hand, there is no single reality that can simply be discovered. Instead, there are multiple realities, and realities are constructed by the social interactions (Gray, 2009). Since socially-constructed realities are explored through meaning making and interpretation, within this epistemological view research generally relies on qualitative methods. With the aim of exploring the experiences of industrial design students during interdisciplinary collaboration, this research adopts constructivist epistemology.

Figure 3.1, explains the process of constructivist research. Social experiences take place in the natural and social environment in forms of events and activities. Then, these experiences are structured and understood through the knowledge and concepts constructed by the research participants. The researcher uses these to interpret the experiences and attribute meanings (Flick, 2004).

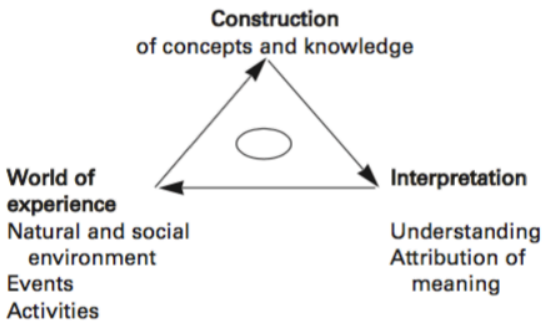

Figure 3.1 Construction and Interpretation as Means of Access to the World of Experience (Flick, 2004)

Creswell (2014), describes qualitative research as "an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (p.71). In this study, the researcher aims to explore an interdisciplinary collaboration, carried out within an extracurricular activity at Middle East Technical University, through the interpretation of the experience of and the meanings

constructed by the industrial design students. Considering the aim of this study, qualitative research approach is chosen.

Qualitative research has its own characteristics that distinguish it from quantitative research and mixed methods research. Creswell (2014) lists the characteristics of qualitative research as natural setting, researcher as key instrument, multiple sources of data, inductive and deductive data analysis, participants' meanings, emergent design, reflexivity and holistic account. These characteristics will be explained referring to the applications from this study:

a) **Natural Setting:** In qualitative research, data is collected from a real life setting, where the experience or interaction under study is taking place. Gray (2009) interprets this characteristic of qualitative research as its strength. He argues that by exploring a real life setting, qualitative research "goes beyond giving a mere snapshot of events and can show how and why things happen" (p. 320).

   In this research, the researcher conducted a field research during the interdisciplinary design studio in order to gain rich and deep understanding of the students' perspectives. Talking with the participants and observing their practices in the natural context results in gathering comprehensive information.

b) **Researcher as key instrument:** In qualitative research, data is collected by the researchers themselves "through examining documents, observing behavior, or interviewing participants", instead of using pre-designed questionnaires or instruments of other researchers (Creswell, 2014, p.588)**.**

   In this research, data is collected by the researcher through participant observation and interviews. Both set of interviews were semi-structured and the lists of the issues to be covered were prepared by the researcher.

c) **Multiple sources of data:** Instead of relying on a single source of data, qualitative researchers tend to employ multiple methods to gather different forms of data.

In this research through participant observation and two sets of semi-structured interviews, multiple forms of data are generated.

d) **Inductive and deductive data analysis:** Qualitative data analysis starts as an inductive process, during which the researchers try to come up with a meaningful set of themes generated from the data. Once the themes are created, the researchers turn back to the original data to find additional information that supports the themes.

   In this study template analysis, which will be explained in detail in the following sections, is used. Starting from a tentative template of themes, the researcher organized and coded the data until achieving the final themes. Once the final themes are chosen, the researcher looked back to the original data to find more quotes to support the themes.

e) **Participants' meanings:** Participants hold the most important part in qualitative research. Qualitative researchers aim to understand the meanings that the participants attributed to the events or activities. As the meaning is constructed by the participants, the subjectivity of the participants holds an important part for the researchers' interpretation (Flick, 2009).

   The analysis of this research builds upon the accounts of the participants and the observation of the participants' behaviors. This approach does not seek to make generalizations nor to describe quantitative data. Rather, it examines how industrial design students attribute meanings to interdisciplinary collaboration and how they collaborate with the students from different disciplines during an interdisciplinary design studio.

f) **Emergent design:** Qualitative research has a flexible research plan as the main aim is to learn in the field and from the participants. Therefore, research questions, data collection methods and the context of the study can change during the process.

   Also in this research, research questions are shaped and changed once the researcher entered the field and the first set of data was collected. New areas

that emerged during the interviews or observations are also investigated in the following stages of the research.

g) **Reflexivity:** Drawing attention to the importance of reflexivity in qualitative research, King (2004) defines it as follows: "The term reflexivity refers to the recognition that the involvement of the researcher as an active participant in the research process shapes the nature of the process and the knowledge produced through it." (p.20). Similarly, Creswell (2014) argues that the background of the researcher may affect the interpretations, thus the researchers should be reflective about their role and position in the research.

The researcher's personal background is an important element in this research. The researcher's being a research assistant at the Department of Industrial Design has its advantages and limitations. Working as a research assistant helped her to establish good rapport with the participants of the study. As the participants have already known the researcher, they were very helpful during the process. Also, coming from the same educational background with the participants, helped the researcher to understand the terms used, the past events that are referred to, such as a course from industrial design curriculum or a past project that the students carried out, and the concerns raised by the participants. On the other hand, researching one's own organization has its challenges (Tietze, 2012). During her interaction with the participants, she had to balance her roles of being a friendly researcher and an objective teaching assistant. Moreover, knowing the processes of curriculum development and organization of the IDS, and knowing the participants in person shaped the interpretations of the researcher. As long as the researcher is reflexive about how her past experiences and current roles affect her interpretations, it contributes to the interpretative nature of the qualitative research.

h) **Holistic account:** By compiling different perspectives and various accounts, qualitative researchers try to resolve the big picture.

Also in this research, the researcher aims to understand interdisciplinary collaboration by reporting the perspectives of industrial design students. In

order to develop a holistic picture, the researcher supports the students' accounts with her observations.

3.2 Context of the Research: Interdisciplinary Design Studio (IDS)

METU Design Factory, formerly known as Centre for Technology, Design and Innovation, is an interdisciplinary research and education center, which was established in 2015 with the support of the Ministry of Development of Turkey. By providing the space and production infrastructure, METU Design Factory aims to bring academics and students from various fields, including design, engineering and business areas, together to work on interdisciplinary projects. On the website of METU Design Factory, the main motivation behind establishing such an interdisciplinary center at METU is explained as follows: "The knowledge generated at the university is going to be transformed into prototype and product." (METU Design Factory, 2016). Both research and educational projects with the focus of interdisciplinary collaboration are supported by METU Design Factory.

Interdisciplinary Design Studio (IDS) was the first educational event of the METU Design Factory. The IDS was designed as an extracurricular activity, during which the students from various departments are expected to develop innovative products while experiencing interdisciplinary collaboration. 13 faculty members took responsibility during the planning and organization of the IDS. The faculty members also experienced an interdisciplinary collaboration among themselves during the curriculum development and planning stages of the IDS. 13 faculty members were from Science and Technology Policy Studies, Department of Industrial Design, Department of Architecture, Department of Mechanical Engineering, Department of Electrical and Electronics Engineering, Department of Metallurgical and Materials Engineering, and Department of Business Administration. Prior to the announcement of the event, these faculty members came together to discuss the learning objectives and the curriculum of the IDS. The first week of the IDS was organized as the training week, during which the students received useful trainings, such as interdisciplinary teamwork, user and literature research, project planning and management, to work effectively in an interdisciplinary design project. While 8 of the faculty members undertook teaching duties in forms of seminars or workshops, all of these faculty

members participated in the IDS as mentors and gave feedback to the teams during the project development. Therefore, later in this thesis these faculty members would be referred as mentors. The following weeks intentionally had a looser schedule and allow the teams to work on their own. In each week three mentoring sessions were scheduled at lunch breaks. Available mentors came together with the students to give feedback on their ideas. Throughout the IDS, with the exception of collective gatherings for team presentations, no more than two groups were attended at the same day to the mentoring sessions. As the attendance of the students decreased, the number of the mentors who came to give feedback also reduced in time. In addition to the mentoring sessions, each week two seminars, which aimed to broaden the perspective of the students, were scheduled at the lunch breaks. Generally, fifteen to twenty students showed up for these seminars.

The IDS was announced through various channels, namely mail lists of the university and the departments, social media accounts of the university and METU Design Factory, and the posters hung at departments' announcement boards (Figure. 3.2). Although the poster includes some information about the seminars and the project in general, the theme of the project was not revealed fully prior to the beginning of the IDS. Later, the participants reported that the poster aroused curiosity since there was not much information on it. The IDS took place between 28th of September 2015 and 23rd October 2015. The theme of the IDS was announced as "Transforming the Box". The theme was intentionally left broad, so that each team can come up with different ideas. Once the studio began, the students were asked to develop emergency scenarios using the box as a metaphor for an agent to be used in emergency situations.

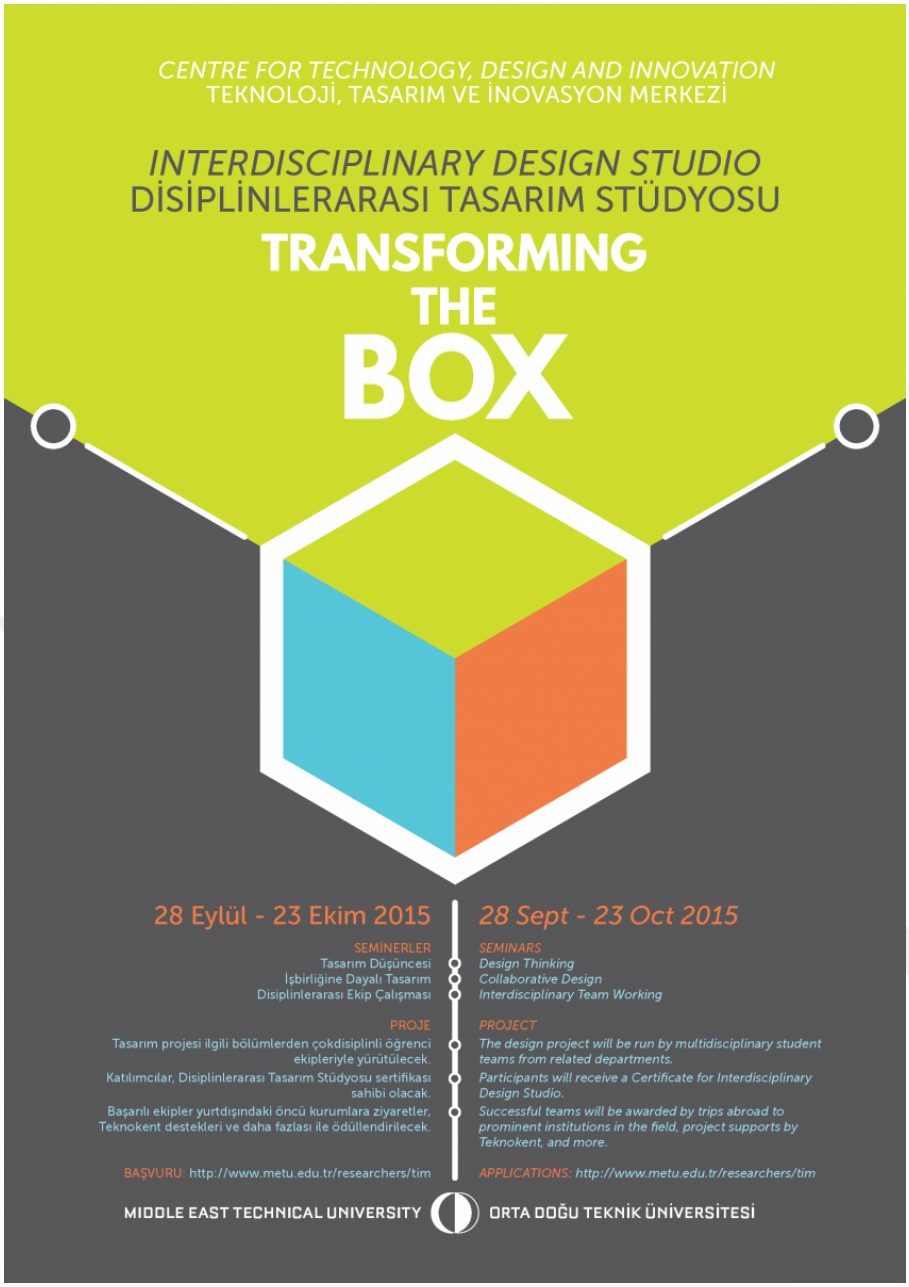

Figure 3.2 The Poster of the IDS

3.2.1 Participants of IDS

Although it was the first event of the METU Design Factory, there were extensive number of applicants to the IDS. While some of the students were personally invited by the tutors, most of them applied after seeing the announcement of the event. Students sent their applications via e-mail including their resume and a short essay to

explain their motivation to participate. In order to ensure interdisciplinary collaboration, the distribution of the participants by their departments were taken into consideration during the selection process. According the number of total applicants, the number of students to be accepted were decided for each department separately. Then, 42 students were selected out of 76 applicants according to their order of application. Only the students from the same departments with the faculty members, who would do mentoring, was chosen. Figure 3.3 illustrates the distribution of the participants by their departments. There were nine students from the Department of Industrial Design (ID), seven students from the Department of Architecture (ARCH), nine students from the Department of Metallurgical and Materials Engineering (METE), six students from the Department of Mechanical Engineering (ME), six students from the Department of Electrical and Electronics Engineering (EEE), one student from the Department of Industrial Engineering (IE), and four students from the Department of Business Administration (BA). Some of the graduate students had different educational backgrounds. The following figure is generated referring to the departments that the students are currently enrolled in.

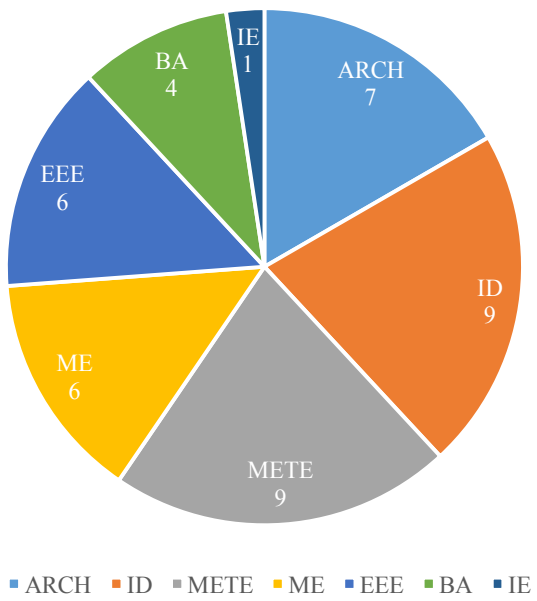

Figure 3.3 Distribution of the Participants by Their Departments

The IDS was open to the students registered at both graduate and undergraduate programs, while latter comprised the majority of the selected students. There were 26 undergraduate students, most of whom were in their third year or fourth year. Only two first year students from Metallurgical and Materials Engineering and Mechanical Engineering departments, who demonstrated extraordinary interest in interdisciplinary working and have satisfactory skills were accepted. Whereas there were only three PhD students, the seven of the graduate students were the recent graduates, who were just enrolled to master programs. Figure 3.4 illustrates the distribution of the participants by degree of education.

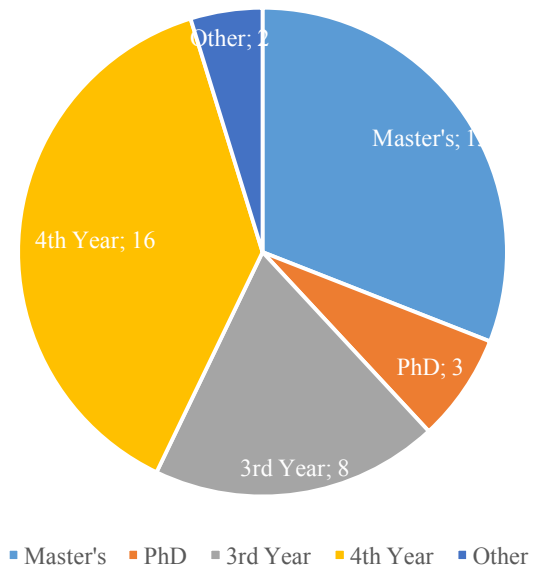

Figure 3.4 Distribution of the Participants by Degree of Education

3.2.2 The IDS Curriculum

The IDS lasted for four weeks and each week had a different focus. Figure 3.5 visualizes the program of the IDS by explaining the main objectives of those weeks.

1 TRAINING WEEK		Students met and built their teams. There were various seminars on interdisciplinary teamwork, design process, business canvas model, user research and scenario building
DAY 1	10.00 - 11.00 11.00 - 12.00 13.00 - 14.00 14.00 - 15.00 15.00 - 17.00	Check In: Welcome to DTS Speed Networking ------Lunch Break----- Warm Up: Transforming the Box Team Up! How to: Interdisciplinary Teamwork
DAY 2	10.00 - 12.00 13.00 - 15.00 15.00 - 16.00 16.00 - 17.00 17.00 - 18.00	Once Upon a Time: Design Experiences -----Lunch Break----- Through the Design Process How to: Project Planning & Management Intro to: Business Model Development How to: User and Literature Research
DAY 3		ALL HANDS on DECK! Teams Start Working on Reseach.
DAY 4	10.00 - 11.00 11.00 - 12.00 13.00 - 17.00	Design Process in Industrial Design Sharing User Research Findings -----Lunch Break----- How to: Idea Generation
DAY 5	10.00 - 12.00 13.00 - 17.00 17.00 - 18.00	Working on Scenarios ----- Lunch Break----- Presentations and Discussions Feedback Session
2 CONCEPTUAL DESIGN		Teams decided on the topic they wanted to focus on. Initial ideas was developed using the methods introduced during the first week, such as scenario building.
3 DESIGN DETAILING		Teams developed their design solutions and got feedback from the mentors. Students used their disciplinary knowledge to solve the design problems and create an innovative product.
4 PROTOTYPING		Teams finalized their project, produced the prototypes using the production infrastructure offered by the METU Design Factory and prepared their final presentations.

Figure 3.5 Weekly Program of the IDS

3.2.2.1 First Week: Training Week

The IDS started one week before the classes began. Therefore, during the first week of the studio, there was an intense program including seminars, workshops and group exercises. Students were expected to attend full day, from 10 am to 6 pm. As the building of METU Design Factory was still under construction, the IDS was held at the Faculty of Architecture building. Most of the activities, including workshops and mentoring sessions, took place at Digital Design Studio (DDS), which is one of the graduate studios of the Department of Architecture. For some of the seminars Kubbealti, which is a lecture hall at the same faculty, was used. Some of the teamwork activities and the juries took place at the fourth year Industrial Design studio. As most of the participants from the Department of Industrial Design were fourth year students, this studio was also used for teamwork by most of the teams during the IDS. Below, the program of the first week is explained day by day as it offers an intense training program compared to the following weeks.

First day. The students and the mentors met at the Digital Design Studio in the morning. Mentors introduced themselves and the project. There was a brief discussion about students' backgrounds and their expectations from the IDS. The program continued with a speed networking session. The aim of this session was to teach students how to introduce their interests and strengths to another student in one minute. Students were asked to gather in the rear car park. There they formed two big concentric cycles, one consisted of the students from Faculty of Engineering and the other consisted of the students from Faculty of Architecture and the Faculty of Economics and Administrative Sciences. In one minute each student introduced him/herself to another student in face of him/her. Then the inner cycle took a turn, so that everyone was faced with a different person. The process continues until the students in one cycle met with all of the students in the other. During the speed networking session students mentioned about their interdisciplinary experiences, their skills and their expectations from the IDS. After that, all of the participants had lunch together at the canteen. Naturally, participants initiated a discussion on their motivations to participate and their understanding of design. Later, mentors joined and it turned into an informal discussion meeting. After the lunch, the project brief was

given at Kubbealti, followed by an open discussion, during which students shared their first impressions about the brief. Once theme of the project, which is emergency, introduced, students were asked to form teams of seven paying attention not to have more than two students from the same department in a team. They were given one hour to form their teams. During the team building stage, discussions revolved around the understanding of the project and emergency. At the end six teams were formed. Table 3.1 shows the distribution of the departments of the participants by teams.

Table 3.1 Distribution of the Departments of the Participants by Teams

Team 1	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**
ME	ME	METE	ME	ME	ARCH
ME	ME	METE	ARCH	METE	ARCH
ARCH	ARCH	ARCH	ARCH	METE	ID
METE	METE	EEE	METE	EEE	ID
METE	IE	BA	ID	ID	METE
ID	ID	ID	ID	BA	BA
EEE	EEE	ID	EEE		EEE
					EEE

Team building session was followed by the *How to: Interdisciplinary Teamwork* workshop. Students were invited to the fourth year Industrial Design Studio, where each team could gather around a separate table to do teamwork activities. At the beginning of the workshop, students were introduced with disciplinary frameworks, and the differences between interdisciplinarity and other disciplinary terms. They were also provided with tips regarding how to work efficiently in teams and how to resolve conflict among team members. The workshop included a series of some team building games and activities. Later, teams were asked to draw their ideal group member collectively. Then, they were given the egg exercise, during which teams tried to make a packaging for an egg with the given materials in 30 minutes. These were the first exercises the participants did as a team.

Second Day. The day started with the discussions on how the students have built their teams. Then, students were asked to create mind maps in teams to visualize their approach to design process. While creating the mind maps students had a chance to learn about different disciplines' approaches to design. Once finished, mind maps were presented to all students and the mentors, who attended the session. These presentations initiated the discussions on how certain terms and concepts, such as design, modelling and research, have different meanings in different disciplines. During the break at noon, students had lunch with their team members. In the afternoon, there were three seminars. First, in the seminar called *Through the Design Processes* a mentor from the Department of Mechanical Engineering explained the design process in mechanical engineering discipline with reference to previous projects. Second, another mentor from the Department of Business Administration made two presentations: *How to: Project Planning & Management* and *Intro to: Business Model Development*. Lastly, the final seminar of the day was *How to: User and Literature Research*, during which three mentors from the Department of Industrial Design explained how to conduct user and literature research. Later, the teams were given a task to collect at least ten diverse user accounts of emergency situations such as health, security, earthquake, fire, accident etc. encountered. The day ended with the general discussions on emergency. Students shared their personal emergency experiences.

Third Day. The third day of the studio overlapped with the first day of the interactive registrations and advisor approvals at the university. Considering this, there was not an in-class activity allocated for the third day. Instead, students were expected to meet with their team members according to their individual schedules and complete the task on user research. Teams met and conducted interviews with people about emergency scenarios.

