AN INVESTIGATION OF EMERGENCE, DEVELOPMENT AND TYPES OF OPEN DESIGN: A CASE STUDY ON SOCIALLY RESPONSIBLE DESIGN APPROACH

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ABSTRACT

AN INVESTIGATION OF EMERGENCE, DEVELOPMENT AND TYPES OF OPEN DESIGN: A CASE STUDY ON SOCIALLY RESPONSIBLE DESIGN APPROACH

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The purpose of this study is to examine the emergence, development and types of open design and to evaluate its effects on a socially responsible design project. For this purpose, a two-stage study was performed. The first stage involves a literature review on open design. In the second phase, a case study was conducted to explore the effect of open design on a socially responsible design project that involved interviews conducted with the founder and volunteers in a project in Turkey that has adopted the principles of open design and designers who have design experience on the subject with their graduation project. After qualitative data analysis, the findings gathered from the interviews were examined and evaluated. The research has concluded that open design has effects and potential in the use of socially responsible design. In the study, it is revealed that the applications of open design in a socially responsible project include the role changes mentioned in the literature. In addition, it provides more convenience in terms of access to open resources and individual production.

Keywords: open design, open design movement, socially responsible design, children with impairment

ÖZ

AÇIK TASARIMIN ORTAYA ÇIKIŞ, GELİŞİM VE TÜRLERİNİN İNCELENMESİ: SOSYAL SORUMLU TASARIM YAKLAŞIMI İLE İLGİLİ BİR VAKA ÇALIŞMASI

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Bu çalışmanın amacı, açık tasarımın ortaya çıkışını, gelişimini ve türlerini incelemek ve sosyal sorumlu tasarımı içeren bir projeye etkilerini değerlendirmektir. Bu amaçla iki aşamalı bir çalışma gerçekleştirilmiştir. İlk aşama, açık tasarım üzerine bir literatür taramasından ibarettir. İkinci aşamada, sosyal olarak sorumlu bir projeye açık tasarımın etkisini araştırmak için açık tasarım ilkelerini benimsemiş bir projenin kurucularından ve gönüllülerinden biri ile yapılan röportajı içeren bir vaka çalışması yapılmıştır. Nitel veri analizinden sonra, bulgular incelenmiş ve değerlendirilmiştir. Araştırma, açık tasarımın sosyal sorumluluk tasarımı kapsamındaki kullanımında etkileri ve potansiyeli olduğu yönünde sonuçlanmıştır. Yapılan çalışmada, sosyal sorumluluk projelerindeki açık tasarım uygulamalarının literatürde belirtilen rol değişimlerini içerdiği açığa çıkmıştır. Ek olarak, kaynaklara erişim ve bireysel üretim açısından kolaylık sağlamaktadır.

Anahtar Kelimeler: açık tasarım, açık tasarım hareketi, sosyal sorumlu tasarım, bedensel engelli çocuklar

To my Defne

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LIST OF ABBREVIATIONS

ABBREVIATIONS

CNC: Computer Numerical Control

DIY: Do It Yourself

3D: Three Dimensional

CC: Creative Commons

PLA: Polylactic Acid

FDA: The Food and Drug Administration

CAD: Computer Aided Design

AM: Additive Manufacturing

ABS: Amniotic Band Syndrome

CHAPTER 1

INTRODUCTION

1.1. Problem Definition

Due to the spreading of the internet all over the world, sharing ideas and knowledge has become easier. Besides, new developments in 3D printing and laser cutting technologies have appeared as a new production method. Although it is not strictly an alternative to mass production, it paves the way for individual production. With the emergence of these individual production techniques and changes in the design applications allow the user not only to be a consumer but also to be included in the production part. Publishing designs explicitly, allowing individuals to share or copy is one of these design applications.

Open design is defined as sharing the design process or ideas mutually, by involving interested experts and amateurs, or sharing the design information freely to the extent that the designer deems appropriate, for the purpose of use, production, modification, improvement or dissemination.

In addition to the shifting role of the user from consumer to maker, the emergence of personal production methods has led to changes in design practice and brought about several advantages. Open design products can reach many places in the world with the improvement of personal production methods and the availability of the internet network.

In the 60s and early 70s, designers and other thinkers have tried to consciously understand the ways of overcoming social inequality through design (Chun and Brisson, 2015). In addition to producing market-based solutions, it has been realized that social and ecologic problems should be solved to provide results or benefit. This is a dilemma that needs to be solved. Some of the explanations made in this direction have been towards finding solutions to problems in developing countries (Papanek, 1972). Small-scale approaches can be benefited by supporting production at an individual level. It is stated that besides solutions that affect large masses, it can be done at the individual level and not only economic inequalities but also physical inequalities can be handled in terms of participation in social life. The designer should have responsibilities in this direction. Pointing out these situations, Papanek (1972) added that the problems of the needy are also a social responsibility that the design should address.

Open design approaches offer a way for the creation of products that are connected to social responsibility with the help of related systems and technologies, which make it easy to access information or services and produce individually.

1.2. Aim, Scope and Research Questions

This study aims to investigate in which ways open design affects the design practice in general and socially responsible design in particular. Considering that open design products can reach the user more easily, the open design understanding can make a difference to the socially responsible design approach.

Therefore, a case study was carried out in which a production process using open design resources took place. For this purpose, interviews were conducted with people who are involved in a project and it was aimed to answer the research questions by combining the literature review with the findings that were obtained from interviews.

Questions:

- How can open design be utilized in socially responsible design projects?
- What are the potentials of open design approach from the standpoint of social responsibility?
- How can open design approach be improved from the standpoint of social responsibility?

- Who are the main stakeholders of open design and in which ways are they involved in a socially responsible project?

1.3. Structure of the Thesis

The thesis consists of five chapters. This chapter presents a brief introduction to the topic of the thesis consisting of the problem definition, the aim of the study and related research questions. The structure of the thesis is presented in the last part.

Chapter 2 introduces an overview of the literature. Initially, a review of industrial revolutions and an overview of open design is presented. After exploring the approaches of open design, some fundamental principles are mentioned. At the end of the chapter, the implications of open design within the design practice are discussed.

Chapter 3 explains the methodology of the case study. It begins with general information about the interviews that are conducted. After explaining the selected qualitative research method that comprises of two phases, the study that is carried out for each phase is discussed in detail.

Chapter 4 covers the topics that emerged from the adaptation of the analysis methods to the interviews. The findings obtained from the interviews were evaluated in each section under the headings determined according to the analysis methods. The findings were then reviewed in the discussion section.

Chapter 5 consists of an overview of the study and conclusions based on the research questions. Also, limitations of the study are mentioned at the end of the chapter.

CHAPTER 2

LITERATURE REVIEW

2.1. Emergence of New Industrial Revolution

With the commencement of the industrial revolution, individual production turned into mass production. Besides, hand production changed to machine production. This shift to mass production increased the importance of design. Unlike the craftsmen of the past, designers confront meeting the needs of a large population, functionality, aesthetics, ergonomics, durability, cost and marketability. Additionally, manufacturing process also became an issue that should be considered (King and Chang, 2016).

According to Anderson (2012), production has been a matter of great importance to large companies, due to expertise, equipment and the costs of producing things on a large scale. Anderson (2012) considers the development and dissemination of 3D printers and the rise of open-hardware empowered by maker movement as a 'new industrial revolution'. Since the process of creation has become digital, it has been possible to make the design of physical objects digitalized and distributable. Similar to Anderson's approach, Berman (2012) also considers the emergence of 3D printers as new industrial revolution and discusses manufacturing technology, supply chain requirements, economic benefits and range of products compared with mass production. Therefore, in order to understand open design, industrial revolution should be understood.

2.2. The Significance of Industry 4.0

2.2.1. Before Industry 4.0

The first industrial revolution was a period of time in which many fundamental changes, developments and inventions took place from 1760 to 1830. Inventions such as steam engines resulted in the development of new machines that provided mass production. Consequently, mass production replaced manual labor. Until that time, craftsmen ran the production stages traditionally and manually, and through these stages, 'design' was coming out without documentation. As a result, these products were custom-made and unique. By the mass production, the field of industrial design emerged to specialize in the design of commercial products that appealed to a broad audience and could be manufactured at scale. Although most things were handled by machinery, someone still was needed to make them work.

The use of machines in the production process that started in the first Industrial Revolution, coupled with the development of new forms of technology such as electricity, started the second industrial revolution that began in the late 1800s, continued into the early 1900s, and involved the growth of railroads. Within the second Industrial Revolution, manufacturing capabilities changed the way objects were made, urbanization changed patterns of consumption, and the emergence of a wider middle class created a demand for fashionable styles from a much larger and more heterogeneous population (Benton, 2000). Whereas the first revolution experienced technical developments mostly in the textile industries, the second revolution on the other hand developed efficiency in the production and distribution process that was achieved by the increase of the transport of labor to factory production units and the improvement of transportation.

The Third Industrial Revolution, also known as the Digital Revolution, happened from the 1960s to 2010. The change from analog and mechanical technology to digital technology led to the creation of computer-controlled machines in manufacturing.

Consequently, digital technologies affect a number of different fields, such as information systems, computer science and engineering, as well as industrial design.

2.2.2. Industry 4.0 is Progressing

Technological advances have driven increase in industrial productivity since the dawn of the Industrial Revolution. Technological developments have led to increase in industrial productivity since the beginning of the Industrial Revolution (Rüßmann et al., 2015). Industry 4.0 is the last level of industrial revolutions that affects the business models and the production methods as well and is also known to differ from the other industrial revolutions with the concept of ‘smart factory’. In this context, the machines are all interconnected, capable of making instantaneous decisions that means controlling their own manufacturing processes. Eventually, they can produce customized products and manufacturing becomes more flexible and faster in order to meet customers' needs.

A mass manufacturing product is designed first and then the factory is tooled to make the exact same product from that design multiple times. However, in Industry 4.0, each product is not necessarily identical. They are customized as needed for their final use. The product design needs to correspond with various use cases of the product and allow the design to adjust as needed. Lasi et al. (2014) state that in the market directed by the buyers rather than the sellers, the buyers could define the conditions of the trade and as a result of this change, the products would increase individualization of products and in some cases it would lead to individual products.

Rüßmann et al. (2015) indicate that with the rise of new digital industrial technology, Industry 4.0 had a transformation that is powered by nine foundational technology advances (see Figure 2.1.). Analytical information based on the evaluation of data sets collected from many diverse sources namely *big data* is guiding many areas from product quality to energy efficiency while supporting real-time decision making.

Autonomous robots can evolve by becoming more flexible and collaborative, which gains the capability of interacting with each other and with the humans. *Simulations* save time and quality by utilizing real-time data to project the physical world into a virtual model which can include the machines, the products, and the people. As universal data integration networks continue to evolve, companies start to integrate with each other and the systems within them by *horizontal and vertical system integration*. Not only the big data analytics, but also the *industrial internet of things* can help them react in real time by communicating and interacting with central controllers. Increased communication has made it more secure; and in this respect, connection and communication protocols have been developed within the frame of *cybersecurity*. As the increase in communication also increases the data sharing, use of this technology will also be supported by *cloud-based systems*. While *additive-manufacturing* methods such as 3-D printing arebeing used for pre-production stages, such as prototyping with Industry 4.0, it has become possible to produce smaller quantities of customized products. The products can now be produced in a desired location whichwill also reduce the transportation distances. On the other hand, these decentralized additive manufacturing systems that can produce on demand will also reduce the need for inventory. *Augmented reality* technology allows users to experience both the real and virtual world simultaneously. In this manner, users can receive real-time data or statistics while making decisions and experience the results in a virtual environment. Within this context, the most relevant subject in industry 4.0 with open design is the additive manufacturing. Industry 4.0 helped the traditional manufacturing to transform into a digital world by the use of flourishing and spreading new technologies like 3-D printers facilitating the means of more individual production.

Besides, spreading of digital technologies and social media enable the opportunities of connecting, learning and sharing information easily. These possibilities multiplied by emerging technologies like the Internet of Things or 3D printing generate new products, services, design practices and ways of consuming goods like customer side production. As a result, enabling the communication between people, machines and resources, the fourth industrial revolution made the control of production process decentralized and distributed.

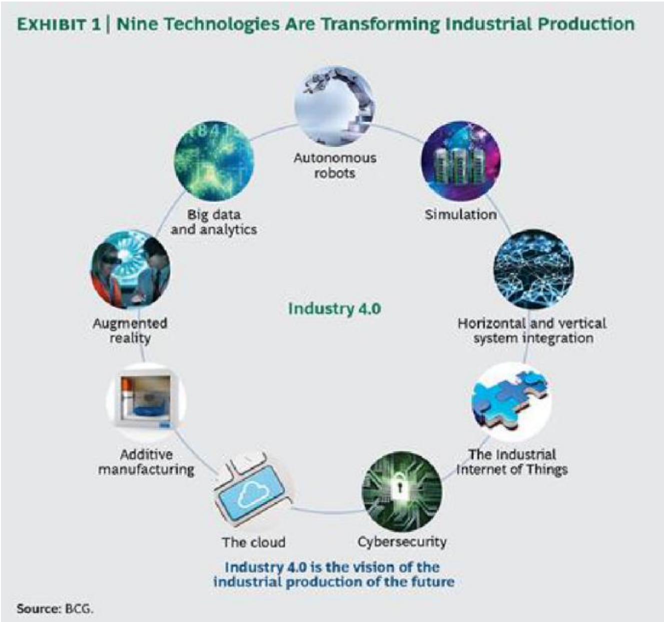

Figure 2.1. The nine technology trends that are the building blocks of Industry 4.0 (Rüßmann et al., 2015)

2.3. Overview of Movements that Affect Open Design

Open design is influenced by two major approaches, the first of which is *maker movement* and the other *is open source software movement*. The methods that will form the basis for tangible product development and production from the maker movement, whereas the concepts such as sharing and openness are from the open source movement.

Making is about building and figuring out how to build, driven by personal interests and concerns. It involves getting things to work, with exploratory tinkering and manipulating objects beyond their typical use (Honey and Kanter, 2013).

In the early ages, lack of mass production, difficulty to reach craftsman because of the distances and shortage of resources directed people to build their needs with more primitive tools in comparison with today. However, as an inherent part of human nature, exploring, learning, planning and creating for needs and interests reveal that making has always existed. According to Aliverti et al. (2015), humans were prodigious makers, therefore, human history began. Dougherty (2012) states that maker movement arise because of people's passion to engage with objects more than just consumers.

Caldwell and Foth (2014) specify do it yourself (DIY) approach being an implicit decision to oppose consumerism and end product can be crafting of experiences instead of creation of a tangible artefact. By the time, making things is perceived as an activity of hobbyists. The origins of DIY as a hobby is provoked from a need to give idle hands something to do, and provide a productive and satisfying way of spending spare time (Atkinson, 2006). DIY is defined as a more democratic design process of self-driven, self-directed amateur design and production activity carried out more closely to the end user of the goods created (Atkinson, 2006). There are various samples of DIY practices, ranging from handicrafts to furniture customization, decoration and garden design.