Fourth day. The day started with the presentation by one of the mentors from the Department of Industrial Design. The presentation focused on the design process and the problems dealt with in the field of industrial design. After the presentation, students were given time to finalize their user research presentations. Teams came up with alternative visualization techniques to present their user research findings. User research findings were shared with the entire group, accompanied by an open discussion. Then, there was a workshop called *How to: Idea Generation*, during which the scenario building exercise was explained with examples. Teams were asked to develop scenarios using the findings of the user research for the following day. After the session, some of the participants spontaneously came together at the faculty canteen to socialize. During that time, students commented on the IDS and shared the highlights of their teamwork experiences.

Fifth Day. In the morning, teams worked on their scenarios. In the afternoon, scenarios were presented to the mentors to get feedback in a jury format. All of the mentors were invited to be jury members. Each team, in front of a presentation board, presented their scenarios to the jury consisting of the mentors from different disciplines. Most of the teams used personas to explain their scenarios. In the first week there was an observable dominancy of design tools and methods over other disciplines'. After the presentations, participants gave feedback about the organization of the IDS. At the end of the first week, participants were asked to develop their scenarios during the weekend.

3.2.2.2 Second Week: Conceptual Design Week

As the classes of the 2015-2016 Fall Semester started in the second week of the IDS, the training sessions had been scheduled to be completed by the end of the first week.

Second week of the IDS was dedicated to the conceptual design phase of the projects. Teams were expected to decide on the emergency problems that they would like to address in the rest of the IDS. Three mentoring sessions were organized during lunch breaks on Monday, Wednesday and Thursday. During the mentoring sessions, available mentors and the teams come together at Digital Design Studio to discuss the ideas and the progress. Mentoring sessions resembles the critique sessions in industrial design and architecture education. As it was mentioned earlier the participation to those mentoring session was low. Also in this week, only a number of the teams got feedback from the mentors on their initial ideas. Yet, not all of the teams had turned up, due to the time constraints. Participants explored different problem areas related to the theme of emergency during the week. At the end of the week students were asked to create a matrix, which explains the topics that they would like to focus on.

Additionally, there were two presentations to broaden the perspective of the participants. The specialist, who is responsible of the workshop of the Department of Industrial Design, introduced the participants with the basic prototyping methods and showed how to turn an idea into 3D model. The second seminar was on intellectual property rights. Participants were informed about the process of obtaining patent.

3.2.2.3 Third Week: Design Detailing Week

At this week, students were expected to use their disciplinary knowledge to collectively find solutions to the design problems. The week started with the presentations of the matrix, in which teams explained their area of focus and the initial solutions they found. Teams got feedback from the mentors and other teams. After the presentations almost all of the teams decided on the product or the system they are going to develop. Similar to the second week, there were three mentoring sessions during lunch breaks. While some of the teams attended the mentoring sessions to discuss their design solutions, others preferred working as a team during the time allocated for the mentoring sessions.

There were two seminars, which took place during the lunch breaks. The first seminar was given by a mentor from the Department of Metallurgical and Materials Engineering. In this seminar the importance of material knowledge on product design

and innovation were discussed. The second seminar was on the history of technology by a research assistant from Science and Technology Policy Studies, during which examples of innovative solutions were presented.

3.2.2.4 Last Week: Prototyping Week

At the beginning of the week teams presented their detailed design solutions to the mentors at Digital Design Studio. Before making the prototypes they received final feedback from the mentors and the fellow students. The main focus of the last week was to make prototypes using the production infrastructure offered by the university. For this reason, a visit to the Department of Mechanical Engineering was organized to familiarize the participants with the production machines. Additionally, there was a seminar on futurism to broaden the perspective of the participants. During the week and the following weekend teams worked hard on their prototypes and final presentations.

3.2.2.5 Closure Ceremony

The closure ceremony of the IDS was organized at the METU Culture and Congress Centre. Being the first educational event of the METU Design Factory, the closure ceremony was widely promoted. Teams presented their final presentations and demonstrated their prototypes. After the presentations certificates were given to the participants. The closure ceremony was followed by a reception, during which the visitors had a chance to explore the projects in detail. All of the projects were exhibited at the hall and teams explained their projects to the interested guests.

3.2.2.6 After Studio Meeting

A meeting was organized three weeks after the closure ceremony to evaluate the studio process. Mentors, students and external stakeholders from METU Teknopark came together to discuss the expectations of the teams for developing their projects further. The opportunities that can be offered by the university was also discussed. Some of the teams reported their request for continue working together as a team.

So far I have explained the curriculum of the IDS, which is the first extracurricular activity of the METU Design Factory. The curriculum was designed by an interdisciplinary group of faculty members, with the aim of bringing students from different disciplines together to experience interdisciplinary collaboration and to create a project on an emergency scenario. This section has provided a detailed overview of the IDS curriculum and the participants. The following part will explain the research stages.

3.3 Research Stages

This research consists of three data collection stages, including pre-studio interviews, observations during the IDS and after studio interviews. Pre-studio interviews include, 14 semi-structured interviews that were conducted with all of the applicants from the Department of Industrial Design, one week before the IDS had started. Once the IDS had started, the researcher conducted participant observation, during which she observed how interdisciplinary teams were working together. Two weeks after the studio, 10 semi-structured interviews were conducted with all of the participants from industrial design department. In total, 24 interviews were conducted and more than 70 hours of observation was made. In the following sections those research stages will be explained in detail.

3.4 Data Collection

This section will explain how the participants were chosen and contacted, and how the data was collected. It will cover the data collection methods employed in this study, namely, semi-structured interviews and participant observation.

3.4.1 Population and Sampling Method

There are different sampling methods, which can be categorized under two: probability and non-probability sampling (Gray, 2009). Probability sampling refers to a sampling method that the participants are selected randomly. It is mostly used when the research aims to generate generalizable findings for that population (Gray, 2009). Non-probability sampling, on the other hand, refers to a sampling method that the participants were selected by the researcher according to their relevance or availability

(Creswell, 2014). In that case, findings require the interpretation of the researcher in order to be applied to that population (Gray, 2009). In qualitative research, mostly non-probability sampling is used in order to generate rich data from small number of participants. In this research, on the other hand, instead of choosing a sample from the population, the researcher conducted research with the whole population of industrial design students who applied to and participated in the IDS, with the aim of obtaining in-depth understanding and insight from them. The population for the first study, pre-studio interviews, consists of the industrial design students that applied to the IDS and includes 14 students. The population for the second study, after studio interviews, consists of the industrial design students that participated to the IDS and includes 10 students. Considering the small number of students in these populations, the research was conducted with all the members of the defined populations. In order to ensure the anonymity, no personal information is provided about the interviewees. All the names and other information that may reveal their identity was removed from the data that is presented in the analysis chapters. In that cases, explanatory captions are used in brackets.

As it was stated before, there were two groups of students among applicants: the ones who were invited by the tutors and the ones who applied by themselves. 7 industrial design students were personally invited by the tutors before the official announcement of the IDS. 7 industrial design students, on the other hand, applied by themselves seeing the announcement of the event on social media. Either invited by the tutors or applied by themselves, this group of students were interested in interdisciplinary collaboration, and thus, they are relevant participants for the first part of the study. At the time of the pre-studio interviews, the participants have not been announced yet. Later, out of 14 applicants from the Department of Industrial Design, 10 were selected to participate in IDS. Although the researcher interviewed with the all 14 of the applicants at the pre-studio interviews, the study continued with the 10 participants, who were selected for the IDS. The fourth year industrial design students were the majority both among the applicants (9) and among the selected participants (7). There were 3 graduate students among the participants, two of which had a special condition to be mentioned. First, there was a student who had a bachelor degree from the Department of Industrial design, yet pursuing a Master's degree from a different

department. As that student was observed to keep the industrial designer identity during the IDS, s/he is referred as an industrial design student throughout the thesis. Second, there was another student who had a Bachelor degree from another department, yet doing Masters' at the Department of Industrial Design. Similarly, that student was also referred as an industrial design student as s/he observed to be demonstrated close characteristics to industrial designers during the IDS.

For the participant observation taking place during the IDS, the researcher observes the dynamics and collaboration of the interdisciplinary teams, consisting of the students from design, architecture, engineering and management disciplines. Although the focus of the observation was exploring the perspectives of industrial design students in interdisciplinary teams, all of the 42 IDS students were observed.

3.4.2 Data Collection Techniques

Two complementary data collection techniques were employed for this study: semi-structured interviews and participant observation. Adopting the constructivist approach, the researcher aims to interpret the interdisciplinary experience through the accounts of industrial design students and her own observations.

Prior to the first set of interviews, interviewees were sent a written consent form (Appendix A). With the consent form, participants were informed about what the aim and scope of the study are, why their contribution to the study is valuable, how and where the interview data will be used. It was emphasized that the participation is voluntary and the participants have the right to withdraw anytime without presenting any reason. The participants' written consent was obtained to make audio recordings and to use those records for the analysis after being anonymized. At the beginning of the interview the consent form was read to the participants and verbal confirmation, in addition to a signed consent form, was requested.

This study is part of a larger research project supported by the university. Whereas the rest of the research team interviewed the faculty members that planned the IDS and did mentorship, and with the students from engineering, architecture and management disciplines, the researcher focused on understanding the experience and perspective of industrial design students during an interdisciplinary collaboration, and therefore,

conducted interviews only with the industrial design students. All of the data in this study, collected through semi-structured interviews conducted with the industrial design students and participant observation during the IDS, was collected by the researcher herself.

At the very first day of the IDS, all of the participants were informed about the research project. Industrial design students were already familiar with the research and the data collection methods that the researcher was using. During the observations additional information about the aim and method of the study is provided for the rest of the participants to assure their consent.

In total two qualitative data collection methods, semi-structured interviews and participant observation were employed with the consent of the participants. These data collection methods will be explained in detail in the following sections.

3.4.2.1 Semi-structured Interviews

Unlike the quantitative methods, in-depth interviews do not aim to find certain answers or test hypotheses. The main aim in in-depth interviewing is to understand the experiences of the participants and the meanings attributed by them (Seidman, 2013). Semi-structured interviews have a list of issues to be covered and questions to be asked, yet the researcher is free to change the order of the questions or add additional probing questions to encourage interviewees to share more (Gray, 2009).

In this thesis 24 semi-structured interviews were conducted with the students from the Department of Industrial Design. When possible, the interviews were conducted face-to-face. However, when the participants were not available for a face-to-face interview due to time and geographical constraints, the interviews were conducted using the online communication tools such as Skype, Hangout or Facetime. In order to simulate face-to-face interaction, video calls were made in all of the online interviews. All of the interview sessions were audio recorded for transcription and analysis, with the written consent obtained from the participants. For the audio recording Quicktime recorder was used. Note-taking was also used as a complementary technique to capture the data. In addition to the notes taken during the interviews, the researcher wrote reflective notes on how the interviews went, what the key points mentioned by the

interviewees are and what the researcher could have done for a better interview. The reflective notes helped the researcher not only to remember the content of the interview but also to be reflexive about her position as a researcher and resulted in improvement in her interviewing and research skills.

The researcher prepared interview guides, including the list of issues and questions to be covered. Yet, the wording and the sequence of the questions changed during the interviews in order to sustain a natural tone and flow. There were two sets of interviews: pre-studio interviews, conducted one week before the IDS, and after studio interviews, conducted two weeks after the IDS. The content and the aim of those interviews will be explained in the following part.

3.4.2.1.1 Pre-Studio Interviews

In order to understand the perspectives of industrial design students on an educational interdisciplinary design studio, it is necessary to understand their assumptions and opinions about interdisciplinary collaboration before the IDS and to learn their motivations to participate in the IDS. Pre-studio interviews were conducted one week before the studio started with all of the applicants from the Department of Industrial Design. There were 14 interviews in total. The duration of the interviews varied from 25 minutes to 50 minutes. Due to the operational reasons, all of the pre-studio interviews were conducted via online communication tools such as Skype, Google Hangout and Facetime in form of a video call. Although in certain cases the researcher changed the order of the questions and the way they were asked, each interviewee was asked the same set of questions to ensure the consistency between all the interviews.

The questions asked during the pre-studio interviews were collected under three topics (Appendix B). After the warming up questions, the following sets of questions were asked. First set of questions aimed to understand what industrial design students' motivations are to participate in an extracurricular interdisciplinary activity. Second set of questions focused on the assumptions and opinions of industrial design students about working with other disciplines. Lastly, the industrial design students' expectation from IDS and interdisciplinary teamwork is investigated.

3.4.2.1.2 After-studio Interviews

In order to develop the full understanding of the industrial design students' experiences during the IDS, it is necessary to hear their opinions after the four week of interdisciplinary teamwork experience. After studio interviews were conducted two weeks after the final presentations of the IDS. The researcher preferred not to interview with the participants immediately after the IDS. It was intended to give participants enough time to clear their mind, so that they could reflect on the process of the interdisciplinary teamwork that they have experienced better. There were 10 interviews in total. The duration of the interviews varied from 40 minutes to 80 minutes. Except one, all of the interviews were conducted face-to-face at the Faculty of Architecture. The researcher prepared a list of the topics that she wanted to ask the interviewees about by revisiting the pre-studio interview records and the field notes taken during the IDS.

At the after studio interviews, the questions were collected under two broad topics (Appendix C). First, the interviewees were asked about the experience they had during the IDS focusing on the challenges they faced and the relations they had with the students from other disciplines. Second set of questions were asked to understand how the industrial design students' perspectives on collaborating with other disciplines has changed after the IDS.

3.4.2.2 Participant Observation

In this research participant observation is used as a complementary data collection method for descriptive purposes and to support the interview data. Gold (1958) classifies participant observation roles into four: complete participation, participant as observer, observer as participant and complete observer (For more recent studies see also: Merriam & Tisdell, 2015; Brannan & Oultram, 2012) In *complete participation*, the researcher does not reveal his/her role as an observer in order to observe people in their natural setting. This kind of observation is also known as covert observation, because the subjects of the study do not know that they are being studied. It is argued that participants can provide more information when the researcher is in disguise. However, covert observation raises serious concerns about ethical issues (Gray, 2009).

Being *participant as observer,* the researcher fully participates in the context of the research, yet at the same time openly reveals that s/he is conducting an observation. The other participants know that they are being studied. The researcher need to pay attention to keep a balance between the participant and the observer role. *Observer as participant* defines a similar role for the researcher, but in this case the primary role of the researcher is observer. Participation is used by the researcher for building rapport with the participants of the study. Participants know that the researcher is collecting data, thus their acceptance of the researcher as a participant becomes an important aspect. Lastly, *complete observer* does not participate in the research setting. Flick (2009) argues that it can be achieved by substituting the observer with a video recorder, as the researcher avoids any interaction with the participants.

In this research, the researcher adopts *observer as participant* role. As the aim and method of the study was explained to the participants at the first day, the participants were aware of the presence of the researcher. Although she did not actively participate in the research setting as another participant of the IDS, she interacted with all of the team members. During these interactions researcher avoided giving feedback to the projects or intervening the team discussions in order not to influence participants. In time, the researcher built rapport with the participants. The participants talked freely about their experiences and feelings about the IDS, mentors and peers.

During the first week of the IDS, the researcher conducted five full day observations, starting at 9 in the morning and finishing at 6 in the afternoon. Occasionally, the researcher spent extra time with the participants after the program to join their casual conversations regarding the IDS and teamwork. In the following weeks, the researcher joined the mentoring sessions and seminars, taking place during lunch breaks. Additionally, the researcher visited the Faculty of Architecture building during weekends and at night to observe how teams work together. The researcher also attended closure ceremony, during which the teams presented their final products, and after studio meeting, during which different stakeholders came together to discuss the future of the projects. In total more than 70 hours of observation made by the researcher.

Observations were captured in the form of a handwritten field notes and photographs. In addition to the field notes taken during the day, the researcher read all of the notes and wrote reflective memos including her own feelings and interpretations about the events. In the analysis field notes were used for descriptive purposes and to support the interview data.

3.5 Data Analysis

After collecting data through interviews, the initial step of the qualitative analysis is transcribing the interview data. First, the verbatim transcription of the interview records was made before proceeding further, as it provides detailed overview of the participants' accounts. Then, thematic analysis of the transcribed data was done using the template analysis method (King, 2012). The process of template analysis begins with the construction of an initial template. Starting with these pre-defined codes, the data was coded. During the process of coding, the necessary changes were made on the initial template. All of the transcriptions were read through several times, until almost no new and relevant data emerged. Then, the findings were organized around the main themes and illustrative examples from participants' accounts were chosen. Lastly, direct quotes from the participants were translated into English. Figure 3.6 shows the process of data analysis.

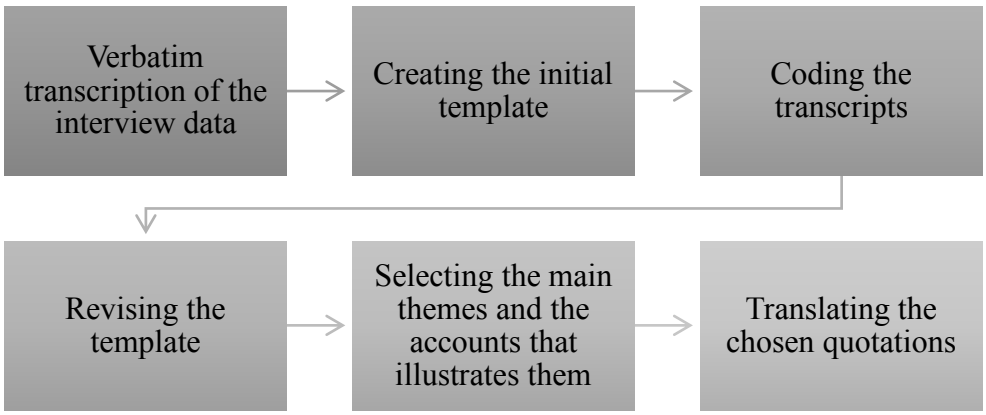

Figure 3.6 Process of the Data Analysis

3.5.1 Transcribing the Interview Data

Verbatim transcription of the interview records is a time and energy consuming process. One hour of interview takes at least 6 hours to transcribe. Although transcribing only the useful parts of the interview was an easier option, it is not possible to decide whether something is important or not without seeing the full picture (Seidman, 2013). Therefore, during this research all of interviews were transcribed manually by the researcher herself. In order to speed the process of transcribing, a software program called *F5 Transcription Pro* was used (Appendix D). By offering shortcuts for play/pause and spool backward/forward, the program substitutes the function of a foot pedal. Moreover, creating short substitutions for the frequently used words and phrases speeds the transcription process.

The transcription of the interviews by the researcher has its advantages both for the researcher and the research. The practice of transcription improves the interviewing skills of the researcher. The researcher was able to detect the areas to be improved such as not giving enough time to the interviewees to think or using certain words repeatedly, and improved in those areas at the following interviews. Moreover, even if the researcher analyzes the data months after the interviews, transcriptions accompanied by the personal memos of the researcher helps to put things in context. In the cases when the interviewees do not complete their sentences, it was necessary to add words to the quotations to make them understandable. In that sense, every transcription involves an interpretation (Rossmann & Rallis, 2012). Therefore, transcriptions done by the researcher who knows the context and related terminology increases the quality of the research outcome.

3.5.2 Qualitative Template Analysis

Template analysis is a qualitative data analysis method that uses templates for thematically organizing and analyzing the data (King, 2012). The researcher creates a list of priori codes (initial template) that corresponds to the themes. The initial template is then revised as the researcher reads and interprets the transcripts. Transcripts were parallel coded, which means same segment can be coded with two or more different codes. The organization of codes are hierarchical, which means related codes are

grouped under higher-order codes. Whereas the higher-order codes give the overview of the analysis, lower-order codes provide details.

Adopting a constructivist stance, the researcher believes that depending on the role of the researcher and the research setting, various interpretations can be made of the same set of data. Template analysis offers a flexible technique that empowers the researchers' reflexivity and interpretation. Moreover, starting with a template ease the process of coding large amount of textual data (King, 2012). For that reasons, template analysis is employed during data analysis.

3.5.2.1 Creating the Initial Template

First an initial template, including the priori codes, was developed. Initial template was used to analyze the transcriptions, but during this process the initial template was also open to revisions. King (2012) suggests that the interview guides, including the list of issues to be covered and the set of questions to be asked, can be used to create the initial template. Also in this research, initial templates were generated consulting the pre-prepared interview guides. Higher-order codes were chosen from the main set of questions. For example, the initial template for the pre-studio interviews had three higher-order codes corresponding to the three set of questions: motivation to participate, assumptions and opinions about working with other disciplines, and expectations from the IDS. Lower-order codes were generated from the questions and the reflective notes taken after the interviews.

3.5.2.2 Coding the Transcripts

Once the initial template was prepared, a total of 556 pages of interview transcripts were coded using computer-assisted qualitative data analysis software, MaxQDA (Appendix E). The researcher allocated time to learn the program before the analysis began. Online demos provided by the MaxQDA were used for that purpose. Similar to hand coding, the researcher went through each sentence of the interview and assigned one or more code to each segment of the interview transcript. Using a qualitative software program has its advantages. Assigning codes is faster and more efficient, as the codes can be color coded and organized easily. Moreover, the program allows the researcher to quickly locate and compare the coded segments (Creswell, 2014). After

the first round of coding, the initial template was revised. Relevant codes grouped under the same higher-order code. Software program gave an opportunity to reorganize the level and place of the codes. The process of coding was repeated until no new and relevant data has emerged. Later, the researcher went through the coded segments one more time manually to select the most relevant themes that would help to build an understanding of the phenomena under study.

3.5.2.3 Revising the Template

In template analysis method, template is flexible and should be changed according to the data and the aim of the project. King (2012) lists four types of modification that can be made while revising the initial template. These modifications can be made separately or can be employed together to achieve the best results. These modifications are insertion, deletion, changing scope and changing higher-order classification. During the coding process all of these changes were made on the initial template.

Insertion and Deletion. When the codes in the initial template do not sufficiently cover the points mentioned by the participants, the researcher can insert a new code. Similarly, some codes can be merged or deleted to achieve a clearer template. For example, the initial template of the pre-studio interviews included the codes 'Design process' and 'Engineering Design Process". Later, the researcher realized that these two codes can be replaced with a new code that covers the issues raised by the participants in both, "Designer-engineer comparison".

Changing scope. The level of the codes can be changed as the researcher develop increased understanding over the course of the analysis. Although 'Learning during an Interdisciplinary Collaboration' was not initially coded as a higher-order code, during the analysis it emerged as a significant issue addressing the aim of the study. As a result, the template was revised and it became a higher-order code.

Changing higher-order classification. In some cases, the higher-category of a lower-level code can be changed. For example, 'Expected benefit' was initially coded under the higher-order code, 'Expectations'. But later, it was decided by the researcher that the issues mentioned under 'Expected benefit' overlaps with the issues mentioned

under ‘Motivation to participate’. Therefore, the segments coded with the ‘Expected benefit’ were moved under ‘Motivation to participate’ (Appendix F).