In the late 1990s, Neil Gershenfeld, a professor at the Massachusetts Institute of Technology (MIT), led his students making objects besides their theoretical achievement. Following this, he started a course called 'How to Make (Almost) Anything'. As it is understood from the name of the course, the students made everything that could be done with new technology like Computer Numerical Control (CNC) machines and laser cutters. In the subsequent period, 'Fabrication Laboratory' which is called Fab Lab, was established which would be turned into the Fab Lab culture that spread around the world (Aliverti et al., 2015). In 2005, O'Reilly Media published the first issue of MAKE that guided for making several things, besides the name of 'maker movement' and the idea can be first seen at this magazine (Martin, 2015). By providing innovation, supporting collaboration, 'MAKE' magazine is now considered as a central organ of the maker movement.

Uprising interest in the community of magazine readers brought about 'faire' where people could get together and exhibit what they made in physical and do conversations. More than 100 makers shared their creations there (Dougherty, 2012). 'Maker Faires' become a common area that incorporates creations and inventions that never existed before and are developed by individuals in their homes, garages or a place with limited manufacturing resources.

The Maker Movement deals with newforms of production and do it yourself work in which hobbyist, tinkerers, engineers, hackers take part. In this concept, making is perceived as building or adapting objects by hand, for simple personal pleasure of figuring out how things work (Honey and Kanter, 2013). Kalil (2013) defines makers as those who have strong drives to making, thinking, problem solving, exploring and sharing in their leisure time to design and dealing with something.

Hatch (2013) identifies nine principles in the 'Maker Movement Manifesto' as make, share, give, learn, tool up, play, participate, support and change. He mentions making within the meaning of doing physical things to create and express ourselves. Although he considers making as a means of satisfaction, he specifies sharing and giving as complements to it. Making includes never-ending learning instinct that leads to the search for new materials, methods and processes. He states that a maker cannot complete a project without the right tools. For the emergence of a making community, sharing and co-creation requires a well-equipped makerspace. On the other hand, he adds that the work done with a playful spirit makes it more productive. He considers participation in a wide range of activities, from working together to participating in society's community membership and engaging in events like the Maker Faire to reach other makers. He states that maker movement stands for supporting in which includes emotional, intellectual, financial and institutional support to make a better future. In the end, he adds that making will change for the better along with all other principles.

According to Hatch (2013), his manifesto is only an initial sketch. Furthermore, he suggests that one can take the manifesto, change, and personalize because it is the meaning of making.

On the other hand, the maker culture promotes informal environments supporting peer to peer learning and learning through making, regarding mechanical and technology driven interests (Caldwell and Foth, 2014) and maker spaces such as 'Hackerspaces' and 'FabLabs' maintain environments where makers and DIYers can share knowledge and provides opportunity of manufacturing resources. Besides, the new spreading technologies such as 3D printers, laser cutters, AutoCAD software, garage-scale CNC mills and things like Arduino and Raspberry PI motherboards give makers the chance of small-scale fabrication and having come down the cost to make them reach to normal consumers.

The *free software movement* was launched in the 1980s by Richard Stallman, defending open source software, opposing the commercialization of the software industry to convert the source code into company secret. Although the word free software represents the freedom to download, use, modify and redistribute the source code, the term *open source* is subsequently introduced to prevent it from interfering with the concept of for free (Abdelkafi et al., 2009). Open source oftware emerged as a market-creating labor organization concept, the Linux operating system is an example (Bonvoisin & Boujut, 2015).

What is important for the development of open source software is that the software is introduced in source code format. The source code is freely available via the Internet, allowing programmers who are physically independent to download and use the software, propose improvements to the community, or modify and redistribute their modified code (Balka et al., 2009). The open source software has a shared model to create a feedback relationship that connects the designer directly to the user by removing the distributor.

The ease of distribution by internet, improvement and accessibility of digital fabrication tools lead to a new occurrence called open design. It has been suggested that open design stands for accessible design in the form of blueprints that are publicly open to view, modify and use under open-access terms with the influence of the open source software. Moreover, open design often implies that the design blueprints are available via open-access digital repositories that they can be adapted at will to meet situational requirements, and that can be used by consumers to fabricate products on demand by commercial, off-the-shelf means of production.

2.4. Open Design Approaches

Open design approach has taken its roots from the open-source and free-software concepts in information technologies field (Boisseau et al., 2018). Although the 'open' concept is widely used in the field of computer engineering, it has also affected other areas such as product design, especially in product development processes and stakeholder issues (Boisseau et al., 2018).

In this section, we will examine open design approaches in two groups as collective design process and post design by users. In the first group of approaches, people work collectively in the design process and have appropriate environments to come together. In the second group, general framework of design has already formed and a space is given to the user in which customization or a limited part of design can be done.

While talking about open design in general, there are important situations where open design approaches cannot be appropriate, and there will be a polarization between everyday design activity (for cups, T-shirts, etc.) and critical designs (medical equipment, very complex systems like mobile phones) (Cruickshank and Atkinson, 2014).

2.4.1. Collective Design Process

The involvement of the user in the development of design has previously been encountered in user-centered design. Abras et al. (2004) define user-centered design as a broad term to explain design methods that end-users affect how a design takes shape. In user-centered design, the researchers and the designers are differentiated according to their roles. While the designers focus on the users and their needs in each phase of the design process, the researchers apply research methods, interview and observe users for uncovering user needs and share the results with the design team. The user contributes to the team indirectly by the help of researcher (Sanders, 2002). Sanders and Stappers (2008) describe user as a ‘subject’ in the user-centered design approach. In participatory approach, on the other hand the user becomes active participant by getting involved in the design process. The person formerly known, as the ‘user’ become a partner so that boundary between the ‘designer’ and the ‘user’ becomes blurred (Luck, 2003).

In participatory design approach, sharing knowledge and suggestions that are provided by open access to design products and processes, enables designers, artists and users to learn from each other (Huybrechts et al., 2013). The outcomes of participation process guide designers to understand what users need and the points they give up the products. This approach ensures product improvement allowing users to involve in the design process.

The participatory design approach is expressed in many ways. Sanders (2002) uses the word ‘resonance’ which is defined as being able to respond easily to the user's opinions and ideas, which can be done by integrating users into the development process. On the other hand, Al-Ahmari (2017) refers to participatory design as infrastructure.

In several industries, user experience is seen as a driving force for product improvement because user is a valuable input for design process. Björgvinsson et al. (2012) emphasize the importance of the practical and varied skills of users. When users are involved in the early stages of the design process, information flow and first-hand evaluation of the product can lead tacit knowledge to emerge. This helps the product meet the right needs if it can be applied to the design.

Figure 2.2. Participatory Design Benefits (Participate in Design, 2017, February 6)

In participatory design approach besides designers, contributors from other disciplines such as marketing and engineering can be seen as stakeholders. In this context, Sanders et al. (2010) refer potential users as non-designers and underlines the importance of finding appropriate ways for stakeholders from different backgrounds to get involved in the process efficiently.

With a successful method, participatory design has benefits listed in figure 2.2. Understanding the actual needs of users helps to create more suitable designs for use. Product returns are often not due to product defect, but because of complexity of use and failure to meet expectations (Björgvinsson et al., 2012). Providing space for users' participation and facilitating their own solutions to come out makes the output more embracing by these people. The people involved in the solution with their skills, knowledge and resources become more confident. Participatory design approach involves open dialogue between various stakeholders. When people understand that there are different positions on a subject, they are usually more open to discovering new solutions. Participatory approach enables appropriate environment where people meet and get in touch with each other's views. As a result, the communication between them increases and strengthens and this leads to mutual understanding.

Since the 1970s, participatory design is discussed as the practice of collective creativity. Nowadays, the terms co-design and co-creation are used in the area of participatory design.

'Co-creation' refers to a collaborative action between experts and the external participants with two-way interaction (Aitamurto et al., 2015). Sanders & Stappers (2008) highlight that co-creation is seen in all stages of design but mostly in the later stages and also added that co-design is a specific instance of co-creation.

Users' presence in this process provides innovative ideas, different approaches and at the end better solutions to meet users' needs. While users' role in this process depends on level of expertise, passion, and creativity, designers have a role by providing expertise that the other stakeholders do not have (Sanders & Stappers, 2008). Websites that allow users to customize their product such as Nike Store (n.d.) can be an example of co-creation.

Co-creation is generally used as an umbrella of activities, which includes co-design and crowdsourcing. OpenIDEO (n.d.) and Quirky (n.d.) are such platforms that customers participate in design process at various levels with innovative ideas or designs ready for production. Aitamurto et al. (2015) explain this participation as mass customization and personalization to personalize products. Thingiverse is another web site that enables designers share files for 3D printing and generate new designs by customization.

2.4.2. Post Design Approaches

The post design approaches take place from the perspective of free distribution of the design data of open design. The basic and important issue is the sharing of knowledge among people and communities who are interested in. In downloadable design, the plans of the project or the product are shared through online channels. The plans which covers computer aided design (CAD) files, blueprints and instructions are given to the user in a way that allows the product to be made exactly and directly from the 3D printer or CNC machines. In DIY, the production process that includes all the way from material selection to production step are shared. Pre-Hacking (Post Production Hacking) is based on the re-use of the design after production by sharing all the information about from material supply to product construction. These will be covered in detail in the following sections.

2.4.2.1. Downloadable Design

Wide spreading of internet access both increase the number of people who benefit from it and creation of new platforms where people can meet. These platforms also become new opportunities for market places.

CAD files and blueprints of design projects are on display with the help of new platforms. ‘Thingiverse’ is one of them, which is a website platform that allows users to share their downloadable digital design files.

Despite the limitations of internet market, a wide product range is observed in this area including medical appliances like tooth, bone replacements and artificial limbs, models of Lego pieces, guns and rifles, and miniature airplanes (Staed, 2017). Besides small items, bigger projects in volume also appear in the open source area like furniture or house.

With the help of digital media, giving the opportunity of choosing, the end user becomes as a decision-maker. The framework aims to design alternative selections rather than a final product. As the user makes decisions, the boundaries of these selections is another subject that is concerned by the designer. In this context, the designer can make a decision of what is free and what aspects of the product should have an added fee.

‘Wikihouse’ is an example of open design project where information and files are freely shared for anyone to use and improve. The owners of the project define it as a digitally manufactured building system and give chance to anyone who wants to design, manufacture and assemble a low-cost and sustainable house that is customizable with their needs (see Figure 2.3.).

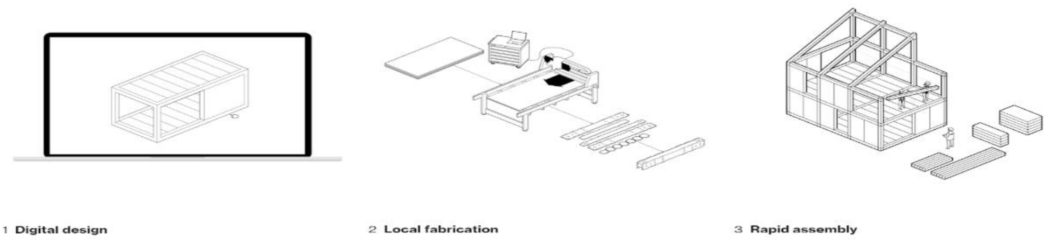

Figure 2.3. Process of production (WikiHouse, n.d.)

The blueprints and the instructions that are needed to build the house are given on the online library. In addition, terms of use in which regulations and use rights are defined also stated (see Figure 2.4).

Figure 2.4. Left:Manufacturing guide Right : The DfMA housing manual (WikiHouse, n.d.)

A second example is ‘sketchChair’ (see Figure 2.5.). In this project, a predefined space is left for the user. An open-source software tool that enables users to have their design development environment is provided (see Figure 2.6.).

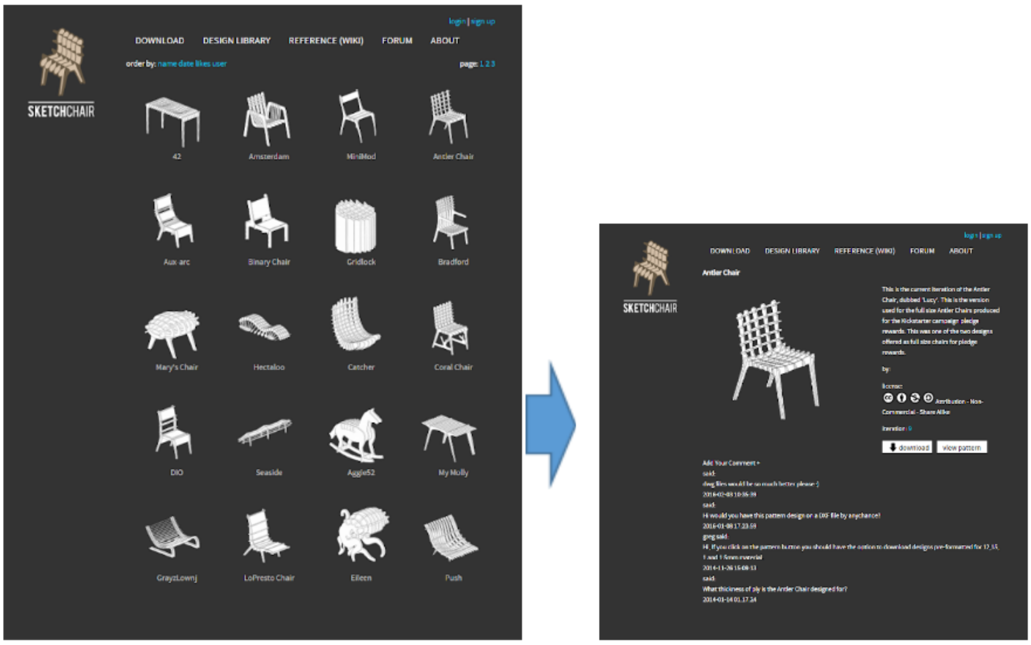

Figure 2.5. Pre-defined design models (SketchChair by Diatom Studio, n.d.).

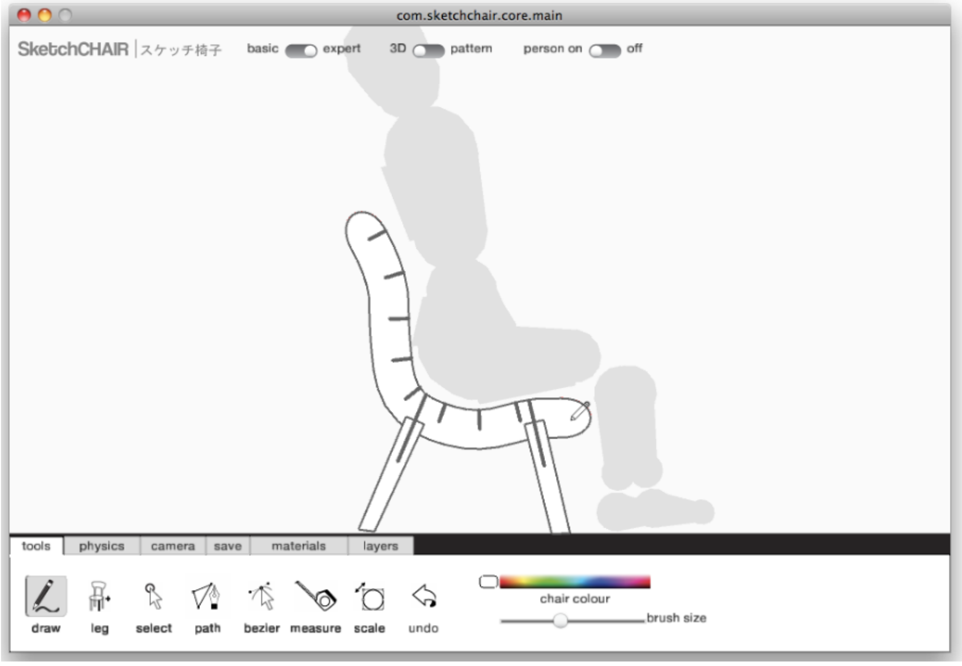

Figure 2.6. The interface that enables the user to design (Diatom, n.d.)