3.5.3 Translating the Quotations

There was one international student who participated in this study. Only the interviews conducted with this student were in English. The rest of the interviews were conducted in Turkish, which is the language that both the participants and the interviewer are fluent. It brings about a necessity to translate the interviews into English. Once the quotations are selected, they were translated paying attention to understandability. Therefore, the transcriptions were not verbatim, yet the words used were as close as possible to the ones at the original accounts.

3.6 Summary

This chapter presented the research approach adopted, and the data collection and data analysis methods employed during the study. Constructivist research approach was adopted in this research as it is believed that meaning is constructed by the participants and interpreted by the researcher. Qualitative research methods were considered suitable to collect data from industrial design students during an extracurricular interdisciplinary design studio. Namely, semi-structured interviews were conducted and participant observation was made. There were two sets of interviews: pre-studio and after studio. Pre-studio interviews investigated the motivations of industrial design students to participate in the IDS, and their assumptions and opinions about and expectations from collaborating with the students from different disciplines. After studio interviews explored how the experience of the IDS was, and how and to what extend this experience affected the way industrial design students think about interdisciplinary teamwork. Participant observation, on the other hand provided the data to be used for descriptive purposes and to support the interviews. Participant observation helped the researcher to develop an enhanced understanding of the IDS, so that it was easier to understand and analyze the interview data. Thanks to the observations she made, the researcher could easily refer to the events and people mentioned by the interviewees. Although these two data collection methods support each other, they also provide specific data that could not otherwise generated. Whereas

interview data provides the perspective and the individual opinions of the industrial design students that the researcher could not obtain by the observations, participant observation provides the factual data, such as schedule of the IDS, the number of participants showed up to mentoring sessions, that the participants may not give objectively. For the analysis of the interview data, template analysis method was chosen. The transcripts were thematically coded using an initial template. During the process of analysis, the template has also changed. The researcher chose the most appropriate themes to present the findings in the most comprehensive way. The final themes were supported with the direct quotes of the participants. Research findings will be demonstrated in the following chapters.

CHAPTER 4

ANALYSIS I: PRE-STUDIO INTERVIEWS

The third chapter has described the chosen research methods, and the curriculum and the objectives of the IDS in detail. Two sets of interviews were conducted with industrial design students: pre-studio interviews conducted before the IDS has started and after studio interviews conducted after the IDS has finished. The first analysis chapter presents the analysis of pre-studio interviews. Within the scope of the pre-studio interviews the researcher conducted fourteen interviews with all of the industrial design students, who applied to the IDS, one week before the studio. This set of interviews aims to understand industrial design students' motivation to participate in an interdisciplinary design studio, their assumptions and opinions towards collaborating with other disciplines, and their expectations from an interdisciplinary teamwork.

4.1 Industrial Design Students' Motivation to Participate in the IDS

The applicants from industrial design department are mostly the students who already collaborated with the people from different disciplines before the IDS. Only two students reported that they have never experienced interdisciplinary collaboration before. Apart from them, the rest of the interviewees stated that they took the opportunities they have encountered to experience interdisciplinary collaboration. Their experiences vary from workshops to design competitions, internships to informal collaborations. Five of the applicants have attended in interdisciplinary workshops, where they participated in collaborative projects with engineers or architects. Two students have entered design competitions with their friends who study in other departments. Seven interviewees experienced interdisciplinary collaboration during their internships. While most of them worked with engineers, some of them collaborated with architects and other design disciplines as well. One student stated that with her friends from different departments, they try to develop imaginary

projects. Therefore, almost all of the applicants had previous experiences of interdisciplinary collaboration.

Most of the interviewees stated that after those experiences, they have been searching for an opportunity to collaborate with different disciplines. As the IDS was the first time that the university offered a chance to experience interdisciplinary teamwork in the form of an extracurricular activity, all the applicants were very eager to participate. A common view among the interviewees was that interdisciplinarity is an important aspect of the design practice, but they had little chance to experience it during undergraduate education. Most of the students underlined the interdisciplinary collaboration potential of the university, yet they believe students cannot make use of its full potential. One student put it as follows:

> Generally, we conduct our research by ourselves. Actually, it is something we have been discussing a lot. METU has a huge potential to encourage such collaborations but we do not make use of it. In fact, it is possible to do projects in collaboration with other departments. Although it is really easy to reach knowledge, we are conditioned to do something on our own. It is the reason why we cannot take the opportunities of our university.

This account illustrates that even if the student is appreciating the opportunities of the university, she did not take action to collaborate with the students from different disciplines at METU before the IDS. Interdisciplinary programs organized by the university, encourage students to collaborate with the students from other disciplines.

Interdisciplinarity holds an important role in design practice. Being aware of the importance of interdisciplinary collaboration, most of the industrial design students see this event as a unique opportunity to work with the people from different backgrounds. One student explained why interdisciplinary collaboration is important in design discipline and his motivation to participate:

> During the past three years in design school, I really feel that industrial design is a field that needs all the other disciplines. Because it's already a field in between other disciplines like mechanics, physics, industrial engineering. It kind of brings all of them together to make a final product. And a designer working alone by himself on a project doesn't make sense. That's the reason that I'm really excited about this project. It's a chance that I'll do a design with a group. Each of them coming from different fields, different point of views.

> They're from different bases of thinking and bringing them together to make a finalization out of it and to create a project would be interesting.

Almost all of the applicants expressed their feelings as being "excited" and "curious" about the studio. As it was explained in Chapter 3, half of the applicants from the Department of Industrial Design were invited by the tutors, whereas other half applied by themselves. The ones who were invited by the tutors, additionally stated that they felt honored to be selected:

> I heard it from [one of the professors from the Department of Industrial Design]. He contacted us. When I first heard the idea I really like it, because we would be working with people from different disciplines. […] We're excited because it's a new project. And also being nominated to such an event excited us. It left an impression with us that we know something. I was really curious about working interdisciplinary. I have never had a chance like this before. That is what I am most excited about.

All of the industrial design students who were invited by the tutors reported the positive influence of being invited. Although they presented additional motivations to participate, they did not deny the persuasive effect of the invitation. An invited student mentioned the e-mail they received: "Actually our hearts were stolen by the e-mail stating that it is about a prestigious project. I thought it would improve me a lot." Only one student reported that being invited was the main motivation for him to apply. He stated that he would not have considered to apply to IDS unless tutors would have personally invited him.

Depending on their background, previous experiences and personality, the applicants from the Department of Industrial Design have different motivations to participate in the IDS. In the analysis of the students' motivations to participate, four themes emerged: interdisciplinary experience with peers, professional benefits, networking and opportunities offered by the METU Design Factory and IDS. These themes will be presented in the following part.

4.1.1 Interdisciplinary Experience with Peers

In the poster of the IDS (Figure 3.2), it was announced that various seminars that focus on design thinking, collaborative design and interdisciplinary team working would be

organized in order to support interdisciplinary learning. Surprisingly, only one student mentioned those seminars during the interview: “Even if I don’t get accepted, I really want to feed myself with the seminars. Just listen in the corner. That would be cool.”

Apart from this student, all applicants put much emphasis on the significance of peer learning, rather than learning from tutors. Similarly, when the applicants were asked whether they have ever collaborated with other disciplines during undergraduate level, most of them reported that they asked help during their projects from their friends rather than professional experts and tutors. Also within the context of the IDS, accounts of industrial design students showed that experiencing interdisciplinary collaboration with peers is the main motivation for them. Three sub-themes have emerged from the analysis. First, the applicants mentioned the importance of working on the same project with the students from different disciplines having the same level of involvement. Second, the interviewees reported that they want to learn from fellow students. Lastly, they expect to broaden their perspective as a result of the interactions with other disciplines. These sub-themes will be discussed in detail in this section.

4.1.1.1 Experiencing Interdisciplinary Peer Collaboration

The interviewees were excited about working with the students from other disciplines on the same project. Referring back to their past experiences, most of them stated that when they asked help for their own projects, students from other disciplines were not willing to cooperate since those students were not directly involved in the project. However, in this interdisciplinary studio they expect it to be different, as being part of the project is a good motivation for collaboration. The below quote from the interview shows the motivation of an industrial design student to practice peer collaboration:

> Normally, when doing my own projects, I want to get help from my friends, from engineers. I always ask them “How can it be? How is it like that?”. But because my friends are not the part of the project, they can’t give me efficient answers. They just say something to save the situation. But here [at the IDS] the people will be involved in the project. Therefore, I thought I can get more information from them.

This view was echoed by various interviewees. In addition to the difficulty of finding people who are willing to help, creating an environment for the collaboration is also a

problem. Another student drew attention to the difficulty of convincing peer students to work collaboratively:

> You cannot find an opportunity to get other people's opinion in such a collective manner. You also cannot find anybody to help when you want to get other disciplines' opinion. But there is a project like this [IDS] and we have a chance to experience working with different people. I think it will be efficient in that sense. Because it is really an issue. People don't want to spend time, even if they do, there is no proper environment. You need to spend a lot of effort to find these two together.

Peer collaboration is highly valued among industrial design students. Having experienced the challenges of working with the students from other departments before, they regard the IDS as a good opportunity for collaboration. Working on the same project results in active involvement of all disciplines. One student states her feeling about it as follows:

> I thought meeting with the concept of interdisciplinarity at university, when we are still students would be very useful. That's why I liked it [the IDS]. I felt like my university would be an R&D office.

4.1.1.2 Learning from the Fellow Students

As it is mentioned earlier, industrial design students expressed their enthusiasm for collaborating with their peers and learning from them. Almost all of the applicants want to learn what kind of problems other disciplines are interested in, how they approach to a problem and how they solve it. A common view among the interviewees was that learning from the fellow students, who have the same level of knowledge is valuable. One student referred it to be the most exciting part:

> The biggest thing that was motivating for me was to have students from other departments that are equal to me, like knowledge level or scale of their works. Coming together, trying to figure out something together or making a project together, that is the most exciting part of it.

Although industrial design students also willing to share their disciplinary knowledge and experience with others, they underlined the importance of learning new things. Some students mentioned their excitement about doing a project combining their

knowledge with the knowledge of other disciplines. The following account illustrates these views:

> The thing I am most passionate about in this project is not only giving information but also developing the project by using our own knowledge and additionally, using each other's. Actually, I hope so. I am dreaming about something like this.

Another student, when asked to describe the interdisciplinary collaboration that they are going to experience at the IDS, described it as a learning process. She imagined to get to know other disciplines and combine those with hers:

> I would ask them how they would design a bicycle [imaginary product example]. To understand their design process. Then I would explain ours. Can we combine anything? How would they make research, how would we do research? […] I would try to learn something from them, so that it will be useful for me later. I am not attending only to introduce my own department. Neither do they.

Whilst a minority mentioned their expectation about learning new tools, like Ardunio, from the students from engineering departments, all agreed that peer learning would give an opportunity to get to know other disciplines. The majority of the interviewees stated that they would like to experience working with the students from other disciplines and thus, they expect to learn how engineering and management students approach to a design problem.

4.1.1.3 Broadening Perspective through the Interactions with Different Disciplines

Most of the interviewees expect "their minds to be opened up" as a result of the interactions during an interdisciplinary collaboration. It was stated that by learning new things from other disciplines, it is possible to approach to the problems from different perspectives. The accounts of the ones who have experienced interdisciplinary collaboration before show that such an experience changed their understanding of interdisciplinarity and it also affected their expectations from the IDS. One student, who has experienced interdisciplinary collaboration before described her experience as follows:

> A friend of mine and I worked with people from other departments during some projects. […] You really enjoy when you collaborate with other people. Seeing an idea from different perspectives really enlightens you. The way you solve a problem and the way you approach to a solution change when you look at a problem from a different perspective. We have been looking for such an opportunity for so long.

This account illustrates how interdisciplinary collaboration broadens the perspective of industrial design students. Similarly, another student, who has participated in an interdisciplinary workshop with sociologist and designers stated:

> I had a lot of interesting things on my mind from that workshop [referring to the interdisciplinary workshop he has attended before]. Somehow your perspective enlarges. You start thinking of something you have never thought before. And you continue using it all your life. For example, I used what I learned from that workshop for five different times. I expect my mind to be opened up at IDS.

Collaborating with other disciplines not only changes the way designers approach to the problem in question, but it also affects the way designers think during future projects. Another interviewee expressed her excitement for working with other disciplines by underlining the importance of how learning from others results in acquiring a different point of view:

> Other disciplines are not your own field. You only have limited knowledge, which you gained during your past experiences. By saying something you have never heard of, these people can contribute to the development of a totally new thing. It is a very different point of view. I think it is really good, it is the thing that excites me.

Overall, these accounts have shown that industrial design students value working on an interdisciplinary design project with the students from different departments. For them, the interdisciplinary experience is based on learning. By the experience of interdisciplinary collaboration, they mostly refer to the relations they are going to have with the fellow students, from whom they hope to learn new things. Although they were not directly asked, they reported that they would rather learning from their peers than learning from the tutors. Working on a same project they hope to gain understanding of how different disciplines approach to a problem, so that they could experience a collaboration during which they combine their own disciplinary

knowledge with other participants'. The interviewees also indicated that collaborating with and learning from the peers would be useful for their future career as it will broaden their perspective and they would learn how to work with the people from different disciplines. The following part will discuss the professional benefits that the students from the Department of Industrial Design hope to get during the IDS.

4.1.2 Professional Benefits of the IDS

Most of the interviewees claimed that the experience of an interdisciplinary collaboration is more valuable for them than an award, a certificate or writing it on their CV, yet their accounts show that getting prepared for the professional life is also an important motivation for them. There is a common belief that this experience would be beneficial for their future career. Two sub-themes have emerged from the analysis: getting prepared for the professional life and improving CV/ portfolio to get a job.

4.1.2.1 Getting Prepared for the Professional Life

The majority of the interviewees approach the IDS as the simulation of the professional life, during which they would have to work close to different disciplines. Most of the industrial design students imagine that they will be working in interdisciplinary teams once they are graduated. One student drew attention to the increased importance of teamwork in today's design practice and stated that designers never work alone. None of the interviewees mentioned working by themselves, as designers. It shows that the industrial design students are well aware of the current trends in the design profession and try to equip themselves with the necessary skills. The following account illustrates those views:

> I don't think we would have a luxury to work apart from other disciplines. I don't think someone would say "You, designers, go and work alone.". You have to work together with everyone else. Therefore, I think it would be a great experience for me.

Being aware of the fact that they need to interact with other disciplines at work, the interviewees reported the importance of experiencing interdisciplinary collaboration during undergraduate education. It was stated that meeting with other disciplines before entering the professional life would give advantages to the industrial design

students. One student stated that every discipline has a different approach and a different understanding of design coming from their education. She suggested an imaginary case that every university had such an interdisciplinary event at the undergraduate level, so that the potential challenges of interdisciplinary collaboration in professional life would be avoided:

> Before being graduated we have a certain understanding of design coming from the education we had and from our professors. If fictionally we think that every university has such events [like the IDS], when we enter the work life we would be the people who have already solved these issues. Otherwise people see an industrial designer for the first time [at work] or a mechanical engineer and a designer first time in their life try to work on something together. It would be a lot harder.

As this quote illustrates there is a common assumption that working in collaboration with other disciplines is going to be challenging, because of the lack of experience and lack of prior acquaintanceship between disciplines. Therefore, industrial design students wanted to take this opportunity, during which they would interact with the students from different departments. It is believed that the experience that they are going to gain at the IDS, would help them understand other disciplines and position themselves, as industrial designers, in interdisciplinary collaborations. An interviewee stated:

> My dream is working in a design office and designing the products that will be produced. For this, I think it would be a really good experience for my future. I think it will help me a lot to observe how to sustain these [interdisciplinary] relations and how to position myself in such [interdisciplinary] groups.

Moreover, it was mentioned by a number of interviewees that participating in the IDS would give them a good start in professional life as they will be able to understand how engineers, architects and business administrators think. Another student stated that she will be more prepared for professional life as she would have a chance to get to know what different engineering disciplines really do:

> It will give me a head start. Because I will now encounter the problems that I would have been encountered when I entered the professional life or after masters. I will have learnt whether engineers really have an engineer mindset or they are like us, tend to do research. I will have got to know engineering discipline. Or more specifically mechanical engineering or computer

> engineering. I don't know what a computer engineer does now. Maybe I will have learnt that. These are the things that will improve me. Considering the work context, when I work in such an [interdisciplinary] environment, I will have already had a knowledge and experience.

Another account summarizes the common view amongst industrial design students by stating that "experience is everything for designers". Therefore, they also see the IDS as an experience that would prepare them for the professional life by giving a chance to encounter and collaborate with the people from different disciplines.

4.1.2.2 Improving CV/ Portfolio to Get a Job

Industrial design students value the experience they are going to gain during the IDS. Although most of them stated that working with the students from different disciplines and learning how different disciplines approach to a design problem is the main motivation for them, interviewees did not deny that the interdisciplinary design studio would look good on their CV and on their portfolio. Almost all of the applicants told that they are going to write their participation to the IDS on their CV and present the outcome in their portfolio. Most of the applicants mentioned that today companies are looking for people, who have experience in teamwork. Therefore, it is believed that presenting the experience of the IDS would be useful during job applications. The following quote illustrates the general opinion:

> Of course [including the IDS in my CV] is important. Yes, people also look at the projects that you've done. They might think that you have team working skills. But when you write [your participation to the IDS] on your CV, they will be sure.

The majority of the applicants mentioned that the IDS would improve their CV and would provide a good reference for their future career. The general assumption was that such an experience would proof their team working and interdisciplinary collaboration skills. Whereas most of the interviewees focus on CV, some showed their excitement about adding a new project to their portfolio as illustrated below:

> When I first heard the idea [of the IDS], I really liked it because we would be working with people from different disciplines. Additionally, I thought a different project to put my portfolio might come up. That's why I got excited and applied.

Among all the applicants only one interviewee stated that he did not care about the professional benefits of the IDS:

> Actually, I don't care about writing it on my CV. In fact, I don't even think about practicing this profession. Project environment is something that we already like. Doing it with a lot of people seems to be fun. As I don't think about entering the professional life I don't see it as a preparation. But I will have tried it.

4.1.3 Networking with the Like-minded People

Networking was an important motivation for some of the interviewees. According to them, the IDS offers an opportunity for meeting like-minded people who are open to interdisciplinary collaboration. The interviewees asserted that building networks with the students from other departments would be useful for their future projects. The majority of the industrial design students reported that they have been asking help from their friends rather than professionals or professors during their undergraduate studio projects. It is believed that consulting a friend is more practical as it is more accessible and the communication with friends is easier. Moreover, one student stated that the during a design project, relations with the people from other departments mostly remained at the consulting level. She claimed that she can only proceed further with her close friends as they can work fruitfully. Therefore, some of the interviewees hope to build friendship with the other applicants from different departments, so that they can ask help when needed in the future. One student drew attention to the difficulty of finding help and she stated she would ask help from her team members after the IDS:

> If I really believe that they want to help and do their best, I would ask for help. Why wouldn't I? Because nowadays acquiring knowledge seems to be quite easy but actually it is not. There is something like acquiring the qualified information. And you can't always find it. If I can build good networks at the end it will be a very important benefit.

Although this account focuses on consulting and asking for help for industrial design studio projects, some of the applicants voiced their intentions for future collaborations with the students from other disciplines. The quote below shows a student's expectation for sustaining the relationships built during the IDS:

> In long term, the relations that are built in here can be sustained by coming together for different projects. The networking aspect is important for me. Meeting with the people who are really interested in [working interdisciplinary] is important.

Although the students were aware of that mentors and tutors from different departments would take part in the IDS, only one student mentioned the importance of networking with the professors.

> First, you may get friends. Second, for example, you will do a project and you need a mechanical engineer to outsource a part of the project. That person [that you worked with in the IDS] can come to your mind. You can say "Oh s/he was knowledgeable about this topic." and you can even call him/her for partnership. Third, as far as I understand there will be close relationships with professors. A direct connection will be established with professors. Whenever there is something you can contact them.

Even this student who mentioned building close relationships with professors put emphasis on networking with peers. All the other accounts that drew attention to the networking focused on building sustainable relationships with the peers.

4.1.4 Opportunities Offered by METU Design Factory and the IDS

Approximately 2 months before the IDS begins, a meeting is organized by the METU Design Factory, and students from different disciplines, student clubs, such as Robotics Club, and faculty members were invited. During this meeting, students from different disciplines had encountered for the first time. Faculty members and students came together to discuss the organization of the IDS and the opportunities to be offered by METU Design Factory. Five students from industrial design department, who were invited by the tutors, have attended this meeting. Referring to the discussions took place during that meeting, those students reported that the students from other disciplines were mainly concerned with the questions of whether there would be any awards, whether their efforts would be graded or whether there would be any other opportunity. These five participants stated that they did not share the concerns of other disciplines. One interviewee explained that unlike the students from other departments, experiencing an interdisciplinary project is the main motivation for the industrial design students:

> For example, the management students asked whether there would be any big companies, whether there would be any prestigious companies to write on their CV? Engineers told they would come only if it would be a course with credits. But, as designers, for us if it is a project, it is enough. We thought "Let's go and experience it!". For that reason, I liked it a lot.

Students said that there were intense discussions at the meeting on whether to offer something that would encourage students to apply, such as an award and trips abroad. Comparing themselves to the students from other departments, industrial design students stated that they value interdisciplinary teamwork experience, that was explained in Section 4.1.1, more than those opportunities. Another student voiced her surprise when she met with the students from other departments:

> We didn't have any concerns about the award or the grade, when we agreed to participate. When people come to the meeting, they asked professors "Wouldn't there be anything [that you will give us]?!" We were surprised. We thought "You are experiencing such a thing, what else can you possibly ask in exchange?!"

The meeting created a shared view amongst the industrial design students who have attended, that other disciplines have different motivations from industrial design students to participate to the IDS. The following account shows the reaction of an industrial design student to that situation:

> [Other disciplines] don't know how a designer works. They act like they don't need a designer in their own projects. We have attended a meeting. In that meeting they were talking like that. At that meeting, I understood that they don't approach to a project as we do. They [Students from engineering departments] started as result-oriented by asking what our expectation from that project was. For example, the aim of the participation was the award for most of them. None of them was demonstrating any excitement during that process. I would like to work with all of them to create an awareness. When they work with a designer, they will see it.

Although the discussions revolved around the opportunities that the IDS and METU Design Factory might offer, industrial design students seem to be more interested in the interdisciplinary collaboration that they are going to experience and the relationships they are going to build with the students from other disciplines. Only two students who have attended the meeting demonstrated their interest in using the machines at METU Design Factory. Although they regarded it as a good opportunity,

it was not mentioned as their main motivation to participate the IDS. Their accounts echoed the promises given at the meeting by the tutors:

> If we can use [METU Design Factory] very efficiently, it will be very useful for me. It seems to have a lot of opportunities. There are a lot of [machines] to use. Using the machines at school is a lot better than going to Ostim [industrial production site] every time for a project.