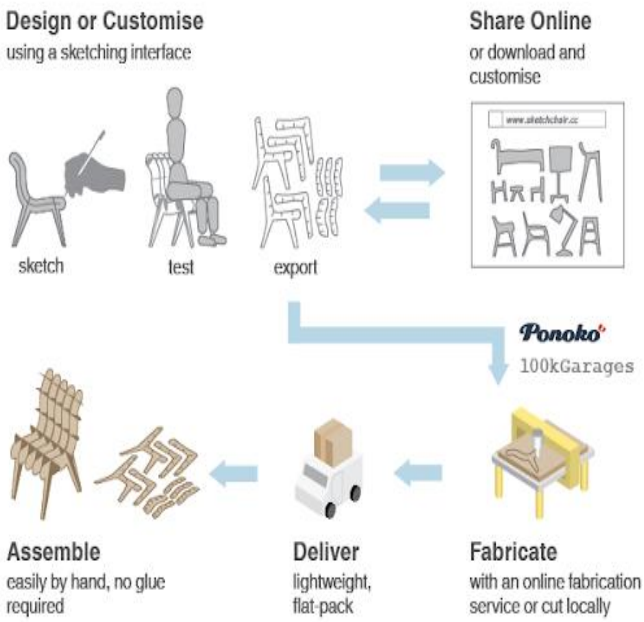

Figure 2.7. Process of development (Diatom, n.d.)

This design space left to users allows them to be involved in the design process and make personalization. Within the program, users not only design but also test stability of the chair. In addition, the designs that are created by this 2D drawing interface can be uploaded to the library and become sharable with other users. The design output is ready for CNC manufacturing (see Figure 2.7.).

Furthermore, giving designers an alternative environment at which they can share designs, downloadable design brings a new system not only to open design but also against mass production. As it is locally produced, the need for transportation is eliminated which is considered of an ecological earning. As the user needs she/he can produce, therefore the concerns of stocking and the time to put the product on the market are out of question (Van Abel et al., 2011).

Besides traditional manufacturing techniques for consumer and industrial products such as injection molding and CNC milling that typically produce a greater accuracy, 3D printing has its own advantage when the speed of manufacturing is in consideration. What is described as speed is accessible and can be used without intermediaries because it can be owned individually. Integrating with CAD software and other digital files like magnetic resonance imaging and low-cost fabrication, distinguish 3D printing from other rapid prototyping technologies (Berman, 2012). Unlike mass production, small quantity of customized items is enabled with lower costs. Customization is not a new subject of 3D printing area but together with lower costs and new opportunity of performance innovations, firms like Nike and Adidas make their prototypes and create 3D printed pair of shoes. Nike also patents their own 3D printing technology for shoes.

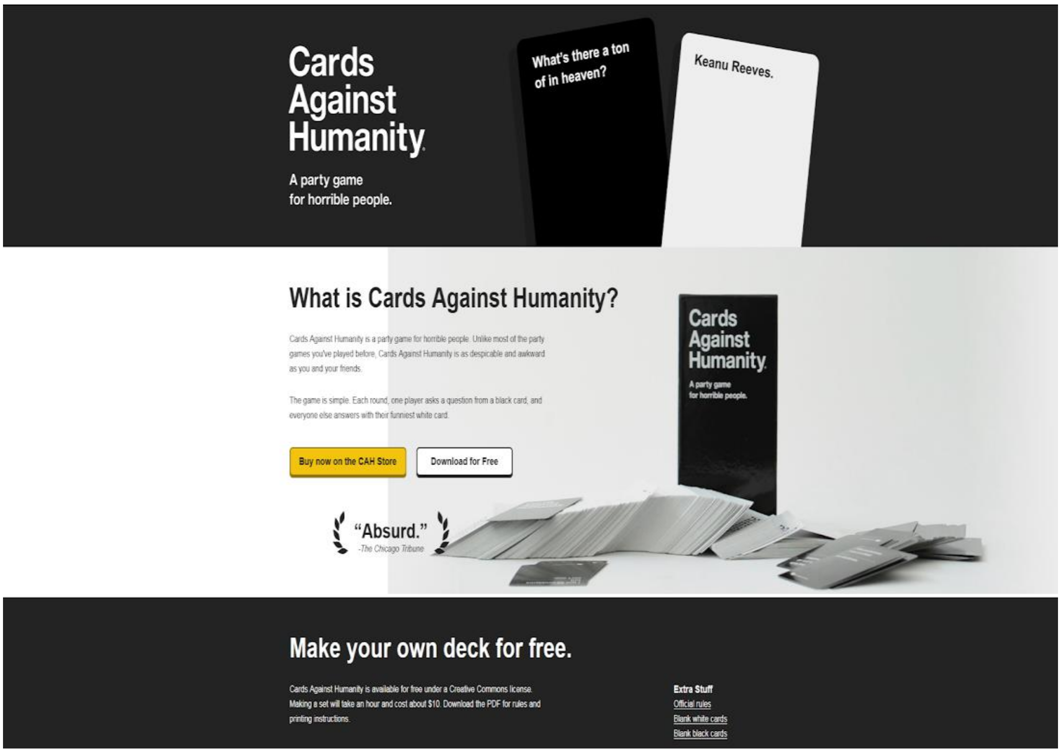

Figure 2.8. The official web site (Cards Against Humanity, n.d.)

Another example is 'Cards against Humanity' which is a party game (see Figure 2.8.). At its official website, visitors can download the card templates for free. They can make their production by printing the PDF document and applying the instructions that is given (see Figure 2.9.).

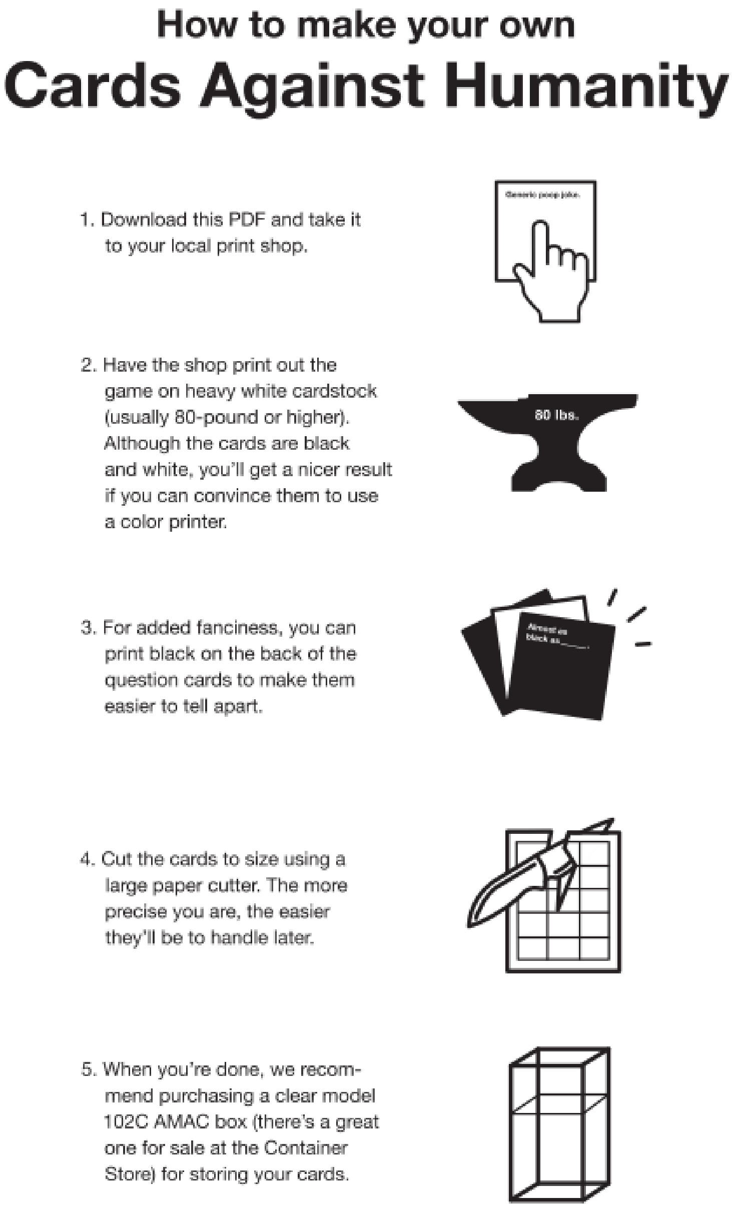

Figure 2.9. How to make manual (Cards Against Humanity, n.d.)

Saakes (2011) states that the design software that provides these technologies that is used in the example of Sketch Chair or Wikihouse remains within the expertise of professionals. The difficulty is to design the software to meet the needs of the end-user, while providing design freedom and validating engineering and human factors (Saakes, 2011). He also draws attention to desktop manufacturing with its advantage of facilitating user confidence by allowing designers to take advantage of many duplicates and cost-effective prototypes.

2.4.2.2. Distributed Design, Do It Yourself (DIY)

Although DIY seems to be as a hobby activity made in leisure time, its origin is based upon a need-driven behavior. In the 1950s', after theSecond World War, labor shortages and lack of money made people tend to improve and do maintenance at their homes by themselves (Atkinson, 2006). Nowadays, DIY is an endeavor to fulfill the desire to give idle hands something to do and spare time with productivity (Atkinson, 2006). According to Caldwell and Foth (2014) sometimes it can be an activity opposed to consumerism and beyond tangible product; it improves individual creation as well.The making of clothes, which arose from the financial need in wartime, has now become a way of the creativity, customization and reflecting self-identity for especially young people (Atkinson, 2006).

Table 2.1. *Adapted from Atkinson (2006)*

	Activity	Input	Motivation
Pro-active DIY	activities contain self-directed, creative design input	raw materials, original combination of existing components	personal pleasure or financial gain
Reactive DIY	hobby and handcraft or building activities	kits, templates or patterns and involving the assembly of predetermined components	range from the occupation of spare time to personal pleasure
Essential DIY	home maintenance activities	economic necessity or because of the unavailability of professional labor	often involve the following of instructional advice from manual
Lifestyle DIY	home improvement or building activities	professional input, usually in the form of design advice	emulation or conspicuous consumption, and where the use of one's own labor is by choice rather than need

DIY activities are done in various areas so boundaries are unclear. Atkinson (2006) categorize DIY activities in four distinct areas seen in table 2.1.

The level of DIY applications may vary depending on creativity level, interest amount, and financial conditions. In addition, DIY requires access to appropriate materials, tools and techniques to strengthen the interest of amateurs (Mulder, 2011). At this point, open design helps users to achieve accurate, guiding and accessible information.

The open design and DIY offers a variety of tools to the user, which can vary at different levels. Easy-to-use templates which users produce without significant modification is the simplest level. At the intermediate level, design templates that allow the user to make modifications and thus create their own design are seen. At the highest level, users who are mentioned as skilled amateurs' access advanced design tools used by professionals (Mulder, 2011). In addition, DIY applications are now not only made with carpenter tools but also new production techniques such as 3D printers. Similarly, the rise of the ‘maker culture’ enhances product tinkering, while the do-it-yourself movement embraces ‘the open’ in design (Aitamurto et al., 2015).

The transfer of the design in digital environment and the widespread use of the internet helped to make DIY applications be easily accessible. On the other hand, Rijken (2011) indicates that in spite of all these opportunities and resources, anything that is expressive or reflective takes its value from ideas and values embodied.

2.4.2.3. Post-consumption, Pre-Hacking (Post Production Hacking)

In the computer world, hacking is known as the act of gaining unauthorized access to data. There is a two-way situation with respect to hacking that is called pre-hacking or post production hacking in the design world.

The first situation can be considered in the same frame as the computer world. Galloway et al. (2004) emphasize that hacking does not rely on the permission or support of designers; it is in fact a creative response to the status quo. In some cases, a product, which is designed for everyone, does not meet physical, sensory and cognitive needs of its users. At this point hacking is, in a way, a reaction to a lack of resources. This deficiency can be seen in the health sector and affects people with disabilities (De Couvreur & Goossens, 2011). De Couvreur & Goossens (2011) explain this with a fact that he encountered in a rehabilitation center. At the center, patients and therapists reuse so many universal products by reorganizing and personalizing them to suit their needs and applications. In addition, ‘the Humana Health by Design Contest’ is another example of hacking in the health sector. Many reuse examples that can be applied in the health sector are seen in the competition. ‘Mouse for People with Hand Disabilities’ is one of them, which uses Wii remote and Wireless Wii sensor bar as a basic tool for making head-on mouse that is controlled by mouth for people with handicaps. List of all the equipment needed to make the product, detailed description of the construction are available at the web site.

Figure 2.10. The Picture of Mouse for People with Hand Disabilities

(Instructables, 2017, November 5)

Boisseau et al. (2018), state that since the purpose of re-design is to reduce the costs and customization, hacking often affects objects of everyday life. Since easy manufacturing at home at low cost is important, these products are mostly low-tech in nature.

The best-known example of pre-hacking is IKEA hackers. A community share customization and reuse ideas of IKEA products through an online platform. They use IKEA products to make new products apart from their own use. Since IKEA is a worldwide company and their products have standardization, reproduction can be done by people anywhere in the world (Saakes, 2011). Rosner & Bean (2009) state that IKEA hacking reflects an increasingly popular interest in tinkering and customization.

In the second situation, there is a concept of design for hacking or hackability. In this case, the designers do not perceive hacking of their designs as unauthorized use, but as the discovery of new solutions and features that can be added to the design (Saakes, 2011). It involves creating spaces for play where people are never forced to adapt to technology and is describe it as a playful design practice inspired by several cultures and practices such as the historic and current hackers, net art, DIY and re-mix (Galloway et al. 2004). He sees designing for makers in another word hackers as a challenge. In addition, availability of materials and the level of expertise that the makers have are important determinants for optimal reproducibility. On the other hand, Saakes (2011) emphasizes engaging with social motives which makes people to do it themselves affect hackability.

2.4.2.4. Meta Design

Kyriakou et al. (2017) mention that the spread of 3D printing technology to consumers is achieved through the reuse of pre-created designs that provide customization and defines new concrete models that are generated from shared models as meta models like the example of Thingiverse. Moreover, the use of two ways of meta models is mentioned. The first one is the emergence of a meta model through reuse with customization. Second, the source code of the meta model itself can be replaced or reassembled with the source code of another meta model. In the second embodiment, it creates a new meta model that can form an extended or different model family compared to its predecessor (Kyriakou et al., 2017).