The students who have not attended the meeting only knew about the opportunities announced at the poster (Figure 3.2). On the poster the following note was indicated: "Successful teams will be awarded by trips abroad to prominent institutions in the field, project supports by Teknokent, and more." Yet, only two industrial design students mentioned about the trips abroad during the interviews. Even the student, who showed interest in trips abroad, put emphasis on working as a group and making a project:

> In the poster that I saw, there was a part offering a chance to go to institutes that work in interdisciplinary fields and that was a huge motivation. Because if there is a chance that we can make a project with the group of other departments and go together to a few institutes that are already working on it, it could become a great chance.

The analysis presented so far demonstrated the motivations of industrial design students to participate in the IDS. It is possible to say that experiencing an interdisciplinary collaboration with the fellow students from different disciplines and learning from the peers are the main motivations to participate. Moreover, the analysis shows that industrial design students have a clear understanding of the significance of interdisciplinary collaboration in industrial design profession and the collaborative skills that the industry is looking for during job recruitment. Therefore, the IDS is seen as a good opportunity to get prepared for the professional life. The common view among the interviewees is that the IDS would give them a chance to experience working with different disciplines and to create a network of like-minded people, who are open for future interdisciplinary collaborations.

4.2 Industrial Design Students' Assumptions and Opinions about Collaborating with Other Disciplines

Industrial design students had certain assumptions and opinions about collaborating with other disciplines before attending the IDS. As discussed in the previous part, seeing the IDS as a peer learning experience, the interviewees value the relations they are going to build with other students. For that reason, it is valuable to explore their assumptions and opinions about other disciplines. This section is organized under two topics. First, industrial design students' accounts about the participants of the IDS will be explored. Second, what kind of relations they expect to have with the engineering students will be explained.

4.2.1 Assumptions and Opinions about the Participants of the IDS

In order to understand their assumptions about interdisciplinary collaboration, the applicants from the Department of Industrial Design were asked to guess which disciplines would participate in the interdisciplinary design studio. The majority of the interviewees stated that if there is an interdisciplinary design project, there should be the collaboration of designers and engineers. Some students also added social sciences and claimed that interdisciplinary collaboration should include "three different functions", namely engineering, social sciences and design. It was widely assumed that each discipline would contribute to the project using their own disciplinary knowledge. In this collaboration engineers were perceived to be the ones who would realize the project using their technical expertise. The following account successfully illustrates the general opinion amongst the interviewees:

> You need to know a lot of things while designing. For example, from technical perspective. What are the physical properties of it? You need to make a research. Is it possible or not? I think engineers can help to make it down-to-earth. How nice would it be if they explain the technical part like the differentials that we don't know, how the friction would change or if they help us on whether the legs of this chair would break or not. I think it will be like this. Because there is a higher possibility that the thing you design will be down-to-earth when you work with engineers. We all know things from different fields. What they know is being scientific.

Some of the interviewees also stated that psychologist and sociologist can help during the research phase to understand the user, and people from management background can help to market the product and to create a feasible business model. Yet, when the interviewees were asked which discipline is essential for an interdisciplinary design project, almost all of the applicants listed engineers along with industrial designers. Amongst all of the engineering fields, mechanical engineering is the one that industrial design students want to collaborate with the most, followed by electronical and electronics engineering. Most of the interviewees stated that mechanical engineers would help them with their knowledge in mechanics and production techniques, and electrical and electronical engineers would help them to combine physical product with software. Although some students listed industrial engineering, computer engineering, metallurgical and materials engineering, those fields of engineering were not considered to be essential for an interdisciplinary design project by the majority. A common view amongst interviewees is that engineering disciplines would help the designers to overcome the deficiencies in their technical knowledge. One student put it:

> I guess I want a couple of engineers. (Laughs) I mean, there is a higher possibility that we can learn about socio-cultural aspects or anatomical information by reading it by ourselves. But it will take a lot longer for us to learn the technical information that those people [engineers] could provide to us. We need to work on that and we need to practice in order to understand it fully. It seems to me that absence of technical aspect is more critical.

Similarly, another account shows that industrial design students regard the students from engineering departments as helpers who solve the technical details for them. She claimed that one designer and one engineer, together, are capable of making a product:

> Yes, also engineers try to ease the life of the people. But I think they make the thing that we try to improve, they solve technical parts of it. Does it sound nonsense? I can't solve the technical parts, so they do it for me. But it seems to me that they are helping me. (Laughs) Also they can't do something on their own. But together we create something beautiful. For example, I can't produce an oven by myself. It would be really hard even if we were four designers. But as one designer and one engineer, we can do it.

Generally, interviewees mentioned about other participants as the ones who would help them during the projects when their knowledge or skills are not sufficient.

Therefore, industrial design students were eager to work with every department to learn something from them. In that sense, the interdisciplinary relation that they imagined to have during the IDS is closer to the crossdisciplinarity (see Section 2.1.3 and 2.2.3), as they put industrial designers at the center and regard other participants as helpers. The relationships that they defined are mostly in form of help seeking rather than collaborating. It seems that even if the industrial design students have an idea about interdisciplinary collaboration and they emphasized its significance, their understanding of interdisciplinarity is different from the definitions made in the literature (see Section 2.1.4 and 2.2.4).

Almost all of the interviewees, when asked if there is any discipline that they cannot imagine working with during the IDS, reported that they can work with any discipline as long as people are willing to collaborate. Whereas almost none of the students think they would have problems when working with the people from different disciplines, only a few students voiced their hesitation about working with the students from the Department of Business Administration. Those students believed that in Department of Business Administration students receive very different education from industrial design students. One interviewee stated that she feels closer to the engineers than business administrators:

> About its marketing aspect, I heard that managers develop something with numbers. They are knowledgeable about that, but I have no idea. As I have never worked with them it can be strange. They are so different. I find engineering departments closer to us, but management can be more different.

As the accounts presented in this section illustrate, industrial design students mostly talked about designer-engineer collaboration when asked to comment on interdisciplinary teamwork. During the interviews, interviewees tend to position their discipline in relation to engineering disciplines. The following section presents the accounts of the interviewees on interdisciplinary collaboration between engineers and industrial designers.

4.2.2 Relations between Industrial Designers and Engineers

The previous section showed that industrial design students see engineering disciplines as a complementary part of industrial design discipline during an interdisciplinary

collaboration, which aims for an innovative outcome. As discussed earlier, during the interdisciplinary collaboration that the interviewees imagined to have, industrial design is the dominant discipline, yet rather than aiming integration, industrial design students aim to solve design problems by consulting the engineering students. For that reason, even if the interviewees indicated that they feel closer to the students from engineering disciplines, it was common to address the disciplinary differences between industrial designers and engineers when talking about interdisciplinary teamwork. The analysis shows that even if they are still students, the interviewees have already developed certain assumptions towards engineering disciplines, which are more complex than the symbolic dualisms.

First, industrial design students perceive engineers as the ones who deal with the functionality of the product while seeing themselves as the ones who combine aesthetics and function. Although they referred to the symbolic link between engineering and functionality, they were not comfortable with the idea of being associated with only the aesthetics part of the products. One interviewee put it:

> I think the priority for them [engineers] is fulfilling a function. Ok, also in industrial design practice it needs to be functional. But in addition to that, physical appearance of the product and its interaction with the user are taken into consideration while designing. Engineers tend to ignore those aspects.

Like her, many interviewees indicated that the problems that the engineers are trying to solve are related to the function of the product, which results in an objective evaluation of the success of the engineering process. Another account draws attention to the main difference between engineering and industrial design practice:

> In my opinion design engineering is, for example, designing a machine, with the aim of reducing the number of movements to push from two to one. Efficiency is important. Can it be placed at the production line? I don't think there are aesthetic considerations. The question is how to achieve the same result with one movement instead of two. And they would feel satisfied with the result if they can reduce it to one. On the other hand, our focus is daily use cases, a product for the end user. I think ours is the combination of form and function.

Following the same argument, all of the interviewees voiced their assumption that engineers tend to ignore user experience while prioritizing the efficiency. One

interviewee explained her argument using the word “emotion”. Also this account is built on another symbolic dualism that associate engineers with logical and objective thinking, and designers with emotional and subjective thinking. Yet, the perspective of the interviewees is more complex as they do not conform to their part of the dualism and see themselves more complete than the engineering students.

> They [engineers] may be looking from a less emotional perspective. While we were also considering the human aspect, they can be really tough about this subject. If they can solve a problem in the most efficient way they can ignore the user. Engineers have a luxury to see users as pawns, forgetting the fact that they are humans. They can see people as a variable in an equation. But as we, on the other hand, build that equation on people, differences occur.

Her argument demonstrates the common assumption among the interviewees that the industrial designers approach to the design problem more comprehensively, considering the users in addition to the technical aspects, whereas engineers are focused only on the technical aspects of the product. Almost all of the interviewees referred user research as the thing that differentiates industrial design from engineering disciplines. Although they assumed that engineers also conduct some research before designing a product or a system, the common assumption is that engineers never talk with and observe the users as the designers do. One student puts it:

> They don’t have to go to communicate with other people. They don’t try to personalize products. The human character of the things is not a determination point for the products they make.

According to interviewees the key concern of the industrial design discipline is to create an innovative product addressing the needs and expectations of the users. Yet, they indicated that in engineering practice, creativity and innovation are not valued as much as efficiency and functionality. The following account illustrates the general opinion among the interviewees:

> [Mechanical engineers] design a part of a mechanical engine or a nail or a screw. I think it is the standardized part of the job. In that sense, we are more free. I think they need to abide by some rules. The term design that they use is not same as ours. According to me, they would call it design when they combine different things with their knowledge, experience and technology to create something new. We also design something new, but in our case it is more free, ideas and concept are more important and innovation is the key. For

> them design can be combination of some mechanical things. In ours it is realizing a new idea.

This view is echoed by many interviews. They indicated that the engineers improve the efficiency of the things considering the time and money constraints rather than pursuing new ideas. One interviewee claimed that what engineers do cannot be called design for that reason:

> [Engineers] change a mechanical product or its parts, maybe improve it. I really think it can hardly be design itself. Because as far as I know engineering courses don't go that far, like trying to challenge things too much at engineering school. What I mean is that they do not question things too much. This might not be design.

The analysis has revealed that industrial design students' assumptions about engineering disciplines goes beyond the symbolic dualisms. Comparing themselves with the engineering students, they believed they can approach to a project more comprehensively, considering various aspects of it at the same time. More importantly, it was stated by the interviewees that who develop creative and innovative ideas are the industrial designers rather than the engineers. Considering that the aim of the IDS was to develop innovative products as a result of an interdisciplinary collaboration, it is possible to say that the industrial design students identified superior roles for themselves referring to their superior project management skills and competences. On the other hand, the interviewees perceive that engineers put functionality and efficiency prior to aesthetics and user experience. These assumptions lead to certain expectations about the challenges they could face during an interdisciplinary teamwork, the strategies to employ the overcome these challenges and the roles to undertake during the IDS. The following section will present the expectations of industrial design students from an interdisciplinary teamwork.

4.3 Industrial Design Students' Expectations from Interdisciplinary Teamwork

The previous section has discussed the assumptions and opinions of industrial design students about working with other disciplines. The data has demonstrated that the industrial design students' understanding of interdisciplinarity is different from the one discussed in the literature review. These students expected to undertake superior roles

during an interdisciplinary project and defined complementary roles to the other disciplines. In this section the expectations of the industrial design students towards interdisciplinary teamwork will be presented. This section is organized under three topics. First, the challenges that the interviewees anticipated to have during the IDS will be discussed. Then the strategies that the interviewees are planning employ during an interdisciplinary collaboration will be presented. Lastly, the roles that the industrial design students expected to undertake is demonstrated.

4.3.1 Anticipated Challenges of Interdisciplinary Teamwork

Referring back to their past teamwork experiences, all of the interviewees mentioned that there are certain challenges of working as a team. They indicated that the personality of the participants holds an important part in success of the collaboration. General opinion among the interviewees was that when the team members are willing to work, open to discussions and actively participate, teamwork would be efficient. One industrial design student voiced her concerns about the team dynamics:

> Really, if we can't get along with the participants in my team, I will be annoyed a lot. I mean a lot. I hope we can reach a consensus. […] Some people are like "I am the best in this topic, it will never work that way". There can be some smart aleck people. If there is one in my team it will be really annoying. […] Also if they don't care about the meetings and if we cannot meet enough, it will be unsuccessful.

Similarly, after stating the importance of human factor in a group project, one of the interviewees drew attention to the fact that interdisciplinary teamwork is "double challenge" for the participants: "Conducting a group work and also these groups being interdisciplinary is actually like facing two challenges at the same time."

The challenges that the interviewees think they will face during an interdisciplinary collaboration are mostly based on the assumption of asymmetric power relations between designers and engineers. Interviewees expressed two concerns. First, the industrial design students expressed their fear of not being taken seriously by the other members of the team due to the subjective nature of the design practice. Most of the interviewees expected to face with the biased approach of the engineers. The following account illustrates those views:

> When I asked for help if they are condescending, if they approach to us with bias, then there can be a problem. If they act like "How could you understand it?! It is my expertise and I will do it", then there will be conflict.

Her concern was repeated by many interviewees. They indicated that other disciplines would question their disciplinary knowledge. Another account shows how this concern leads to industrial design students' hesitation to share their opinion:

> I would comment on the design, but I hope they won't be so harsh like "What would you know?! It will not work like that.".

Some of the interviewees underlined the importance of receiving respect for their own disciplinary expertise. The following account successfully illustrates this common expectation: "Of course we will find a way to work together. But in order to do that they need to accept that I know something just as I accept the areas they know."

As it is discussed in the previous section, the interviewees see industrial design practice as a problem solving activity that combines form and function while taking the users' needs and expectations into account. The second concern raised by the industrial design students is that the engineers would object to the suggestions of the industrial designers by claiming that their considerations are unnecessary. One interviewee stated:

> For example, it is something very important for me, it is an innovation or it is interesting. But it is not that interesting for the engineer. S/he may see it as unnecessary. Maybe s/he thinks that it will make the production difficult or it will increase the cost. In that case, in that conflict situation, we all need to be patient and persuade each other. I will take a step back, and s/he will take a step towards me.

Some of the interviewees stated that when the people from other disciplines intervene with the design decisions by just considering the efficiency of the production or the profit to be made, it would cause a conflict among the team members. One interviewee gives an example for such a situation from her past experience:

> Even when I talk with my friends [who study at engineering departments] about my own product, it turns into a fight. They say "Don't be silly, it is not going to work that way, do it like this.". I reply "If I do it this way, I can't achieve what I aimed for." They don't want to understand that

> because they only care whether it is physically possible or not. For example, when I design something for disabled people, they ruin everything I did considering the disabled people by saying "It is not possible that way.".

These accounts shows that the interviewees anticipated to have some challenges during the IDS. Some of these challenges, such as lack of willingness or lack of participation, are generally related with teamwork. In addition to those, interviewees think they will conflict with the participants from other disciplines. The analysis indicates that the interviewees based their conflict anticipation on the differences between engineers and designers. Referring to the power asymmetries in the professional relations between industrial designers and engineers, the interviewees voiced their fear of not receiving the necessary respect for their disciplinary knowledge and not being able to stand behind their decisions when exposed to engineers' criticism about the production and cost. Even if the interviewees have a certain perception about the challenges that they could face during an interdisciplinary teamwork, they were still prepared for an interdisciplinary collaboration as they shared the strategies to cope with those challenges. Strategies to enhance interdisciplinary collaboration mentioned by the interviewees will be described in the following section.

4.3.2 Strategies of the Industrial Design Students to Enhance Interdisciplinary Collaboration

As demonstrated above, the interviewees foresee potential challenges that they would encounter during an interdisciplinary collaboration. Instead of accepting those challenges, however, they listed the strategies to overcome. During the analysis three strategies have emerged: explaining what industrial design is and what industrial designers do to other participants, creating a common ground for communication, and getting support from another industrial design student.

First, most of the interviewees stated that during their past experiences they realized that people from other disciplines do not have a clear idea of what industrial design is and what industrial designers do. It was presented as an important barrier of an efficient interdisciplinary collaboration. One student shared her observation of how explaining the profession changes the perception of the people she asked help from:

> If they have no idea about our department, they are helpful only after we explained the department and what we do. Otherwise they approach to us thinking that we wouldn't understand it anyway. But when you explain the knowledge you have acquired till that time and the skills you have, they understand that you have a certain expertise and you would understand the information they will give to you. Then, they start giving useful information.

Although this excerpt illustrates the situation when an industrial design student asked help during her studio project, general anticipation among the interviewees was that they are going to face similar challenges during the IDS. Therefore, the majority of the interviewees indicated that explaining the scope of the profession and the skills that the industrial designers have, can be helpful for receiving respect. In other words, it is commonly believed that once the participants from other disciplines understand what industrial designers are capable of, they would respect the disciplinary expertise of the industrial design students. Another interviewee claimed that the problem they anticipated to face during the IDS has its roots in how the Department of Industrial design is perceived within the university. She suggested that they should not only explain what industrial designers do during the IDS, but also promote and introduce the department to the university in order to create an awareness.

> Maybe we need to explain design in a clearer way. […] Nobody has an idea about what we do. Sometimes we cut paper, sometimes we make weird sketches. But still nobody understands it. We need to communicate it better. Yes, exhibitions do it to some extent, but it is not enough. We can organize workshops or some events for the people who are interested in design.

Second, the interviewees underlined the importance of creating a common language among interdisciplinary team members. Most of the industrial design students stated that they would employ different techniques and use different tools to communicate their ideas to the rest of the team. One interviewee after expressing the difficulty of communicating with the people from different disciplines, due to the use of technical terms, drew attention to the need for a common language. She claims that creating a common language would enable two-way communication during interdisciplinary teamwork. Similarly, another student emphasized the importance of communication and stated that they have already developed communication skills during education:

> We have a specific language that we use among ourselves. Certain things are very clear for us [when we communicate with another industrial designer]. But

> I believe we have also learnt to communicate with others to a certain extent, as we practiced explaining our projects to another people.

The industrial design education is project-based and during each project students are asked to conduct user research. They are encouraged to bring their sketchs and models when talking with external parties. For that reason, they seem to have learnt how to explain their design idea to other people. Referring to their experiences at the education, the interviewees indicated that they would use sketching and modelling to create a common ground for the communication. One interviewee described her concerns about and solutions for communication problems in a team:

> For example, if I am the only industrial designer in the group, I will start sketching. I wonder if we can communicate with the sketches. I would try to sketch as good as possible to put my ideas on paper accurately. […] If the mechanical engineer knows the modelling tools, I would ask him/her to model his/her ideas. I hope to create 3D models together, compare and discuss on those. I would also do some mockups. In order to talk the same language, we need to put something on the table. If we all make something and iterate it, I think we will communicate better.

This account successfully illustrates the environment industrial design students hope to create during the IDS. Most of the interviewees believe that they could overcome the challenges of interdisciplinary collaboration by explaining themselves and their ideas clearly. Yet, two interviewees were not so optimistic. They voiced their fear of being suppressed by the students from engineering and management departments. The third strategy, which is getting support from another industrial design student, is mentioned by those interviewees. Those interviewees claimed that if there would be two industrial design students in a team, they could handle the situation. One student indicated that explaining themselves to the engineers would be a challenge and they would be suppressed. He stated that brainstorming with another designer would help him to proceed further, while creating ideas with an engineer is harder. As these students regard engineers as the ones who would help the designers about solving the technical problems of the project, they believed creating ideas with an engineer would be a challenge. The reason why they have such a concern based on their understanding of interdisciplinarity, which does not aim for integration of knowledge, tools and ideas.

In a similar vein, the following excerpt illustrates how the interviewees regard idea generation as their responsibility rather than a collective act:

> Why wouldn't I want two designers in my group? It would be really nice. It is not like relying on someone to have your back but during the idea generation and idea development I think two designers can be easier for the communication. […] When you talk with a student from industrial design, you can more or less explain what you want. But talking with another people you use the same words but a totally different world is created in their mind. Because they are coming from a different discipline.

The analysis presented so far shows that the industrial design students have developed a certain understanding of their differences from other disciplines, which are more complex than the symbolic dualisms that define inferior roles for the designer. Seeing themselves competent enough to manage an interdisciplinary design project, they defined superior roles for themselves, while considering others as secondary. Still, the interviewees' anticipation of the challenges that can be encountered during IDS are based on the power asymmetries between engineers and designers. Although they are confident of themselves, they presume that the engineers, not being familiar with the skills of the industrial designers, would try to suppress them. Yet, instead of conforming to these power asymmetries, the interviewees mentioned that they would voluntarily take active roles to overcome those challenges. This section has demonstrated that interviewees adopt solution-oriented approach, the next section will discuss the roles that the interviewees expected to undertake during the IDS.

4.3.3 The Roles that the Interviewees Expect to Undertake During the IDS

As discussed earlier, the industrial design students have explained that the engineering students are specialized in one area and lack the ability of approaching the project comprehensively. Adopting that view, almost all of the industrial design students see themselves in managerial positions to solve conflict and organize the collaboration during the IDS. When the interviewees were asked why they think they would undertake managerial roles, it was claimed that it is due to the nature of the industrial design discipline. By nature, industrial design discipline is interdisciplinary. One industrial design student stated that in order to make people's life easier, an industrial designer should adopt not only the designer mindset but also the mindset of a

mechanical engineer as well as an electronical and electronical engineer. Her view was supported by various interviewees. It was common to refer industrial design discipline as an interdisciplinary discipline, which is the combination of many different disciplines. Being a member of that discipline, the interviewees claimed that they are already familiar with interdisciplinary teamwork:

> When considered as a department, I don't think interdisciplinary work is something we are unfamiliar with. I don't think we will experience the difficulties of being a stranger [at the IDS]. Even if it is not official, we have already experienced it in our life [as industrial design students].

Most of the students indicated that the characteristics they have developed during their education prepared them to be leaders in interdisciplinary teamwork. An interviewee claimed that due to the education they have received, mostly based on projects, they have a larger perspective than other disciplines, ranging from function to ergonomics, aesthetics to marketing. Like her, many interviewees mentioned the importance of having a broader perspective. One interviewee put it:

> In each team, the designer can run for the leadership, because s/he has a broader perspective than most of the other departments. I think we have more or less learnt how to manage a design process. I think I have developed the ability of seeing the bigger picture. That's why, I guess we would like to help the ones who can't see it.

Although industrial design students accepted the fact that each discipline relies on valuable disciplinary knowledge, participants claimed that the ability of seeing the bigger picture helps them to merge those separate pieces of knowledge into a comprehensive end product. Another student indicated:

> Although a mechanical engineer knows biomimicry, a sociologist knows how to conduct interviews, industrial designers are the ones who could combine those and could create a concrete result. Actually we don't have a specific method, but we are good at combining others'.

In addition to the ability of seeing the bigger picture, the interviewees also mentioned the other skills that they have developed during the studio projects, such as time management, organization skills, etc. The following account explains why industrial design students think they have necessary skills to be leaders:

> In every group, one person is needed to be the leader to organize the group members. Maybe an electronical engineer could also do it, but I think I will be that person. Why me? Because I think we are really familiar with it. I think we are familiar because we constantly conduct group projects, spend non-stop effort to have a grasp of the process, and always trying to meet a deadline. I think nobody has those skills more than the designers. For that reason, in each team the designer can be in the managerial position.

Referring to the characteristics they have developed during the industrial design education, the majority of the interviewees stated that they could undertake the responsibilities of organizing the division of labor among the team members and ensuring the effective communication in the team. Although they stated that they would have a managerial position within the team, most of them added that they would not prefer to be labeled as a manager, who do nothing but organize other people. Most of the interviewees emphasized that they would "take the hit" at every stage that they can. One interviewee put it as follows:

> I would like to be a person who makes the things happen. I would like to manage. By management I mean I would like to see the work plan. Who can do what and how? If someone is good at something I would like to delegate it to that person. But emerging like a leader or like a manager who says "Do this, do that" is not something I would want to be. Especially in a student activity.

In addition to managing the design process, the general assumption is that industrial design students would take active roles during the idea generation stages by triggering the discussions among the team members. The following excerpt illustrates those views:

> I will make sure the communication between the group members is going well. I am quite sure about myself, I can handle this. Also I will make sure that the idea doesn't get closed up at the beginning, I will open it up, and will try to push people to challenge themselves more. I will try to push it a little bit far from what is routine, what is usual.

In the previous section, the accounts of the interviewees have shown that the industrial design students anticipated to have problems during the IDS, which are mostly based on the asymmetric power relations that define inferior roles for the industrial designers. Surprisingly, instead of conforming to those roles, almost all of the interviewees stated that they would become leaders, and manage and organize the interdisciplinary team.

It was commonly mentioned that by using the skills that they have acquired during their undergraduate education, industrial design students would help other team members to get organized, to manage time efficiently, to communicate with different disciplines, to create innovative ideas and to realize those ideas.

4.4 Conclusions

First part of the analysis has explored the motivations of industrial design students to participate in the IDS, and their assumptions and opinions about working with other disciplines and their expectations from interdisciplinary teamwork.

The accounts presented in this chapter shows that the interviewees have a clear understanding of the importance of interdisciplinary teamwork for the industrial design profession. All of the interviewees stated that they would work in collaboration with the professionals from different disciplines in the future. Therefore, it is commonly believed that the experience of the IDS would prepare them for the professional life. Whereas, the accounts mentioned the benefits of IDS during their job hunting, much emphasis was put on learning how to work in interdisciplinary teams. Getting know the people from different disciplines, that they would have otherwise encountered for the first time in the professional life is considered as an important benefit of the IDS. Therefore, the applicants from the Department of Industrial Design demonstrated enthusiasm about experiencing interdisciplinary teamwork. For them, learning how to work in collaboration with different disciplines, mostly in form of a peer learning, consists the basis for an interdisciplinary experience. Having identified the need for interdisciplinary collaboration, they have already asked help from the people from different disciplines during their studio projects, and tried to find external opportunities such as internships and workshops, during which they could collaborate with the people from other disciplines. Yet, it was reported that despite their efforts, in most cases the interaction remained weak and did not turn into an effective interdisciplinary collaboration. For that reason, the interviewees interpreted the IDS as a good opportunity to experience interdisciplinary teamwork with their peers. The data shows that participating in an interdisciplinary extracurricular activity, supported by the university is valuable for the interviewees.

The industrial design students, who participated in this study, indicated that working with the fellow students from different departments is the main motivation for them to participate in the IDS. Peer learning is an important factor that enhance the experience of this sample group during an interdisciplinary collaboration. The interviewees reported that they expect to learn how different disciplines work and to broaden their perspective through the interactions with the peers. It was stated that the interviewees hope to sustain the relations that they have built during the IDS for the future collaborations. The current data highlight the importance of peer learning in an extracurricular activity such as the IDS. Encouraging students to exchange knowledge and experience at the IDS seems to be an accurate decision, as the peer learning is preferred over formal learning.

The data shows that the industrial design students, who applied to the IDS think that engineer-industrial designer collaboration is essential for an interdisciplinary teamwork. Therefore, during the interviews they tend to position their discipline in relation to the engineering disciplines. The analysis has revealed that although it is possible to detect some symbolic dualisms such as matching engineering discipline with function and objective thinking, the perspective of industrial design students goes beyond those dualisms. The industrial design students have complex and ambivalent assumptions and opinions about working with other disciplines. On one hand, they feel competent in managing an interdisciplinary design project, thanks to the skills and knowledge they have acquired during the education, and see themselves more well-rounded than the engineering students, who specialized in one area. On the other hand, anticipated to have certain problems during their collaboration with engineering students, mostly assuming that the engineering students would try to overpower them using their technical knowledge. Yet, instead of conforming to the inferior roles that the traditional power asymmetries between engineers and designers define for the industrial designers, the interviewees have developed strategies, mostly based on improving the communication in the team, to overcome those challenges. Despite the ambivalence in their opinions, the industrial design students had an understanding of interdisciplinary collaboration, during which they expected to undertake superior roles and manage the teamwork. This finding opens up a fruitful discussion about the current design education and the roles that industrial designers take in professional life.

CHAPTER 5

ANALYSIS II: AFTER STUDIO INTERVIEWS

The previous chapter has presented the main findings emerged from the analysis of the pre-studio interviews. So far, the motivations of the industrial design students to participate in an extracurricular interdisciplinary activity, namely the IDS, and industrial design students' assumptions and opinions about and expectations from an interdisciplinary teamwork were discussed. The second analysis chapter addresses the findings of the analysis of after studio interviews. From the previous discussion, it can be seen that the industrial design students, who applied to the IDS, identified interdisciplinary teamwork as essential to design innovative products. Yet, when they described the relations that they imagined to have with the engineering students during the IDS, it was apparent that they delineated a superior role for themselves, while regarding others as "helpers" to realize the project. Although they see themselves qualified enough to manage an interdisciplinary design project, they still anticipated certain challenges that they could face during the IDS. They also mentioned the strategies they are planning to apply to overcome those challenges. After studio interviews aim to understand first, to what extent and in what ways the experience they had during the IDS was in parallel with their assumptions, and second how and to what extent collaborating in an interdisciplinary team affected the industrial design students' perspectives on interdisciplinarity.

After studio interviews were conducted two weeks after the IDS had finished, with the participants from the Department of Industrial Design. As it was mentioned earlier, out of 14 applicants, 10 industrial design students were selected to participate in the IDS. These students formed interdisciplinary teams with the students from different departments, including Department of Architecture, Department of Metallurgical and Materials Engineering, Department of Mechanical Engineering, Department of Electrical and Electronics Engineering, Department of Industrial Engineering, and

Department of Business Administration. In total six teams were formed. The detailed information about the group composition and the curriculum of the IDS was provided at the Section 3.2.2. IDS lasted for four weeks. The first week of the IDS included intense training sessions to equip the students with the essential knowledge and tools to work on an interdisciplinary design project. After the first week, the IDS offered a looser schedule that includes three mentoring sessions and two inspirational seminars at the lunch breaks. During those three weeks the teams arranged their group meetings by themselves and worked on the project. Since the three weeks of the IDS were overlapping with the classes of the 2015-2016 Fall Semester, teams reported the difficulties of arranging time to meet as a team. Moreover, the building of METU Design Factory was still under construction during the time of the IDS. For that reason, the participants of the IDS could not be offered a space to work as a team during the activity. Although the mentoring sessions were taking place at the Digital Design Studio during lunch breaks, the participants could not use that place to continue working with their teams. It was observed that mostly fourth year industrial design studio was used for team meetings, as seven of the participants from industrial design department were fourth year students.

The theme of the IDS was announced as "Transforming the box". Using box as a metaphor, each student team was asked to transform the "box" in order to respond an emergency need. Among the six teams two of them developed an application, three of them designed a physical product and one of them offered a system solution. The teams addressed a wide range of emergency situations, namely, creating a temporary shelter for disaster-victims and refugees, providing a safe place at home during an earthquake, promoting safe driving, ensuring work safety, navigating disabled people, and keeping health record of expecting women.

This chapter will revisit the issues mentioned by the interviewees during the pre-studio interviews such as learning during an interdisciplinary collaboration, challenges of interdisciplinary teamwork, strategies to overcome those challenges, the roles that the designers undertake during an interdisciplinary design project, and industrial design students' understanding of interdisciplinary teamwork. The aim is to identify how the

interviewees' opinions have changed after the IDS, during which they have experienced interdisciplinary collaboration for four weeks.

5.1 Learning during an Interdisciplinary Collaboration

Pre-studio interviews have demonstrated that for industrial design students, learning was an important part of interdisciplinary collaboration. The interviewees stated that they feel excited about learning from the fellow students who study at other departments, how different disciplines approach to a problem and what the tools and methods of different disciplines are. Except one, none of the interviewees put emphasis on learning from the mentors during the pre-studio interviews. Yet, after the IDS, the interviewees pointed that although they endeavor to learn from the mentors, due to the organizational shortcomings, they could not benefit from the knowledge of the mentors fully. Similarly, the common belief among the industrial design students was that during IDS, the students from the Department of Industrial Design could not learn new things as much as other disciplines did. Hence, most of the industrial design students voiced their disappointment about learning new things during the IDS. This section will elaborate on the reasons of the dissatisfaction mentioned by the interviewees about both learning from the mentors and from the peers during the IDS.

5.1.1 Learning from the Mentors

At the IDS, there were four forms of interaction between the tutors and the students. First, there were compulsory seminars and workshops during the first week of the IDS. Second, there were mentoring sessions during which student teams got feedback from the faculty members participated in the IDS as mentors. Third, at the end of certain design stages, such as user research, idea generation and detailing, open juries took place, during which the teams presented their projects to a group of mentors and other fellow students. Lastly, there were additional seminars, which aims to introduce students with a new topic and to inspire them during the project. These seminars took place during the lunch breaks and the participation to those seminars was voluntary. Although the interviewees knew that there would be tutors from different departments, almost none of them placed a particular importance on learning from the tutors before the IDS. On the other hand, once these students participated in the IDS, they have

realized that the IDS offers them a good opportunity to interact with and learn from the tutors from different disciplines. One interviewee stated that after seeing the IDS's potential, her level of expectations was increased.

> To my surprise, I had very low expectations at the beginning. IDS met those low expectations. But when I participate, I saw what more can be done. For example, the tutors from the Department of Mechanical Engineering are coming. We can learn these, we can learn that. Actually IDS could have had a wider perspective. In that sense it didn't satisfied my expectations.

The interviewees indicated that they could not sustain their active interaction with the mentors after the first week. Most of the industrial design students pointed out that due to their busy schedules, they could not attend the seminars during lunch breaks. The following account shows that not being able to attend the seminars were interpreted as missed opportunities by the interviewees:

> Once [the first week] was over, we were on our own. Then something was missing. I couldn't attend the seminars at the Kubbealti. I have a class till 12.30, then we receive critique from the mentors for 15 minutes. I couldn't make it to the seminars. If only I had attended those seminars, IDS would have been more satisfying for me.

Whereas various interviewees indicated that they feel sorry for missing the seminars, the interviewees did not feel the same about not attending the mentoring sessions. As explained in Chapter 3, the attendance of both the mentors and the students to mentoring sessions were low. When the interviewees were asked why they did not attend the mentoring sessions, they listed a number of reasons. First, the mentors were asked to attend the mentoring sessions based on their availability. For that reason, some days the students felt disappointed as they could only talked with one or two mentors, while other days a number of mentors waited for the students to show up. Together, the low attendance of both the mentors and the students formed a vicious circle, due to which the mentoring sessions could not be as effective as it was planned. An interviewee commented on it as follows:

> Time management was really an issue [during the IDS]. I think the IDS shouldn't be at the same time with the school. Because also tutors have other things to do. For example, when we come to receive critique during the lunch breaks, sometimes we could only find one mentor. Not finding anybody to talk to demoralized our team.

Second, the interviewees stated that they did not attend the mentoring sessions as there was nothing to show, or receive critique on. The researcher observed that during the second and the third weeks, most of the participants avoided the mentoring sessions as they felt that there was nothing new to talk, yet once they decided on the idea they identified a need for mentoring. But then, they did not have enough time to talk with the mentors as they were busy with getting prepared for the final presentation. One interviewee argued that as a team they could not get the most out of the mentoring sessions for that reason:

> We received critique for two times before the presentation. But I can't say that we used the full potential. Because I believe [IDS] had a huge potential to get benefit from a variety of tutors. We couldn't use it. As I told you, we were very late to decide on something. When you haven't decided on anything, you have nothing to ask.

At the IDS, mentoring sessions were planned as informal discussions during which the mentors and the students come together. However, the accounts of the industrial design students revealed that the mentoring sessions were interpreted as critique sessions. Since industrial design students were already familiar with the critique sessions from their studio education, their expectations from the mentoring sessions were shaped accordingly. The accounts that presented here show that these students tend to sustain the habits they built during their education, such as not attending critique sessions unless they have something new to show and trying to get feedback from different tutors on the same idea. Similarly, they evaluate the effectiveness of the mentoring sessions by comparing them to design critiques. Some of the interviewees stated that the mentoring sessions were not effective as there were no constructive feedbacks. One interviewee stated that the mentors did not draw attention to the weakness of their project, therefore, they had to spot their own mistakes and improve their projects on their own. Her view was shared by other interviewees. Another participant compared the mentoring sessions with the critiques at the industrial design education and stated that the former was not as effective as the latter:

> We [as a team] didn't think that we received useful feedback during the IDS. For that reason, we tried to talk with different people, who have different perspectives. [Explained that they received critique from a tutor from the Department of Industrial Design who was not a mentor at the IDS] Critiques

> at industrial design studios can make us think from different perspectives. Speaking with that tutor made us think about the weak parts of the project. That critique not only focused on the positive parts. Therefore, it was very useful.

Although the interviewees found the mentoring sessions ineffective, they still value learning from the tutors. Two interviewees, who are at the same group, stated that they visited a mentor from an engineering discipline at his lab to ask a question. They indicated that during one to one meetings with the mentors, the team could get more in-depth comments compared to the mentoring sessions. Moreover, three teams reported that they contacted the tutors from different departments who were not mentors at the IDS to discuss their projects. The interviewees stated that mostly engineering students visited their tutors when the team encountered a technical problem to solve. Industrial design students, on the other hand, stated that they wanted to hear the opinion of different tutors during the project. One interviewee put it as follows:

> We didn't see the mentors at IDS as a resource. Because we have been already seeing them during the IDS. They were busy, they already had a lot of things to do. We sometimes talked to them but at some point we thought we need to talk with different tutors. For that reason, we visited tutors from different departments. It was better for our team.

Even though industrial design students did not mention about learning from the tutors before the IDS, it seems that they appreciate the potential of tutor learning during the studio and they made an effort to interact with both the mentors at IDS and the tutors who did not participate in the IDS. The common belief among the interviewees is that they could not benefit from the knowledge of the IDS mentors enough. Therefore, during the after studio interviews industrial design students voiced their disappointments. Although the mentoring sessions and the seminars did not meet the expectations of the industrial design students, it can be inferred that meeting with the tutors from different departments in an extracurricular activity changed the perception of the industrial design students about the interactions with the tutors. The interviewees stated that they would not hesitate to contact the tutors from other departments when they need help in their future projects. One interviewee said:

> [IDS] didn't meet my expectations. There wasn't direct networking [with the tutors] but I am sure the tutors, who voluntarily take part in IDS, would help me with pleasure when I need to consult something or take an appointment.

During the IDS the students understood that the tutors from different departments can be as accessible as the tutors from their own departments. Another interviewee indicated that although she did not have strong relationship with all of the mentors during the IDS, she would not hesitate to ask for help from them, because they are the tutors of her teammates. She stated that when she needs help she would contact the tutors through her friends.

5.1.2 Peer Learning

During the pre-studio interviews the importance of learning from the fellow students who study at different departments was emphasized by the industrial design students. Prior to the IDS, the interviewees stated that they would like to learn how different disciplines approach to a problem and which methods and tools different disciplines use. Although the interviewees indicated that they have learned how to work with different disciplines, after studio interviews showed that industrial design students were not satisfied with what they have learned during the IDS and from the fellow students. This section will demonstrate what the industrial design students think they have learned during IDS and will explore the reasons for their dissatisfaction.

When the interviewees were asked what they have learned from the fellow students during the IDS, they listed a number of things. First, as they expected before the IDS, industrial design students got to know different disciplines and practiced working with them. One interviewee stated that after the IDS he understood how to work with different disciplines. Similarly, another student put it:

> For example, electrical and electronical engineering used to be very abstract on my mind. But I realized that they are also *designing* a circuit. It had become more clear for me. I also learned what a mechanical engineer do professionally from [my team member].

In the same vein, an industrial design student claimed that the IDS made her to appreciate the contribution of different disciplines to a design project. She also stated that she learned a lot about working interdisciplinary:

> [During the IDS] whenever something came to my mind, I didn't search for it like crazy, someone gave me the information. They [other team members] came up with suggestions. It showed me that working with other disciplines is really important. I also learned a lot about working together. For example, respect is very important.

Second, having worked with the students from engineering departments during IDS, industrial design students reported that they have noticed the potential of technology for design. One student stated that "I am not very good at technology, [after the IDS] I thought that I need to improve it. It was a good lesson for me." Another interviewee reflected upon the industrial design education and criticized her prior approach to technology:

> I learned that a lot of things are actually possible. For example, during our design education, strangely, we keep our distance from technology. […] I had also developed a technophobic attitude. I haven't realized it before the IDS. I always try to solve things mechanically. But why? There is technology and we need to learn to live with it. […] But now I have in my mind that I can solve something with a sensor. I guess IDS had broadened my horizons.

Third, some of the interviewees stated that during the IDS they have learned from other students where to find reliable and relevant information. An interviewee put it: "I have learned very interesting things. Maybe I am not going to use them today, but now I know where to search for what." Likewise, some interviewees stated that they got familiar with the technical terminology of other disciplines during the IDS. One industrial design student explained the difficulties he has experienced before the IDS and how it changed after the collaboration with the students from different departments:

> I have learned very good mechanisms. When I was making research on internet during my own projects, I couldn't find these mechanisms. But as [a teammate from the Department of Mechanical Engineering] know the terminology, he can easily find these mechanisms with two keywords. I have learned the terminology.

The accounts of the industrial design students showed that they have experienced peer learning. As a result of their collaboration with the fellow students during the IDS, they got to know different disciplines and learned how to work in interdisciplinary teams, they have developed an awareness about the importance of technology for

design, and finally, they have learned where and how to find the reliable and useful information from other disciplines. What they have learned from their peers were in parallel with the interviewees' expectations that they have voiced during the pre-studio interviews. Surprisingly, the interviewees were not satisfied with their learning experience. They tend to link this dissatisfaction to the dominancy of design discipline at the IDS.

As discussed in the previous chapter, industrial design students, when asked to describe interdisciplinary collaboration during a design project, described the designer at the center of the collaboration, as a team member who asks mostly for technical help from the engineers when required. During the planning of the IDS curriculum, special attention was paid to ensure the active participation of each discipline during the project. Yet, the interviewees reported that the IDS curriculum had strong resemblance with the industrial design education. It is claimed that the use of design tools and methods during the IDS resulted in industrial design students' undertaking of superior roles in the teams compared to the students from other disciplines. One interviewee stated that she felt like a "host" as most of the meetings and activities were taking place at the Faculty of Architecture and the briefs used during IDS were very familiar to industrial design students. Similarly, another industrial design student mentioned that even if the mentoring sessions were named differently, they were same as the critique sessions, which are the most important learning activities in architecture and industrial design education.

Considering these arguments, it is possible to say that what the IDS has offered to the students was in parallel with the anticipations of industrial design students, in the sense that design being at the core. However, even if it overlaps with their initial anticipations, industrial design students expressed their discontent about this situation by stating that they could not learn as much as their peers studying at other departments. One interviewee stated that: "[IDS] turned into a final project [referring to the graduation project done at the fourth year of industrial design education] that you do with seven other people."

During the first week of the IDS, the researcher observed a similar perception among the students from engineering departments. Several engineering students stated that

the industrial design students did not learn something new as the curriculum of the IDS was very similar to the design education. During the after studio interview an industrial designer explained how they felt about it:

> I guess we left behind the times that we explained what design is, what that is, what this is. Because during the first weeks, we [industrial design students] were feeling that we were trying to make them [students from other departments] industrial designers. Also the designers in other teams felt this way. But they are not going to be designers. Their professions are different; our profession is different. We will meet halfway.

A common view amongst the interviewees was that the industrial design students could not improve themselves during the IDS, as much as the students from other disciplines did. One interviewee stated: "We couldn't receive much from [other students]. Actually we couldn't improve ourselves but we did our best for the project. I would be more satisfied if we had also improved ourselves." His views were supported by various interviewees. Some of the interviewees listed the things that they taught to their peers:

> Personally, I think I have contributed to [the team learning]. I showed how to use Photoshop, I showed how to make a video. I improved their [other team members'] vision about making a poster and preparing presentation boards [2D visualization]. I think we [designers] contributed a lot, even though we couldn't get anything.

Similarly, industrial design students indicated that they have already known the tools, methods and computer programs that were used during the IDS, therefore they could not add to their existing knowledge. Some of the interviewees stated that they would learn more if their team had other members. For example, an interviewee, who did not have a student from the Department of Business Administration in her team, claimed that she would have learned a lot more about marketing if there were a management student in the team. Similarly, another student, whose team was working on a mobile application, stated that she felt the absence of a graphic designer to teach her something:

> I wish there were a web designer or a graphic designer. I wish s/he could teach me something. Because I felt like I have learned everything by myself. I wish someone could have helped me. I should admit that I felt alone.

Although the interviewees were feeling disappointed about not improving themselves by learning new things, they reported that especially students from engineering departments have learned a lot during the IDS and their opinions about industrial design students have changed. All of the interviewees reported that they observed serious changes in the attitudes of engineering students towards industrial designers. One interviewee stated that the students from engineering departments used to regard industrial design as craft, but after seeing the outcomes of the IDS they respect the profession more. Another interviewee indicated that the student from the Department of Mechanical Engineering wanted to be a partner with an industrial designer in his startup company, after the IDS:

> They [students from engineering departments] changed a lot. They told us [industrial design students] how well-equipped we are. They said "You are receiving an incredible education in your faculty." We are very critical about our own education. Actually we learned to be critical about everything. But they understood the potential of this profession and be amazed.

All of the interviewees reported similar dialogues with the students from engineering disciplines. Another interviewee shared her conversation with a student from the Department of Electrical and Electronical Engineering: "He said he gained a faith in industrial design profession [during the IDS]. He stated that he didn't know what we do [as industrial designers] but he realized that it was a really important department.".