On the other hand, Fischer & Giaccardi (2006) refer to meta-design as a new collaborative design structure while talking about co-creation. In order to find more creative solutions to the problems that are encountered, they consider the inclusion of the user as a co-designer in the design process that embraces not only design time but also throughout the entire existence of the system. In order to do this, creating environments with activities, processes and objectives that enable users to act as designers is mentioned (Fisher, 2003; Fischer & Scharff, 2000). Thus, it will define a new role by providing the designer with a design space in which he can take part as a co-designer, instead of simply designing the object (Mul,2011).

Fisher (2004) states the design area as socio-technical environments that give the user the power to create and be involved. On the other hand, Stappers et al. (2011) state that the role Mul (2011) calls the meta designer does not mean to lose his or her expert position completely. Fischer (2004) states that virtual environments have the potential to create suitable environments for meta designs. Besides, it is possible that meta design can be found not only in individual production but also in mass customization, as the Nike mentioned earlier is an example of this.

2.5. Fundamental Principles of Open Design Practice

Open source is a term that refers to a product's permission to use the source code, to reuse, rework and change the content or design documentation (Wikipedia, n.d.). Additionally, contributing design work to existing open source projects is defined as an act of open source. Open source practice is firstly employed in software development. Through accessible and sharable platforms, where motivated communities with common practices share, adopt, produce and further develop innovative solution.

The term ‘open design’ is a practice that takes working principles from open source software and implements them in the domain of design (van Abel et al., 2011). The principles remain the same; sharing the source who are interested in by opening it and allowing to reproduce a copy or personalize by changing. Due to the fact that the final product is intangible, open source practice differentiates from open design practice in software. Therefore, sustainability and contributing stakeholders’ issues have also been addressed, as physical product and production process are involved. Therefore, prominent principles, which are sharing, openness, sustainability, personalization and contributing stakeholders, will be explained in the next sections.

2.5.1. Sharing

The movement of the open source, which started before the movement of open design, was based on sharing the information and the idea as well as being free and open.

The issue of sharing has also taken place in many issues related with open design, which is essential for the dissemination of information. The open source development model includes the continuous development of concepts, products and services, as well as making the source code publicly available to anyone who wishes to use or modify them for their own purposes (Huybrechts et al., 2013). The process of making not only involves the duration but also adapting and customizing and at last sharing with others so they can adapt it to their own uses. Discussing the maker culture, sharing is a must besides other characteristics which are learning in the process of product creation and involving of transdisciplinary communities because of their different backgrounds (O'Duinn, 2012; Wolf et al., 2014). The maker movement is defined as increasing interest in the creation of physical goods through digital tools and internet shared plans and techniques (Burke, 2014). In addition to this, co-creation is mentioned as a collective activity that is shared by two or more people (Sanders & Stappers, 2008). Besides, in a participatory design in addition to knowledge, roles and responsibilities are also shared in decision-making.

Wolf et al. (2014) states that open knowledge sharing as in virtual environments have some barriers. The first one is motivational barrier that means individuals' intention to share. Social aspect is the second one that needs willingness to cooperate with strangers. Technological barrier to communication or documentation is another condition to be fulfilled. Moreover, intellectual property issues related to sharing knowledge openly through digital environments also affects global sharing.

Besides barriers, motivational drivers like fun factor, being recognized by others, satisfaction of self-making, collaboration and helping others are also indicated. Gorengflo (2011) refers to sharing as a survival issue relevant with living well and reduce footprint while making ourselves happy beyond material concerns. Making it easy to be involved in conversations, internet is also a facilitator factor of distributing and sharing the control and ownership through the new generations (Sanders & Stappers, 2008).

Since it uses mostly digital platforms, additive manufacturing is frequently mentioned in open design area. Designs in the form of digital files and facilitating of it to modification and customization are considered one of its advantages and challenges of the additive manufacturing field (Ford and Despeisse, 2016). Moreover, outsourcing manufacturing by sharing designs easily take a part in the advantages of 3D printing in comparison to other technologies (Berman, 2012).

Before sharing knowledge through internet or an open platform, the information needs to be documented. Documenting is defined at the final stage before sharing (Wolf et al., 2014). Fab labs can be a good example not only sharing digital fabrication blueprints and production devices but also documenting the operating instructions for using the machines in the worldwide community.

2.5.2. Openness

The word 'openness' in the dictionary is referred to as accessibility and lack of restriction. In the design context, openness is accessibility of knowledge and practices. Besides, it refers to a publicly accessible possibility to participate in the design process, so that both non-designers and designers participate (Aitamurto et al., 2015). While openness was only seen in the context of software, it led to the digital fabrication with the effects of digital developments in the analog world (Maria, 2011).

Innovation and new product development studies focus on user-centered approaches and customer engagement in several stages of the design process, while current definitions of open design focus on the openness of technical design knowledge and largely exclude, particularly, the initial stages (Aitamurto et al., 2015). The definition includes not only the openness of products, but also the openness of processes. It is examined in different phases the design process like ‘project time’ and ‘use (Huybrechts et al., 2013).

The concept of open source also raises the issue of user rights, which entails making changes to the product, reuse and redistribute the modified version. ‘The creative commons license’ creates a framework for these issues while preserving intellectual property rights.

2.5.3. Sustainability

With the technological evolution of 3D printers and increasing access to open design products, the traditional fabrication has shifted to personal production. The emergence of advanced manufacturing technologies and consumer demands for more customized products and services, are causing shifts in the scale and distribution of manufacturing (Ford & Despeisse, 2016). Due to the continuous evolving in co-production or personal fabrication of goods and accordingly shift in production change, making assumptions of current consumption is uncertain (Kohtala, 2015). Because of the importance of fabrication techniques and other related issues in sustainability area, additive manufacturing is a mostly cited topic in open design context in terms of sustainability.

Additive manufacturing (AM) covers a broad range of production technologies that fabricate products layer-by-layer, enabling three-dimensional objects to be ‘printed’ on demand (Ford & Despeisse, 2016). AM has the potential to provide a range of sustainability advantages. Owing to creating products layer-by-layer, additive manufacturing is inherently less wasteful than traditional subtractive methods of production (Ford & Despeisse, 2016). There is a decrease of material consumption due to it being an additive process with the help of the capability to optimize geometries and create lightweight components, also reduces energy consumption

(Chen et al., 2015). They also specify the waste reduction due to the ability to create spare parts on-demand. Ford & Despeisse (2016) state that make-to-order manufacturing with the help of a database of digital designs not only reduces or eliminates the inventory waste, but also reduces the inventory risk with no unsold finished goods. Also allowing production of spare parts for replacement provides lower cost at customization and personalization. Besides, in the open design process, since the user does the production, there is no need for transportation, which has a positive effect on the environment.

Rejeski et al. (2018) state that there is not much research on the toxicity and environmental potential of AM processes and materials. Besides, such impacts may exist during the processing and disposing of the materials used in AM processes. In terms of materials, a variety of polymers, metals, ceramics and composites can be used for AM. Polylactic acid (PLA) which is a polymer commonly used in 3D printing filament has the ability to be recycled with little quality loss.

On the other hand, energy consumption during manufacturing should also be considered as a sustainability factor. Rejeski et al. (2018) declare energy consumption is directly related to the cost of manufacturing and carbon emission during the production. However, consumption of energy that 3D printers use is more than that of comparable conventional processes at process or machine levels. In addition, in AM processes human and machine errors can be much frequently seen than expected (Rejeski et al., 2018).

For this reason, sustainability needs to be evaluated in many respects from product-based manufacturing cost to product raw material selection, from energy consumption to carbon emissions.

2.5.4. Personalization

Tseng et al. (2010) state that personalization involves possible changes in basic design and product characteristics, and it is essential for personalization, while implying adaptability and interchangeability in the design. Moreover, Mourtzis & Doukas (2014) define the aim of personalization with meeting individual customer needs through direct intervention into the design of products.