The industrial design students' inconsistent opinions about interdisciplinary collaboration during the pre-studio interviews also appear in the after studio interviews. The interviewees, on one hand, feel dissatisfied about the interdisciplinary experience as they claimed they could not learn much. On the other hand they concurrently listed a number of things that they have learned, and stated that they feel happy to change other students' opinions about industrial design. One interviewee put it: "As the industrial design profession is not fully established in people's mind in Turkey, I really enjoyed seeing that the people [other students at the IDS] understand and appreciate what we do." The interviewees felt satisfied as they discharged the role that they have defined for themselves as promoting and explaining the importance of design during the IDS.

5.2 Challenges of Interdisciplinary Teamwork

Pre-studio interviews showed that the interviewees had clear ideas about the challenges they expected to face during an interdisciplinary teamwork at the IDS. Although they also mentioned the importance of willingness and active participation, their concerns mostly focused on the conflict with the students from engineering disciplines. They foresaw that they would not receive respect for their disciplinary expertise and that their decisions would be judged by the other students. However, after studio interviews showed that different challenges of interdisciplinary teamwork that they have not mentioned before, such as time management and working space became prominent during the IDS.

5.2.1 Disciplinary Differences

As discussed above, among the industrial design students it was common to assume that they would experience conflict with the engineering students due to their disciplinary differences. After studio interviews, on the other hand, showed that despite of their differences these groups worked in an interdisciplinary project without a major conflict. Some of the interviewees indicated that it was because of the fact that the IDS was not a realistic simulation of the professional life. An interviewee described the IDS as an "utopic simulation" referring to the dominance of industrial design discipline during the IDS. Another one claimed that they could not notice disciplinary differences as they are still students:

> As we [all of the participants] couldn't complete our [identities] as a designer or an engineer yet, we contributed to the project with our basic level of knowledge of our disciplines. Therefore, I was not amazed to see something that I couldn't solve but s/he [an engineering student] did. As our disciplines haven't set in yet, I don't feel like [the IDS] was interdisciplinary. It would be a lot different if we were in a professional setting.

The common belief among the interviewees was that they did not experience challenges during their interactions with the engineers because industrial design was the predominant discipline at the IDS. The interviewees believed that it is the reason why engineers did not undervalue the industrial design discipline as they anticipated. Although they did not experience a serious conflict with the engineers, their general

opinion about the profession did not change after the four weeks of interdisciplinary experience. They attributed positive features to the individuals, while keeping their existing assumptions for the engineering profession. Several interviewees stated that the engineers they have in their teams were not "normal engineers", were not "the engineers they imagined" and did not have "classical engineering mindset". When they were asked what these terms mean, they listed all the characteristics that they assumed to cause conflict between industrial designers and the engineers, such as not paying attention to the aesthetics at all, merely focusing on profit and efficiency, not respecting the opinions of the designer etc. One interviewee stated that his opinion about engineering did not change after the IDS, because he also observed "real engineers" during the IDS:

> No, it [my opinion about engineers] didn't changed. Because we saw the other engineers. Like real engineers. There are some people at other teams that I'm afraid to work with. I feel like they don't understand our point of view. When this is the case, I feel like what I would say will be meaningless in his/her eyes. But we need to try.

As this account illustrates, despite of their positive experience during the IDS, overall, the interviewees' opinion about the profession did not change. Yet, seeing that there are some members of the profession that they could work with, created positive attitudes among the industrial design students towards future collaborations with the engineers.

Different from the pre-studio interviews, a new group of students have entered the narratives of industrial design students. Although only a few interviewees mentioned the students from the Department of Architecture during the pre-studio interviews, after the IDS the interviewees have developed opinions about these group. It is worth underlining that the industrial design students, albeit being the members of the same faculty, did not know much about the architecture students and how architecture discipline approaches to a problem before the IDS. After the four weeks of interdisciplinary experience, the industrial design students claimed that they felt close to the architecture students during the IDS as they have a similar approach to the project, and are familiar with similar visualization tools. After their interaction with the architecture students the interviewees were also able to spot the differences

between industrial design and architecture disciplines. One interviewee noted their discussions on a detail of the project:

> I didn't feel alone [during the IDS] as there were the friends from the architecture. They also know 3D modelling, they know Photoshop, they are used to preparing presentation boards. But they have never thought about details. […] I was asking the dimensions of a handle. I said "The user can stumble, we should leave 1 cm allowance.". They said "Do we have to think about 1 cm? Let's ignore it." I responded "No, it is design. Actually we should solve all these details." I was in the position who pushed forward, who care about the details.

It is possible to say that the IDS helped the industrial design students to recognize their differences from and similarities with other disciplines clearly. Although, being introduced with different disciplines did not change their assumptions and opinions altogether, it certainly had a positive effect, as the interviewees claimed that they would like to continue working with those people in the future projects.

5.2.2 Communication

The interviewees indicated that despite the disciplinary differences they did not experience major communication problems in their teams during the IDS. It was reported that having a common goal was an important facilitator for an effective communication. An interviewee stated that the communication among the team members advanced as they set a common goal:

> At the beginning I was like a translator between the industrial design and other disciplines, but once the common goal was set and once the things we needed to do were decided, everyone understood why we did something. It was a lot easier.

At the pre-studio interviews the interviewees voiced their anticipation that having different disciplinary languages would cause conflict in the team. Yet, during the IDS the teams seemed to achieve to create a common language. One interviewee indicated that the common language was built in time by the efforts of the team members:

> We [industrial design students] tried to learn their [students from other disciplines] language a little. They did research in not only their areas, but also different fields. We tried to understand what they do, how the program works;

> they tried to understand how we work. There was no other way. If we couldn't succeed that we would need a manager who understands everyone.

The teams also built friendship and created a friendly language as a team. An interviewee stated that as they became friends rather than team members, they developed a common sense of humor. The positive effect of building friendship on team communication was highlighted by various interviewees. One interviewee put it:

> As we turned into friends, even the ones who hesitated at the beginning spoke their mind freely. No body hesitates to contribute to the discussion, everybody talks and listens.

Some of the teams reported that occasionally they organized events such as visiting a museum, going for a coffee, having a dinner as a team to socialize. An interviewee stated that if they could not get on well as a team, it would affect the success of the project. She claimed that they would not even meet as much as they did, if they were not having fun together.

The interviewees reported that at some cases they use online tools for communication. In order to arrange team meetings and to have casual conversations, all of the teams used Whatsapp, an instant messaging smartphone application. During the research phase all of the teams shared their documents using cloud file storage services such as Dropbox and Google Drive. Some teams stated that they created a Facebook group to share the interesting and inspirational videos and articles. An interviewee stated that these tools were useful to document the process. Although these virtual tools facilitate the teamwork to some extent, the interviewees stated that these tools could not replace the face-to-face interaction. Therefore, they were useful for a team member, who missed a meeting, to catch up, but could not replace the actual meetup. Only one team tried using Skype, a software for online video calls, when one of the industrial design students was out of town. However, they reported that it was not efficient. The general opinion among the interviewees was that the team members should meet physically at the same place during the idea generation and idea development stages to discuss the ideas, generating scenarios and solving the details.

5.2.3 Space

As mentioned earlier, the building of METU Design Factory was not in use during the time of IDS. Therefore, the participants were free to choose the space to work as a team. Although it was not mentioned during the pre-studio interviews, in the analysis of the after studio interviews space emerged as an important element of the teamwork. Four teams used fourth year Industrial Design Studio for team meetings throughout the IDS. One team, even though the industrial design students were fourth year students, stated that they preferred to be at a casual setting and have snacks around, and thus chose to work at a café. Another team, which consisted of industrial design students at graduate level, indicated that they faced problems to find an appropriate space to work on the project. For every meeting, they worked in different places including various studios within the Department of Architecture and the Department of Industrial Design as well as the garden of the Faculty of Architecture and labs of the Department of Metallurgical and Materials Engineering.

When the interviewees, who used fourth year Industrial Design Studio, were asked why they chose that place, they reported that it was the most appropriate space to work as a team. An interviewee stated that they searched for a "natural territory" in the university that everyone can access, but the Faculty of the Architecture was the only place that was open till late hours. Working at the industrial design studio is generally regarded as a positive experience by the interviewees. They also reported that the students coming from different departments enjoyed working at the industrial design studio. It was commonly stated that these students find industrial design studios more comfortable as they can listen to music, eat something, talk aloud and use the space freely by hanging post-its and laying papers. One interviewee put it:

> They [the students from other departments] didn't like their own buildings. They think this place is more inspirational, they think it is more appropriate to work, they say they feel more comfortable here. They said "Even when we go to the canteen, we feel like we are in different environment. Our buildings are dull." For that reason, they voluntarily come here.

Although both the industrial design students and the students from other disciplines feel comfortable working in industrial design studio, the interviewees indicated that

using that place for a long period of time have become annoying for the other fourth year industrial design students who did not participate in the IDS. An interviewee stated that for that reason, they could not feel very comfortable after some time:

> Yes, we are working in a studio but there are also other people. Sometimes we make noise but we don't want to disturb others. I think of myself, studio is our home, when someone else comes, I don't feel comfortable. Considering that, other people might get disturbed, we couldn't be very comfortable. If we had a place to work, we would only work on the [IDS] project when we were there. I think it is important for creating a team spirit.

All of the interviewees stated that they wished METU Design Factory had offered them a place to work. An industrial design student at graduate level indicated that they had experienced real problems to find a proper place to work as a team:

> Some days we meet and search for a place to work for two hours. Then we were tired of searching a proper place. We went to the library reserve hall, it was full. We came here [Faculty of Architecture] there were no empty studios. We needed to work on computers, so we couldn't work at the canteen. It was really hard for us. Actually we thought why wouldn't they [organizers of the IDS] showed us a place to work as a team.

Even though the interviewees, who worked at the fourth year Industrial Design Studio, were pleased to work in there, they also supported the idea of having a different place to work on their project during the IDS. One interviewee claimed that if METU Design Factory had a building, it would have created a sense of belonging for the participants. Another interviewee drew attention to another advantage of having a defined space to work:

> After all, I have realized that I feel really comfortable at the studio. But [METU Design Factory] showing us a place to work is not only useful in terms of space, but also in terms of time. It would have provided us a schedule. For example, if we had an appointment to use that space between 3 to 5 pm, we would all be there during that time. But now we have lost a lot of time for planning.

The interviewees also came up with some suggestions about the ideal workspace for an interdisciplinary teamwork. Although the place that they have described have a lot in common with the industrial design studios, the interviewees expected the space to address some of the challenges that they faced during the IDS. First, the interviewees identified a need for a space that they can leave their stuff, such as sketch books, mock-

up materials and computers. An interviewee stated that not having a place to store their mock-ups and materials caused a problem during the IDS. Another account supported that view by stating if they had a place as a team, they would have worked more efficiently as they could hang some post-its and track their process through them.

Second, all of the industrial design students mentioned that they would prefer working in a more casual environment, where they would both work and socialize. It was common among the interviewees to request comfortable sofas to socialize with the team members. An interviewee described the ideal workspace for an interdisciplinary teamwork as follows:

> Actually I imagine it to be like our studio. But I think a cozier environment can be created by providing a space where we can sit on beanbags and chat, in addition to the normal tables to work. Of course access to the food and drink is also important. That space should offer those.

Third, some interviewees indicated that if the space included the printers and modelling machines such as laser cutter and 3D printer, they could have tested their ideas sooner and quicker. One interviewee stated that the space should be the combination of the studio and the atelier. Another account successfully illustrates those views:

> I think there should be laser cutter and 3D printer. As we knew modelling tools, we make our 3D model in Rhino and Solidworks. It would be really nice if we had a chance to see [our design solutions] in progressive manner. For example, if we used laser cutter during the process, we could have solved the details better. We could have come up with a better model.

The accounts presented in this section illustrates that the IDS not offering a place to work for the teams caused certain challenges. Although the students managed to resolve the challenges by themselves during the IDS, mostly by using the fourth year Industrial Design studio, they shared their suggestions for future activities of the METU Design Factory. The suggestions by the interviewees showed that the space for interdisciplinary collaboration expected to be different from the existing studios. The place should support team spirit, socialization, whereas providing opportunities to test ideas quickly and easily.

5.2.4 Participation

During the pre-studio interviews, the interviewees mentioned about the importance of active participation. After studio interviews showed that participation during an interdisciplinary collaboration was a more prominent challenge than the interviewees anticipated. The interviewees stated that they paid attention to arrange meetings to ensure the full participation of the team members. Yet, it was not always possible due to the different schedules of the members. An interviewee put that the project would not go further when there was somebody who could not attend when an important decision would be taken. He complained that that person would question the taken decision and this would require to start over. The existence of the free-riders, who avoid work in the team was another challenge mentioned by the interviewees. An interviewee drew attention to free riders:

> There should be something that manages the team. I wouldn't call it hierarchy, but there should be an order. Because inevitably, there are some people who doesn't work when they are left free.

Similarly, another interviewee shared her experience of dealing with the free riders. She stated that it was one of the most challenging parts of the teamwork as the IDS was a voluntarily activity. She put it:

> It was really hard. There is a person who doesn't work. But I have no authority to make him/her work. We don't have any long term relationship based on interests to motivate him/her to work. For that reason, I couldn't figure out how to push them.

After the first week of the IDS, the participation of the students from other disciplines have decreased due to the busy schedule of the academic classes. Although the industrial design students attended the majority of the team meetings, an interviewee reported that his motivation also decreased as the other team members did not show up. In the same vein, another interviewee noted that he would have selected the team members based on their level of participation. The importance of active participation was highlighted by all of the interviewees at the after studio interviews. It was commonly stated that they could learn the most from the students with whom they spend most time. An interviewee put it:

> They could get into the project as much as the time they spent at the studio. It also applies to us. With whom I spend more time, I got more information from him/her about his/her area. Our interactions were shaped around the level of participation.

This section showed that the industrial design students value the active participation during an interdisciplinary teamwork. After studio interviews have shown that even if the students from other departments participated to the team meetings, industrial design students experienced challenges regarding the use of time. The next chapter discusses the different conception of time of industrial design students and the students from other departments.

5.2.5 Different Approaches to Project Planning and Use of Time

After studio interviews have shown that the industrial design students have developed certain habits regarding the use of time during their projects at their undergraduate education. The interviewees indicated that during the IDS, they approached to it as a design project, to which they would dedicate their time and energy unconditionally. However, they reported that during the IDS, they realized that the students from engineering departments have a different approach towards a project. It is possible to say that industrial design students' habits of prioritizing the project over other things, working for long hours, working at night caused conflict among the team. Several students shared their observation that when there was an after-hours work to complete, only the students from the Faculty of Architecture stayed late to finish it. In that sense, being from the same faculty, industrial design students find the students from the architecture department closer to themselves. One student noted:

> We were here [in the Faculty of Architecture] almost every weekend, and also during nights. We have such an advantage that four people [two industrial design student and two architecture student] already knew how things work at the Faculty of Architecture. For example, students from electronical engineering didn't know. [They said] will you stay all night? If you consider it as a design project, you can stay up all night, you can stay at the studio. And it is OK. Because you don't have anything else to do. Even if we had other classes to follow, our focus was the project [the IDS]. But it was because we got used to it, the others found it weird.

Industrial design students stated that due to the working habits that they have already developed, they felt more responsible for the project during the IDS and self-sacrificed when necessary. As they interpreted it to be normal, they did not complain about their busy schedules and high responsibility. An interviewee stated:

> I made some sacrifices. As I am used to pulling an all-nighter, I was working with my group till 12, and doing my duty for the next day staying up till 3 or 4. Because meeting as a group was a lot harder I was adapting myself to it.

The two different approaches to the project planning revealed itself during the IDS, when the deadline for the final submissions were announced. All teams but one asked for a deadline extension. The requests came from the industrial design students, as they thought they could do better if they had additional time. An interviewee explained it:

> I have a kind of faulty mindset that things should be improved to its best version, and all the time till the last minute can be used. […] We [industrial design students] thought that the date for the deadline was not right. We can't make it till that time. It wasn't like "please postpone it" but more like "you set it wrong in the first place, so postpone it."

Similarly, another interviewee reported that her approach to deadlines have changed during the industrial design education. She noted:

> It used to happen at basic design [studio]. The deadline was first announced as two, but then it was postponed to next day at twelve. I used to become really angry for that. Because I was coming at two with a finished project. Even if I didn't like it I finalized it. But then in four years, I have evolved in this topic. If something can't be done in given time, it can be postponed. We [industrial design students] realized that we can also criticize the time.

On the other hand, the researcher observed that not all the students from the engineering department were happy about the deadline extension. One of them voiced his discontent by stating that the deadline extension in engineering school is unacceptable. When the industrial design students were asked about it, they agreed that engineering students were not used to receive extension on their deadlines, but at IDS they were not surprised to receive extension:

> I have never heard an extended deadline in engineering, I have a lot of friends. They get in trouble when they are late. But here they [team members from the engineering departments] weren't surprised, because they knew that it is

> something different. From the beginning they had that perception: It is design, it wouldn't be like this in engineering. Therefore, extended deadline wasn't surprising for them because they were already in a weird place.

All of the interviewees reported that they were highly motivated to improve their project and the final presentation during the extra time, but some teams stated that the students from the engineering departments did not share their enthusiasm after the extension. One interviewee notes that the engineering students were panicked when the deadline was extended as they planned it to be finished earlier.

5.3 Strategies Used during the IDS

Before the IDS begins, the interviewees offered certain strategies to employ during an interdisciplinary teamwork to ensure better communication and collaboration. The strategies that they mentioned were explaining what industrial design is and what industrial designers do, creating a common ground for communication, and getting support from another industrial design student. Although during the after studio interviews it was reported that the industrial design students did not face the challenges that they have anticipated, during the IDS they still employed those strategies.

5.3.1 Introducing Their Own Discipline

First, as mentioned in detail in Chapter 3, during the first week of the IDS, students had a chance to learn more about each discipline following the seminars, presentations and the workshops carried out by the mentors. The interviewees reported that since the mentors from the Department of Industrial Design explained what kind of problems industrial designers deal with and introduced some of the methods and tools used in design process, they did not have to explain their teammates what designers do. Rather, they showed their teammates how designers work during the project. As discussed in the previous chapter, the main concern of the industrial design students regarding interdisciplinary relations was not being taken serious by the students from engineering departments. In the pre-studio interviews they emphasized that unlike the common assumption, industrial designers do not only focus on the aesthetics of the product, but also care about its functionality. The interviewees indicated that they have managed to convey that idea to the other participants during the IDS. Interviewees

from all teams stated that the other students' opinions about industrial design have changed after working together on the same project.

Referring back to the past experiences of the interviewees, during which they had to explain their discipline before consulting others about their projects, it is possible to say that collaborating in the same project was a much more effective way of introducing their own discipline as well as getting know the other disciplines. Yet, here it is important to note that although the industrial design students clearly stated that their opinions about engineering disciplines did not fully changed, they declared with confidence that they managed to change the opinions of others about industrial design discipline. The following account shows how and why other disciplines' opinions have changed:

> I think it changed. Because we [industrial design students] constantly remind function is [important] too, function is [important] too. They also noticed by seeing what we do. [For example,] I say "You are making it round, but someone can't push it". I argued with a focus on function. Then they found it rational. They saw clearly how I worked, they saw how much I cared about the function.

Her view was supported by all of the interviewees that they could explain themselves better by showing how they work, how they approach to a problem and what they care about the most during the teamwork. Another interviewee shared her experience with the student from the mechanical engineering. She reported that they were trying to solve a mechanism and the student from the mechanical engineering had shared the readymade mechanisms that he found on the internet. But none of those mechanisms were meeting the criteria they had. Then, she said, she modelled a new joint at Rhino. When she asked the engineering student, he said "It is a very rational solution and we can use it in our project." The industrial design student interpreted it as an important moment that she could demonstrate her expertise:

> It is really important how you present yourself as an industrial designer. Maybe I couldn't solve that joint, or I didn't have interest in physics, I would accept whatever he found. But I didn't do that. […] He noticed that he couldn't solve it on his own, but we can solve it together. Because on my own, I can see things partially, he sees things partially but when we look together things change. We both realized that we could only go further like that [working together].

5.3.2 Creating a Common Ground for Communication

During the pre-studio interviews the interviewees emphasized the importance of creating a common language among the interdisciplinary team. They stated that they would use sketching and modelling to create a common ground for communication. After studio interviews have shown that the industrial design students managed to facilitate discussions on the project by using different techniques.

The most often used technique for communication was sketching. The interviewees reported that when the ideas were not put on paper, everyone pictures them differently in their mind. Once the sketch is made everything becomes clear. During the IDS mostly industrial design students made the sketching. However, they reported that their sketching practices changes in order to explain themselves to other students. An interviewee who was in the team developing a system design indicated that they draw "algorithm alike" system diagrams and discussed everything over the diagram. Another interviewee stated that she used more section drawings than she would use in her own design projects. She claimed it was easier for the students from engineering departments to comment on and contribute to section drawings. In some cases, both the industrial design student and the mechanical and electronical engineering students used sketches, yet with some differences:

> I was generally drawing [the product] from the perspective view. For example, as if it was on table or as if it was on my hand to make it easier to understand and to show what it would look like. But the engineers, mechanical and electronical, were drawing sections. We had different approaches to the sketching. I was thinking how a detail would look like in perspective, I say "The assembly detail wouldn't look good here." But he [the engineering student], after checking the section drawing, could reply "No, they will snapfit." We managed to communicate.

Besides sketching, the teams used mockups to test their ideas. The interviewees indicated that although the students from other disciplines found it odd at first, then they conformed and started developing ideas over the mockups. Similar to physical mockups, 3d models created a common ground for the team members to discuss their ideas. One interviewee shared how they solved details with the student from mechanical engineering:

> We more or less decided on the physical form of the product. We decided that I would model it and send it to [the student from mechanical engineering]. Then I said: "Let's bring our computers and sit next to each other. So that while I am modelling, you can warn be about what is possible, and what is not.

In addition to these techniques, one of the participants said that she used moodboards to give the team an idea about the product they are designing. Several interviewees stated that they asked the students from other departments to imagine themselves in the scenarios to empathize with the users.

An interviewee claimed that she learned how to communicate an idea to non-designers during the IDS. She drew attention to the differences between communicating with a fellow industrial design student and a student from another discipline:

> I think I have learned how to explain an idea to other people. When I talk with another designer we could easily understand what we mean. But you need to explain it by using an example or by developing a scenario. Because otherwise they don't understand. I learned a lot about how to communicate the design language to others.

5.3.3 Getting Support from Another Industrial Design Student

Before the IDS, only two students had indicated that they would like to have two designers in their team. During the IDS four teams had two industrial design students (including the student with industrial design bachelor degree), whereas only two teams had one. All of these interviewees who have another industrial design student in their team stated that being two industrial design students in the team was a huge advantage for them. First, their workload was halved as within the team there was another person who was capable of modelling the products, preparing the presentation boards and making the models. Second, they believed that having another designer in the team helped especially when they were stuck at the idea generation stage. They claimed that two designers together could develop concepts further. Lastly, they sometimes wanted to talk with another person from the same department during the IDS about the project and about the other disciplines.

The two industrial design students, who were the only industrial design students in their teams also stated that they preferred to have another one. Besides its advantages

of decreasing the workload, these students drew attention to the fact that they needed someone else to support their ideas. One of them put it:

> Sometimes I have felt that responsibility. I say something as really believing in it. I defend that it should be in that way, but am I doing right? I was thinking that: "I wished there were one more industrial designer now."

The other student also supported this view:

> If two people support an idea, [they might think] "these two are thinking in the same way." It would have been more effective. Because they don't know whether I am a good designer or a bad one. Am I good at my classes? Maybe I am really a bad designer. Why would they trust in me? I mean before doing the project. Once I did [the project], they said: "Welldone, we liked it a lot." At least they have seen my work. I gain their trust. But if they haven't seen anything, two designers would be better.

These accounts shows that these two students felt the responsibility of introducing their discipline adequately to their team members. Therefore, whenever they doubt about something, or whenever they need a feedback of another industrial designer, they reached for their friends at the IDS. Both of the students reported that feeling the need, they got critique from other industrial design students.

5.4 The Roles Industrial Design Students Undertook during the IDS

During the pre-studio interviews, the interviewees voiced their concerns that the students from the engineering departments would suppress them, or would not take them seriously. Yet, when the role they would like to take during the IDS was asked, they reported that due to the superior skills that they gained during the industrial design education, such as time management and project planning, they found managerial roles more appropriate for themselves in the teams.

After studio interviews have shown that the roles that the industrial design students undertook during the IDS, such as leadership and management were mostly in parallel with the interviewees' prior assumptions. The interviewees reported that they took active responsibility in projects management, including the distribution of the roles among the team members, they ensured the effective communication among the team and they checked the overall quality of the end result.

In all of the teams, the industrial design students took responsibility of assigning tasks to the team members when necessary. One interviewee drew attention to the differences between the engineering students and the students from the Faculty of Architecture:

> When the architects come, we easily divided the tasks. Although every one commented on like "Let's do it like this." who actually did this were always industrial design students or architecture students. Engineers were in a mindset that "Tell me what I should do, and I will do it."

Another interviewee, similarly, stated that the industrial design students are capable of assigning tasks to the other team members. She claimed that even if they do not know every discipline in detail, knowing the project schedule and knowing which discipline should contribute in which stage make the industrial designers important for an interdisciplinary teamwork.

Moreover, the interviewees stated that they could work as a mediator between the architecture and engineering students, as they stand in the middle. An interviewee shared her experience:

> [The student from architecture] was coming up with off-the-wall ideas. […] [The students from electric and electronic engineering] found it really weird and started thinking that they were in the wrong place. At that times I adapted the idea to the real life and explained it to [the engineering students]. Or as I could understand from what they were talking about the material, I could explain how it will affect the form to the architecture students.

Lastly, the interviewees indicated that they were the ones who thought about the final outcome and ensured that everything was on track. One interviewee stated that she brought the separate pieces done by other team members together and created the final project. It was commonly stated that being experienced from their own design projects, industrial design students could easily follow the design process. The following account is worth quoting in length as it successfully illustrates the general view among the interviewees:

> At some point everything about the project, the system of it was on my mind. When people say "Let's do that", I check the system first, then I say "Yes, it's OK". When I talked with other friends, who worked in interdisciplinary teams, they said the same thing. Usually the system is in the mind of the designer. For

> example, we had separate parts that we talked about, the environment conditions, the users, as a scenario. A person only focuses on the area that s/he is interested in, but then everything was not checked. Ok, I am changing a part of the system but how much the whole system effects. At that point, I was the one who checks it.

The accounts presented in this section show that the industrial design students perform the roles that they have anticipated for themselves during the pre-studio interviews. It is clearly stated that the industrial design education had equipped them with the necessary skills to manage an interdisciplinary design team. After the IDS the interviewees reported that they realized the importance of their own discipline. Even one of the interviewees clearly stated that he believes in himself, as an industrial designer, more after the IDS and even if he was not considering to work as an industrial designer professionally, this event changed his mind. Another students notes:

> I learned that our profession is very integrative. A lot of disciplines can be integrated with a designer. Because everyone is very disconnected, they need something. I think every company, even if they are not doing design, could hire a designer to ensure the interdisciplinary connection.

5.5 Industrial Design Students' Perspectives on Interdisciplinary Teamwork

As discussed in the Chapter 4, the interviewees defined interdisciplinary teamwork as asking help from the people, who have expertise in different disciplines, while working on a project. Their understanding of interdisciplinarity mostly overlaps either with the definition of crossdisciplinarity or multidisciplinarity, which were explained in detail in the Chapter 2. During the after studio interviews, on the other hand, all of the interviewees reported that their perspective on interdisciplinarity have changed after the IDS. Surprisingly, having learned the differences between the disciplinary terms, some of the interviewees stated that what they used to think about interdisciplinarity was actually multidisciplinarity. One interviewee put it:

> I would have explained interdisciplinarity [before the IDS] as everyone doing the thing that s/he is good at. Actually I realized that I did not have an understanding of interdisciplinarity, I only knew multidisciplinarity. But I think I could learn it now. Before, for me everyone was doing the task that s/he knows. But I realized that I need to ask the mechanical engineer that how the form of this product should be, how we should develop the idea. So, the concept of interdisciplinarity has changed in my mind.

As mentioned at the Chapter 2, the IDS was organized with the aim of enabling the integration of design, engineering and business disciplines by bringing together the interdisciplinary student teams. For that reason, this thesis is aligned with the integrationist understanding of interdisciplinarity. Even if the IDS did not offer a single definition of interdisciplinarity to the participants, after the IDS, the accounts of the interviewees showed that their perspective to interdisciplinarity got close to integrationist interdisciplinarity. While all of the interviewees emphasize working together to create something new, some even used the words "intertwined" and "compound" to described interdisciplinary collaboration.

> I used to think [about interdisciplinarity] as a little multidisciplinary. For example, I design the product, the mechanical engineer checks how to produce it, the material engineer chooses the material, I tell him that the material should be like this, and s/he would do it. I used to think like that. But it wasn't like this. [Disciplines] should intertwined at every stage of the project. […] A real interdisciplinarity can be the union of all the disciplines. S/he would explain me different materials and the product will be changed accordingly. I feel like this would be really useful.

After the IDS, each interviewee could clearly define the interdisciplinary teamwork from their perspective. Some of the definitions resembles the frequently used terms to define the aim of an interdisciplinary collaboration, creating "an integrated whole". An interviewee defined as: "[Interdisciplinarity is everyone bringing the knowledge from their own discipline together and turning those into a final product or a final outcome.". Similarly, another interviewee explained:

> I think interdisciplinary teamwork is a way of work that people from different disciplines contribute their ideas, even not specific to their own discipline, and get familiar with each others' discipline. […] I was there [at the IDS] with my designer characteristics, electronic engineer was there with his/her characteristics, also the mechanical engineer. But we not our departments there, we were something else. Everyone thought together and came out of his/her shell. In interdisciplinary [teamwork] people came out from their shells and became another whole. They complement each other.

Another student shared how they integrated different approaches in their team during the IDS:

> The architecture students directly head to the space. [They said] "The parts can come together and create a big space, let's work on this.". I was thinking from

> the product perspective. When we combined these a very interesting thing have emerged, which is a small product that can turn into a space. It was interesting.

It is possible to conclude that the IDS has changed the perspective of the industrial design students on interdisciplinary teamwork. Having developed an understanding, the interviewees questioned and criticized the teamwork experience they had during the IDS. Although the interviewees noted that their experience could have been better, except two, all of them stated that they experienced interdisciplinary teamwork during the IDS. One of the interviewees, who thought their collaboration during the IDS was not interdisciplinary stated that the reason is that they were like a friend group working on a project, rather than the individuals representing different disciplines. The other student claimed that their teamwork experience was multidisciplinary rather than interdisciplinary:

> For example, when we discuss something about the color or form of the product everyone should say something. Everyone should say something; everyone should stay at the same distance. I think it is how an interdisciplinary teamwork should be. But ours was not like that. Designers were closer to the activity, as it was organized by and at the [Faculty of] architecture. For that reason, it turned into multidisciplinary teamwork. Materials engineer searched for the material, the mechanical engineer solved the mechanical details.

5.6 Conclusions

This chapter has presented the analysis of after studio interviews in comparison with the pre-studio interviews. The analysis demonstrated the interdisciplinary teamwork experience that the industrial design students had during the IDS and discussed the ways it overlaps with and differentiates from the prior assumptions of the interviewees.

As discussed in the Chapter 4, the industrial design students defined the interdisciplinary experience they would have during the IDS as a peer learning experience, during which they could learn new things from the students, who study at different departments. The after studio interviews showed that through this learning experience the interviewees learned new things from their peers. First, they have seen how different disciplines approach to a design problem by working jointly on the same project. Second, the interviewees reported that they have realized the importance of technology for industrial design during the IDS. Third, they have learned how to find

the reliable and useful information from other disciplines as a result of their relations with the students from other departments. Still, the interviewees were not satisfied with the experience they had during the IDS. Industrial design being the predominant discipline at the IDS, industrial design students claimed that they could not learn new things as much as their peers did.

Although great emphasis was placed on peer learning during the pre-studio interviews, except one, none of the interviewees mentioned learning from the faculty members, who would be mentoring during the IDS. Yet, observing the collaboration among the tutors from different disciplines, and having close interactions with the mentors, the interviewees realized the potential of learning from the tutors from the different departments. Even if the effectiveness of the mentoring sessions and the seminars were questioned by the interviews, it is possible to say that meeting with the tutors from various departments during the IDS have changed the perception of industrial design students about learning from tutors. After the IDS, these students reported that they would consult the tutors from different disciplines during their own projects.

Before the IDS, industrial design students expected to have certain challenges during an interdisciplinary teamwork. These challenges mostly built on an assumption that the industrial design students would be in inferior positions during their relations with the engineering students. It is interesting to find out that the interviewees did not experience a serious conflict with the engineering students during the IDS. Yet they referred those students as “exceptional”, and they still believed that they would have certain problems during their relations with the engineers in professional life. During the IDS, on the other hand, different challenges such as communication, space, participation and different approaches to project planning and the use of time became more prominent. The analysis provided a detailed overview of the students experiences about those challenges.

Pre-studio interviews have shown that the industrial design students were already prepared for an interdisciplinary collaboration as they even mentioned three different strategies they would employ during the IDS. First, they stated that they would explain what industrial design is and what industrial designers do to the other participants to make sure they understand the industrial design practice right. Second, the

interviewees mentioned that they would create a common ground for communication by using sketches and mock-ups. Third, some of the interviewees reported that they would like to get support from another industrial design student during the IDS. The analysis of the after studio interviews showed that during the IDS, the interviewees employed the strategies that they have mentioned before. Interestingly, the analysis revealed that the motivation behind employing those strategies was feeling responsible for introducing the industrial design profession and explaining what industrial designers do to the students from other departments during the IDS.

Despite their hesitations about the power relations they would have with the engineering students, industrial design students identified themselves as highly competent for the management of the interdisciplinary teams. They stated that the industrial design education equipped the students with the necessary skills, such as project management, time management, having both the technical and social knowledge, to manage the interdisciplinary teams. For that reason, before the IDS all of the industrial design students were prepared to be the leaders in their teams. The analysis also showed that during the IDS, industrial design students undertook active roles as they anticipated. Also in the after studio interviews, the interviewees restated that during their undergraduate education they are trained to be well-rounded professionals. Surprisingly, the experience of an interdisciplinary teamwork, albeit it did not directly change the opinion of industrial design students about other professions, make them think reflexively about both the industrial design profession and the industrial design education. Having seen that they are capable of leading and managing interdisciplinary teams, it is stated that they understood the importance of industrial design profession and gained disciplinary self-esteem and self-confidence.

As discussed in the Chapter 4, the interviewees expected to collaborate mostly with the engineering students during an interdisciplinary design project. In that sense, they had a narrow perspective on interdisciplinarity, which was limited to the relations between industrial designers and engineers, and was in form of a help seeking for industrial design students when needed. However, after studio interviews have shown that in addition to engineering students, they also learned to collaborate with architecture students. Moreover, after the IDS, the interviewees defined

interdisciplinarity by underlining the importance of collaboration and teamwork, rather than receiving help and technical support. Considering those changes in their accounts, it is possible to say at the end of four weeks of interdisciplinary design project, the perspective of industrial design students on interdisciplinarity was broadened.

Chapter 4 and 5 have presented the major findings of the study. The following chapter will share the prominent conclusions.

CHAPTER 6

CONCLUSIONS

This chapter presents the conclusions of this research. The chapter begins with a brief overview of the study. Then, the main findings derived from the two analysis chapters are discussed in light of the existing literature. The chapter ends with the limitations of the study and recommendations for further research.

6.1 Overview of the Study

The aim of this study is to understand the industrial design students' perspectives on working with other disciplines and, in particular, interdisciplinarity. In order to fulfill this aim, the interdisciplinary teamwork experience of industrial design students, who attended the Interdisciplinary Design Studio (IDS), organized by the METU Design Factory, is explored.

In this thesis, first, the related areas in literature were investigated. Presenting different disciplinary frameworks helped identifying the characteristics of interdisciplinary teamwork in relation to others, namely disciplinarity, multidisciplinarity, crossdisciplinarity and transdisciplinarity. Moreover, the current trends and changes in both the industrial design profession and the industrial design education were discussed to draw attention to the importance of interdisciplinary collaboration for industrial design discipline. Lastly, the relevant studies on interdisciplinary design education were presented in order to underline the contribution of this thesis (see Chapter 2).

Second, the context of the study comprising the detailed overview of the IDS curriculum and background of IDS participants was presented. Then, the field study consisting of two sets of interviews, pre-studio interviews and after studio interviews, and participant observation was explained in detail (see Chapter 3).

Third, the two analysis chapters presented the accounts of the interviewees. The first analysis chapter reported the results of pre-studio interviews and discussed the findings (see Chapter 4). Second analysis chapter, on the other hand, presented the results of after studio interviews and discussed the findings in relation to the pre-studio interviews (see Chapter 5).

The final chapter of this thesis presents the conclusions. This thesis has four main conclusions, which will be discussed in detail in the following section.

6.2 Prominent Conclusions

The main purpose of this study was to enhance the understanding of industrial design students' experiences during interdisciplinary teamwork. Literature review has revealed that there is a general scarcity of empirical studies on interdisciplinary teamwork that address the perspectives of industrial design students. The extant studies on interdisciplinary collaborations in design are rather based on quantitative survey data, and usually focus on the perspectives of either course organizers or engineering students. This indicates a need to understand the industrial design students' approach to working with different disciplines. In doing so, the main research question was formulated as follows:

> How and to what extent does the experience of interdisciplinary teamwork affect the industrial design students' perspectives on working with other disciplines and interdisciplinarity?

In order to provide answers to this question two sets of interviews, pre-studio interviews conducted before the IDS and after studio interviews conducted after the IDS, were conducted with the industrial design students and participant observation was done during the IDS. Based on the findings of the fieldwork, this thesis draws four prominent conclusions:

1. The industrial design students are aware of the importance of interdisciplinary teamwork for the industrial design practice and they feel prepared and willing to collaborate with the people from different disciplines.

2. Collaborating with the students from different disciplines in an interdisciplinary team during their education prepares the industrial design students for the professional life, where they would interact with the professionals from different backgrounds.
3. During their relations with other disciplines, the industrial design students feel responsible for explaining and introducing the industrial design profession to others. Collaborating in an interdisciplinary team also makes them think reflexively about their own profession and boost their self-confidence.
4. The experience of interdisciplinary collaboration changes their perspectives on working with people from other disciplines. After the collaboration with different disciplines their perspective enlarges and their understanding becomes closer to the integrationist understanding of interdisciplinarity.

In the following sections those conclusions will be discussed separately and in relation to the current discussions in the literature.

6.2.1 Awareness of the Significance of Interdisciplinary Teamwork

As discussed in Chapter 2, industrial design practice has undergone serious changes in the last couple of decades. The contemporary industrial design practice is process oriented, it is regarded as an essential element of innovation with a broader scope, ranging from physical products to experiences. Together, these changes outline the necessity of collaborative work in industrial design practice (Feast, 2012). Complex design problems of today can be solved only by the collaboration of the people with different fields of expertise. As collaboration has become commonplace in industrial design practice (Dykes et al., 2009), industrial designers need to develop necessary skills to contribute in interdisciplinary teams (Wilson & Zamberlan, 2015). Inns (2007) describes six emergent roles for the designer of 21st century: negotiator of value, facilitator of thinking, visualizer of the intangible, navigator of complexity, mediator of stakeholders, and coordinator of exploration (see Section 2.5).

The study has demonstrated that the industrial design students are aware of these current changes in industrial design practice. Having identified the need for collaborative work, the importance of which is emphasized by the current literature, these students explored the opportunities to experience interdisciplinary teamwork before the IDS. Pre-studio interviews have shown that almost all of the industrial design students have experienced interdisciplinary collaboration in the form of a workshop, design competition, internship or informal collaborations among friends. It was stated that before the IDS the interviewees were in search for another opportunity to work in collaboration with the people from different disciplines. The analysis revealed that even if they are still students, the interviewees are aware of the current trends in industrial design profession and try to equip themselves with the necessary collaborative skills.

Moreover, the industrial design students had a clear understanding of the roles that they need to undertake during an interdisciplinary collaboration. Interestingly, pre-studio interviews have revealed that the roles that these students expected to have were in parallel with the roles that Inns (2007) describes. During an interdisciplinary design project, these students anticipated to facilitate the creative thinking and idea exploration among the team, act as a mediator between different disciplines, manage the process by considering the different dimensions of the project and communicate their ideas to others using sketching and modelling tools. Seeing themselves more experienced and competent in project management due to the project-based approach of industrial design education, the industrial design students defined active roles for themselves in an interdisciplinary teamwork. After studio interviews have also shown that the roles that the interviewees defined for themselves at the beginning matched with the roles that they actually undertook within their teams during the IDS. Having anticipated to have these roles before participating in the IDS, they were ready for such an interdisciplinary collaboration, as they even developed the strategies to overcome potential challenges. These strategies were explaining what industrial design is and what industrial designers do to other participants, creating a common ground for communication, and getting support from another industrial design student.

Taken together, this study has shown that the industrial design students are aware of the importance of the interdisciplinary collaboration for the industrial design practice, and willing to collaborate with different disciplines. Moreover, the industrial design students are ready for such a collaboration as they are aware of the roles that they would undertake during a collaborative work and prepared themselves by developing strategies.

6.2.2 Getting Prepared for the Professional Life

During the pre-studio interviews, the industrial design students mostly commented on the relations they are going to have with the engineering students at an interdisciplinary collaboration. The analysis has revealed that although it was possible to detect some dualistic views on designer-engineer relations, overall industrial design students' assumptions and opinions about engineering disciplines are complex and indecisive. Although they see themselves more competent in managing an interdisciplinary design project, and they regard engineering students as function and profit oriented "helpers", their accounts showed that there is an anticipated power asymmetry between these two groups, which is also discussed in the literature (see Kaygan, 2014). The industrial design students stated that, not knowing the skills and competences of industrial design students, the engineering students would try to overpower them with their technical knowledge. After studio interviews have shown that during the IDS, these students did not experience the power asymmetries between engineering students and themselves that they have anticipated. Still, their assumptions and opinions about engineering disciplines have not completely changed after the four weeks of interdisciplinary experience. Even so, collaborating with the students from different disciplines seems to be useful to prepare them for professional life.

The literature has emphasized the importance of experiencing interdisciplinary collaboration during university education, before entering the professional life. Itkonen et al. (2009) demonstrate that the engineering students, who do not experience interdisciplinary collaboration during education, have problems to work with designers in professional work settings. Similarly, Britton et al. (2015) argue that the students who learned collaborative skills during education would be more effective team members in the workplace. Cox (2005), in his review for preparing future

generations of creative specialist, states that the "higher education courses should better prepare students to work with, and understand, other specialist." (p.28). The findings of this study complement those of earlier studies. During the IDS, the industrial design students have seen that there are members of other disciplines, with whom they can communicate and collaborate. Having experienced interdisciplinary teamwork during the education, these students are more open for future collaborations with the people from other disciplines. All of the interviewees reported that they would like to sustain their relationships with the students they have met at the IDS and would like to work in interdisciplinary teams in the future. As the previous conclusion illustrated, the industrial design students were already prepared for an interdisciplinary collaboration, and they even developed some strategies to employ. After studio interviews have shown that having noticed that the strategies they planned have worked and they could manage the interdisciplinary design teams, these students feel more confident about their collaborative skills. Moreover, they got to know how different disciplines approach to a design problem and how people from other disciplines work. In that sense, it is possible to conclude that the IDS was a successful extracurricular activity that contributed to the preparation of the industrial design students for the professional life.

This study has shown that collaborating with the people from different disciplines before entering the professional life equip students with the necessary collaborative skills. Interdisciplinary programs and courses during university education, by offering a chance to students to encounter with the ones from other disciplines earlier, would improve the interdisciplinary relations of those people in workplace.

6.2.3 Feeling Responsible for Introducing the Industrial Design Profession

Industrial design profession has been historically dealt with the issue of professional recognition. Being a member of an ambiguous domain, which has undefined and shifting boundaries, industrial designers have been faced with the struggles of developing professional identity and receiving recognition (İlhan & Er, 2016). In order to receive professional legitimation, industrial designers are "constantly looking for affirmation and acceptance" (Julier, 2010, p.255). Similarly, in the context of Turkey, the founders of ETMK (Industrial Designers Society of Turkey), in early 1990s, have

identified the lack of the recognition of the profession as a major problem, and organized their agenda to promote industrial design profession through exhibitions, competitions and awards (Hasdoğan, 2009). Although Hasdoğan stated in 2009 that the recognition of industrial design profession in public institutions and in the industry has been raised thanks to the efforts of the professionals, still she defined main objectives of design professionals as raising public awareness and setting standards for good practice (2009). The recent study of İlhan & Er (2016) confirms that even today the industrial designers are facing similar problems in work life, which put them into a position to defend the profession against others. This thesis has shown that the industrial design students are aware of the problem of professional recognition that the industrial designers face with in the professional life. Pre-studio interviews have shown that these students anticipated to have problems with other disciplines, assuming that they would be unfamiliar with the industrial design practice. Thus, they were prepared to defend and promote their discipline during an interdisciplinary collaboration with the students from different disciplines. During the IDS, the industrial design students felt the responsibility to introduce the industrial design practice accurately. Similar to their professional counterparts, these students underlined the importance of solidarity among industrial designers while promoting the profession (see Hasdoğan, 2009). It was stated by the interviewees that when there are two designers in a team, they feel more confident.

Interestingly, while introducing and promoting their discipline to the students from other disciplines, industrial design students' perspectives on their own discipline have also changed. Bremner and Rodgers (2013) state that an interdisciplinary collaboration can result in new understandings of the primary discipline. Also during the IDS, the industrial design students had a chance to reflexively think about the industrial design practice. Exploring their own skills and competences during an interdisciplinary collaboration, these students developed an awareness about their own strengths and weaknesses. As a result, after collaborating with the students from different departments, the confidence of industrial design students is boosted. This study has confirmed the suggestions of Raijmakers et al. (2012), who drew attention to the importance of experiencing collaborative work during education. They argue that "a

learn-by-doing approach, and first-hand experience of differing stakeholder roles is essential to becoming confident of one's own position as a designer." (p.8).

Overall, this study has shown that the industrial design students shared the concerns of industrial design professionals about the professional recognition. They voluntarily undertook the roles of explaining the industrial design practice to others. In doing so, they concurrently thought about their own discipline reflexively and appreciated their own skills and competences. For that reason, experiencing an interdisciplinary collaboration during education not only contributed to the professional recognition and acceptance of the industrial design profession, but also increased the self-confidence of the industrial design students as future professionals.

6.2.4 Broadened Perspective on Interdisciplinarity

The analysis of the after studio interviews clearly showed that the IDS, an interdisciplinary design studio that lasted for four weeks, has changed the industrial design students' perspectives on interdisciplinarity. As discussed in Chapter 4, before the IDS begins the interviewees described the collaboration they are going to experience at the IDS as asking help from the students who study at different departments when needed. Whereas they attributed dominant roles for themselves, they regarded others as "helpers". Dykes et al. (2009) define crossdisciplinary design as a collaboration, during which the designers are the dominant ones, who develop the concept and consult others to solve problems during the process. Also in multidisciplinary teams, each discipline brings their own disciplinary perspective, knowledge and methods to solve a shared problem, yet the collaboration does not aim for an integration (Repko, 2012). In that sense, the industrial design students' definition of interdisciplinarity, before the IDS, was lacking the emphasis on integration, and thus, was closer to crossdisciplinarity and multidisciplinarity.

The IDS, on the other hand, aimed to integrate knowledge, methods and tools of engineering, industrial design, architecture and business administration disciplines by bringing together the students from different departments. Having known the aim of the IDS and the general trends in design practice, this thesis adopted the integrationist understanding of interdisciplinarity (See Section 2.3). For the integrationist

interdisciplinarians, in addition to the active interaction among the team members, integration of the tools, methods and approaches of different disciplines holds an important part in interdisciplinary collaboration (Repko, 2012). Although the interviewees reported their dissatisfaction and criticized the organization of the IDS, it is possible to say that the IDS made them question their understanding of interdisciplinarity. After the IDS, the interviewees defined interdisciplinarity by underlining the importance of integration. Thus, the four weeks of interdisciplinary experience, albeit the industrial design discipline was still the predominant one, was enough to show the industrial design students the importance of working in collaboration with different disciplines, and changed their perspective on interdisciplinarity to more integrationist understanding.

Moreover, before the IDS, according to the interviewees the relations between the engineers and industrial designers hold the most important part in an interdisciplinary design project. And by engineers, they mostly referred to mechanical engineers and electrical and electronics engineers. Yet, after the IDS the industrial design students had experienced collaborative work with other disciplines such as architecture, business administration and other engineering departments. Having experienced working with a variety of the departments, the industrial design students appreciated the contribution of different disciplines to an interdisciplinary design project. In that sense, their perspective on interdisciplinary collaboration was broadened.

This thesis explored how and to what extent the experience of interdisciplinary teamwork affects the industrial design students' perspectives on other disciplines and interdisciplinarity. This study has shown that the experience of the IDS, during which the students from different disciplines collaboratively worked for four weeks, has changed the perspective of the industrial design students on interdisciplinarity. Together with the previously discussed conclusions, it is possible to say that even if the industrial design students had a prior understanding and awareness of the significance of interdisciplinary collaboration, experiencing interdisciplinary teamwork during education was useful to get prepared for the professional life, as they had collaborated with different disciplines before entering the work setting. As interdisciplinary teamwork is referred to be a more advance level of collaboration than

multidisciplinarity and crossdisciplinarity, broadening the perspective of the industrial design students was a desired outcome of the IDS. This study has enhanced the understanding of the industrial design students' perspectives on interdisciplinary educational programs and concluded that the industrial design students benefit a lot from the collaborative experience that they had with the students from other departments during education.

6.3 Limitations of the Study

The scope of this study was to explore the interdisciplinary teamwork experience that the industrial design students of Middle East Technical University (METU) had during the Interdisciplinary Design Studio (IDS). Due to the contextual characteristics of METU and the IDS, some of the findings of this research may not be applicable for the students from different countries and from different universities, and for different interdisciplinary design studios.

Moreover, the researcher's being a research assistant at the Department of Industrial Design has its limitations. During her interactions with the research participants, she had to balance her roles of being a friendly researcher and an objective teaching assistant. More on the reflexivity of the researcher can be found in Section 3.1.

6.4 Recommendations for Further Research

The interdisciplinary design studio that was explored in this study was the first event of the METU Design Factory and only included the students from the Department of Industrial Design, Department of Architecture, Department of Metallurgical and Materials Engineering, Department of Mechanical Engineering, Department of Electrical and Electronics Engineering, Department of Industrial Engineering, and Department of Business Administration. At the time of the execution of this thesis, the second interdisciplinary design studio (IDS-2) was organized. That time the participants were selected from a larger pool of students including the ones from the social sciences and each interdisciplinary team was paired with a partner from the industry. It would be interesting to see how the involvement of different stakeholders would affect the interdisciplinary design studio experience. Further research might

explore different interdisciplinary educational programs and courses to enhance our understanding of industrial design students' perspectives on interdisciplinarity further.

This study has revealed that experiencing an interdisciplinary collaboration during university education was useful to prepare industrial design students for the professional life and to increase their confidence in themselves as industrial designers. Building on this knowledge, a follow-up study can be designed to explore the professional experience of these students, who participated in the IDS. A future study, which compares the workplace relations of the ones who have collaborated with other disciplines during the education and the ones who did not would be very interesting.

As argued in this study, collaborating in an interdisciplinary team resulted in reflexive thinking of industrial design students about their own discipline. A similar study can be conducted with the industrial design professionals who work in collaboration with the people from different disciplines to see how and to what extent their perspectives on industrial design profession has changed after experiencing interdisciplinary teamwork at workplace.

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APPENDIX A

CONSENT FORM

Title of Thesis: Interdisciplinary Teamwork Experience of Industrial Design Students in the Interdisciplinary Design Studio

Name of Researcher: Özümcan Demir

Supervisor of the Study: Pınar Kaygan

My name is Özümcan Demir, and I am a graduate student at the Middle East Technical University, Department of Industrial Design. In my Master's thesis, I am exploring the understanding of interdisciplinarity among industrial design students, examining the case of Interdisciplinary Design Studio (IDS) organized by METU Design and Innovation Centre. From your application to IDS, I understand that you have an interest in interdisciplinary design collaboration. Therefore, I would like to invite you to be a participant in this study in order to talk to you on your assumptions about and attitudes towards working together with students from other disciplines. If you agree to participate, I am going to conduct a number of interviews with you to track the changes in your assumptions and attitudes during and after the IDS. You would have valuable contributions to the study. Thank you for your interest and time.

Please read the form, and ask questions about anything you do not understand, before deciding whether or not to participate.

- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.

CONSENT FORM (continued)

- I understand that the audio recordings made during interview(s) will be used only for analysis and for illustration in MSc thesis, conference presentations, academic papers and lectures only after being anonymised. No other use will be made of them without my written permission, and no one except for Özümcan Demir will be allowed access to the original recordings.

- I understand that excerpts from the interview may be included in the final thesis or other publications. However, under no circumstances will my name or identifying characteristics appear in these writings.

- I understand that if I have any complaints in the course of the research, I can contact Assist. Prof. Dr. Pınar Kaygan, who is the supervisor of this study. e-mail: pkaygan@metu.edu.tr

I confirm that I have read and understood the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

Name of the Participant_____

Signature of Participant_____

Date _____

Signature of Researcher _____Date _____

Please contact *Özümcan Demir, (+905557080604, ozumcan@metu.edu.tr)* with any questions or concerns.

APPENDIX B

PRE-STUDIO INTERVIEW GUIDE (TURKISH)

1. Giriş
• Araştırmacının kendisini ve projeyi tanıtması • Katılımcılara onay formunun bir kez daha okunması ve sözlü onaylarının istenmesi • Katılımcıların görüşmenin içeriği ve süresi hakkında bilgilendirilmesi
2. DTS'ye Katılım Motivasyonu ve Geçmiş Disiplinler Arası Deneyimler
• Neden bu stüdyoda yer almak istedin? Başvurmak için motivasyonun neydi? • Senin daha önce böyle bir deneyimin oldu mu? Nasıl gitti? • Sence tasarım eğitimi sırasında öğrenciler disiplinler arası çalışmaya yönlendiriliyor mu? • Projelerin sırasında başka bölümden hocalardan ya da arkadaşlarından yardım aldığın oldu mu? Hangi alanlarda? Onlara nasıl ulaştın ve onlar seni nasıl karşıladı?
3. Diğer Disiplinler ve Disiplinler Arası Çalışma Konusundaki Varsayım ve Fikirler
• Başvururken bunun disiplinler arası bir stüdyo olacağını (başka bölümlerin de olacağını) biliyor muydun? Böyle bir stüdyoya hangi bölümlerin katılacağını düşünüyorsun? • Sence interdisipliner bir çalışma için tasarımın yanında olmazsa olmaz bölümler neler? • Birarada nasıl çalışırız hayal bile edemiyorum dediğin bölümler var mı? • Sence tasarım ne demek? Bu kavramı kullanan başka bölümler de var, bu konuda ne düşünüyorsun? Sence onlar tasarımı ne anlamda kullanıyor? • Proje süreci tasarımda nasıl işliyor? Farklı disiplinden tasarım hakkında hiç bir şey bilmeyen birine bizim takip ettiğimiz süreci nasıl anlatırsın? • Farklı bölümlerin de benzer süreçler izlediğini düşünüyor musun? • Sence tasarım disiplinler arası bir çalışmada ortak bir kavram olarak kullanılabilir mi?

PRE-STUDIO INTERVIEW GUIDE (TURKISH) (continued)

4. DTS Sürecinden Beklentiler
• Stüdyodan ne bekliyorsun? Ne hayal ediyorsun? • Farklı farklı disiplinden/ bölümden insanla birlikte çalışacaksınız, sence nasıl bir ortam oluşacak? • Peki bir ürün üzerinden konuşsak diyelim ki bir bisiklet(robot) yapılıyor. Süreç nasıl işleyecek? Hangi bölüm hangi aşamada daha aktif bir rol alacak? • Sen nasıl bir rol üstleneceksin? • Süreçte tartışma çıkar mı sence? • Sonucunda ne olsa bu süreci başarılı/başarısız olarak değerlendirirsin? • Bu çalışma türünün sonrasında sana akademik ya da profesiyonel anlamda bir katkısı olacağını düşünüyor musun?

* The interview guide provides a list of issues to be covered and questions to be asked during the pre-studio interviews, yet, due to the nature of semi-structured interviews the wording and sequence of the questions were changed, and additional probing questions were asked in order to sustain a natural tone and flow and to encourage the interviewees to share more.

APPENDIX C

AFTER STUDIO INTERVIEW GUIDE (TURKISH)

1. DTS sürecindeki deneyim
• DTS nasıl geçti? Neler yaptınız? • Bu süreçte karşılaştığınız sorunlar oldu mu? Bunları çözmek için neler yaptınız? **Zaman Kullanımı:** • Buluşmalarınızı ayarlarken nasıl bir yol izlediniz? • Proje için ne kadar zaman ayırdınız? Sabahladığınız oldu mu? Proje için fazladan kalınması gerektiğinde kimler kaldı? • Teslim tarihinin ertelenmesi sizin ekipte nasıl karşılandı? Sen bekliyor muydun? • 4.sınıf stüdyosu ile eş zamanlı devam etti. Zaman planlamasını nasıl yaptın? Hangisine öncelik verdin? **Mekan Kullanımı:** • Mekan kullanımı ile ilgili neler söyleyebilirsin? Genellikle nerede çalıştınız? • Stüdyonun kendine ait bir yeri olmamasının grup üzerinde olumlu ya da olumsuz bir etkisi oldu mu? **Grup Kompozisyonu** • Grubunuz genel olarak nasıldı? Keşke bu grupta olsaydı dediğin başka bir disiplin var mı? • Sen gruptaki tek tasarımcıydın, bu nasıl bir deneyimdi? İki tasarımcı olsaydınız ne farklı olurdu? / Grupta iki tasarımcıydınız, bu nasıl bir deneyimdi? Tek tasarımcı olsaydın ne farklı olurdu? **İletişim** • Grup içinde iletişimi sağlamak için ne gibi araçlar kullandınız? • Bir fikir/ürün üzerine konuşurken birbirinizi anlayabildiniz mi? • Sen bu süreçte nasıl bir rol aldın?

AFTER STUDIO INTERVIEW GUIDE (TURKISH) (continued)

2. Genel Değerlendirme
• Geri dönüp baktığında süreci nasıl değerlendiriyorsun? İyi ki böyle yapmışız ya da daha iyi yapabilirdik dediğin şeyler var mı? • Stüdyo genel olarak beklentilerini karşıladı mı? • Neler öğrendin? Farklı disiplinler arasında bilgi ve beceri alışverişleri oldu mu? • Bu projeye devam etmeyi düşünüyor musunuz? • Aynı grupla farklı projeler üzerine çalışmayı düşünüyor musun?
3. Diğer Disiplinler ve Disiplinler Arası Çalışma Konusundaki Fikirler
• Bu stüdyoda izlediğiniz süreci düşününce disiplinler arası çalışma ne demek sence? • Bu deneyimden önce disiplinler arası çalışma hakkındaki ne düşünüyordun? Değişti mi? • Diğer grup elemanlarının tasarıma bakış açısı değişti mi? • Senin diğer disiplinler hakkında fikrin değişti mi? Bu deneyimden sonra kendini yakın hissettiğin, beraber çalışmaktan zevk aldığın bir disiplin var mı?

* The interview guide provides a list of issues to be covered and questions to be asked during the after studio interviews, yet, due to the nature of semi-structured interviews the wording and sequence of the questions were changed, and additional probing questions were asked in order to sustain a natural tone and flow and to encourage the interviewees to share more.

APPENDIX D

TRANSCRIBING THE INTERVIEW DATA

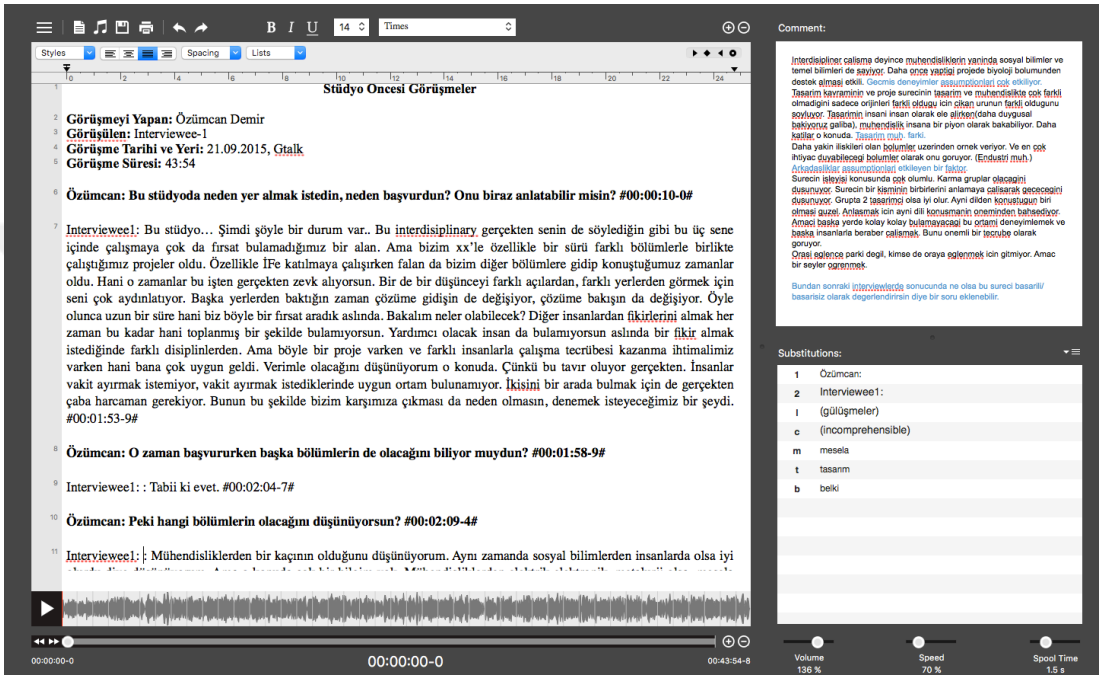

Figure D.1 Transcribing the Interview Data with F5 Transcript Pro

APPENDIX E

CODING THE TRANSCRIPTS

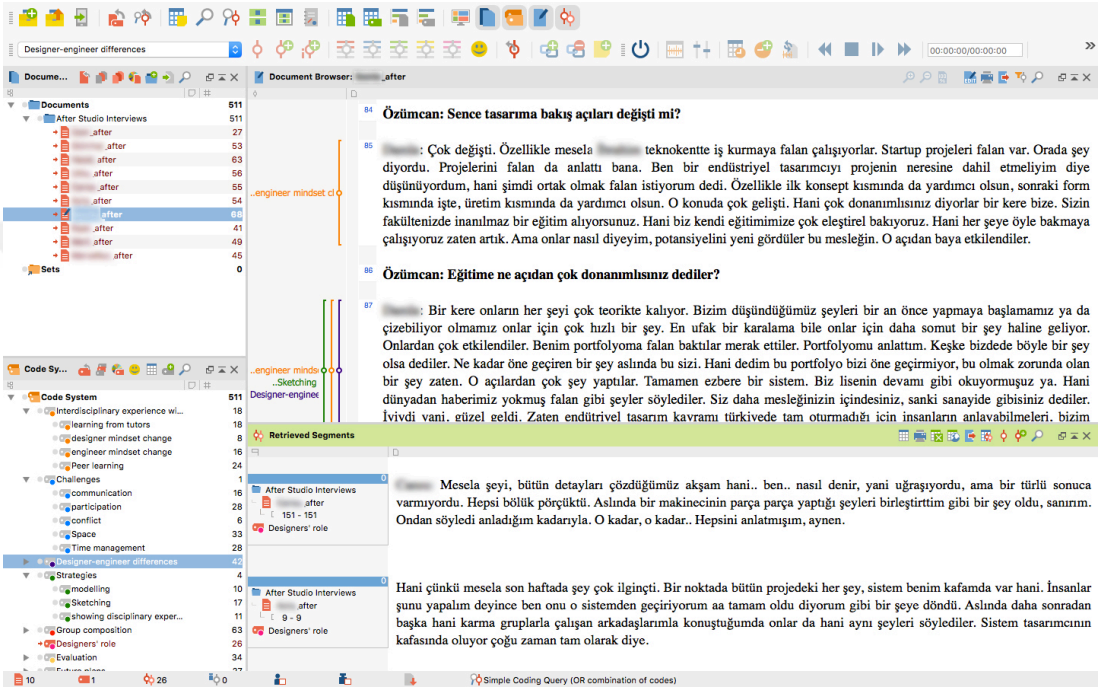

Figure E.1 Coding the Transcripts with MaxQDA using Template Analysis

APPENDIX F

REVISING THE TEMPLATE

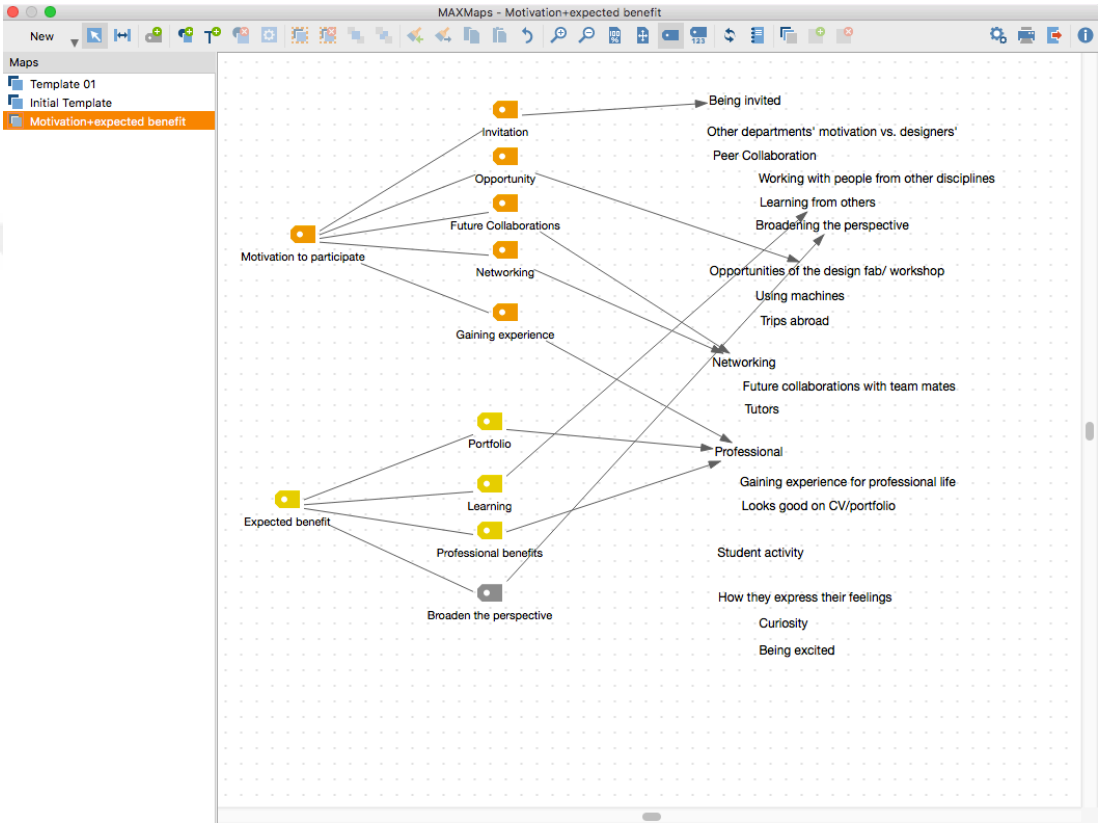

Figure F.1 An Example of Changing Higher-order Classification and Revising the Template