Cruickshank & Atkinson (2014) explain personalization as an opportunity that provides the purchaser of a product to intervene in the production process, while Hu (2013) states that consumers participate in the design process at different levels.

Avital (2011) indicates that open design allows for change and reuse and in doing so enables adaptation at any time to meet situational requirements. However, Tseng et al. (2010) state that needs can be based on cultural background, individual tastes, and aesthetic preferences. Jiao (2011) states product differentiation that is come up with in the dimension of user experience and allows possible changes and adaptations of the basic design and product features that fulfill the affective, cognitive and functional needs.

Aitamurto et al. (2015) mention that users' involvement in the design within crowdsourcing and co-creation platforms, enables participation in mass customization and personalization. On the other hand, Hu (2013) emphasizes an opportunity for a new product realization paradigm by the ubiquity of the internet and the availability of responsive production systems, such as 3D printing. This opportunity is defined as the personalization of products in accordance with the individual needs and preferences of consumers.

In the literature, especially in the field of economics, personalization and customization issues are discussed together and their differences are included. According to Tseng et al. (2010), product differentiation is at the level of individual customers' needs in personalization, while unlikely it is in the defined market segments according to explicit requirements in customization.

Jiao (2011) cited explicit data in customization as ratings or preferences, and exemplified implicit data used in the personalization strategy as purchased items or displayed web pages.

In addition, in terms of design, personalization is distinguished from customization in two dimensions, expanding the product design space and fulfilment of the intangible customer experience (Tseng et al., 2010). Moreover, Tseng et al. (2010) state that active participation in the design process effects in not only pleasing individual needs and eliciting requirements but also total quality of a product. For active participation, co-creation is used that eliciting experience related requirements.

Co-creation, crowdsourcing and DIY applications allow users involve in design process. At this stage, design decisions, feature and material selection give the user an opportunity to make personalization.

Contributing Stakehold Stappers et al. (2011) describe three main roles known in the traditional view of design that are the user, the client and the designer. The user who buys, the client who manufactures and distributes and the designer who conceives the product (see Figure 2.11.).

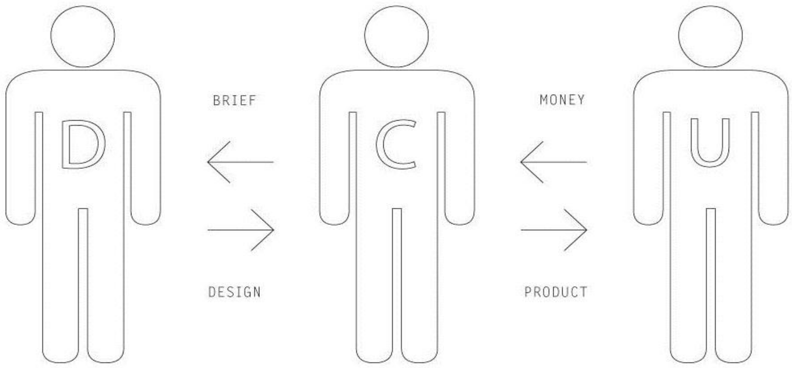

Figure 2.11. The Old View: (Strictly) Separated Roles (Stappers et al., 2011)

In open design, the most prominent change in the relocation of stakeholders is the user's role. Previously, the user took place only as a consumer, whereas the roles of the designer and the producer can be done by the user in open design.

Stappers et al. (2011) states that breaking down the barriers between designers and end-users and letting non-designers become designers are one of the aims of open design (see Figure 2.12.).

As in the case of user-oriented design processes, it is seen that the user is involved in the design process. However, no exchange of ideas has been made in these methods. In collaborative methods such as participatory design or co-creation, the user participates the design process by finding needs, idea generation or usage expertise rather than only testing. Including usage expertise by the participation of design process, actual needs of end-users can be discovered and new solutions can be generated at the early stages of design.

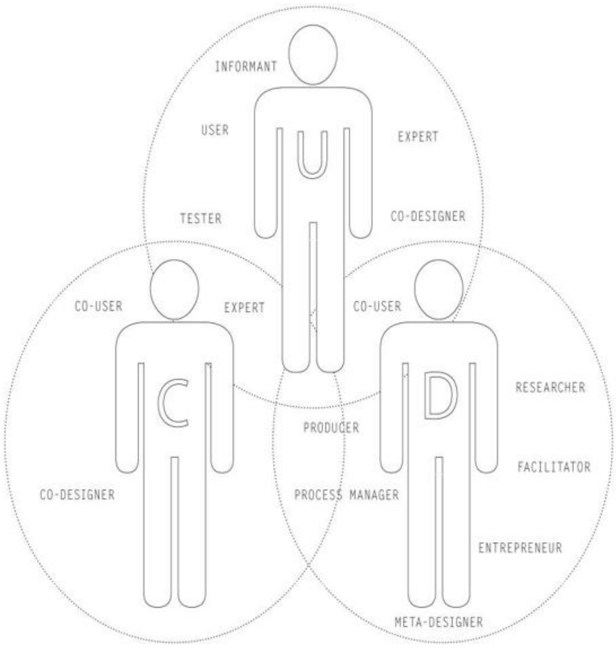

Figure 2.12. The New View (Stappers et al., 2011)

On the other hand, the client can also be seen as a barrier between the designer and the user. The client undertakes production and distribution in the old vision. In the new view, new channels such as web sites in which the design blueprints that are shared online takes place of the distribution part. However, fabrication of design objects is getting easier with new ways of fabrication such as 3D printing, thus they take the production part in the new view.

2.6. Implications of Open Design in/on Industrial Design Practice

2.6.1. Intellectual Property

The emergence of open design applications affects the practice of designers, business of products and brand owners. This launches several questions in terms of intellectual property and design practice. The basic rule for intellectual property is that all works are in the public domain unless intellectual property rights protect them. Copyright protects the creative, original expression of an idea, while patents protect the idea itself and its technical characteristics (Katz, 2011). The intellectual property rights used so far are based on the fact that the design belongs to the designer and the production and distribution is done from a single branch.

Open design pave the way for sharing, freely distributing copies and modified versions of a work or an idea. Moreover, the relationship between the designer and the end user change, while at the same time shifting the design role to the user. In this context, the issue of how to protect the intellectual property rights of the designer has come up.

Creative Commons is a non-profit organization that releases a suite of licenses that is founded in 2001. These licenses allow an open source model, which is free of charge and used to determine the legal conditions of use, spreading, and re-use of products embracing a broad range of media, including music, literature, images and movies (Katz, 2011).

The owner defines copyright by choosing a set of options to apply to their work. The options consist of four conditions. An icon corresponding to each condition is available for intelligibility (see Table 2.2.).

Table 2.2. *Creative Commons License Conditions (Derived fromCreative Commons Licenses (n.d.))*

Icon	Right	Description
	Attribution (by)	All CC licenses require that others who use your work in any way must give you credit the way you request, but not in a way that suggests you endorse them or their use. If they want to use your work without giving, you credit or for endorsement purposes, they must get your permission first.
	ShareAlike (sa)	You let others copy, distribute, display, perform, and modify your work, as long as they distribute any modified work on the same terms. If they want to distribute modified works under other terms, they must get your permission first.
	NonCommercial (nc)	You let others copy, distribute, display, perform, and (unless you have chosen NoDerivatives) modify and use your work for any purpose other than commercially unless they get your permission first.
	NoDerivatives (nd)	You let others copy, distribute, display and perform only original copies of your work. If they want to modify your work, they must get your permission first.

Creative Commons hosts six copyright licenses, based on combinations of the four conditions at Table 2.3. Besides, CC also provides CC0 that allows licensors to waive all rights and place a work in the public domain without restrictions, it is called "no rights reserved".

Table 2.3. *Creative Commons License Types (Derived from from Creative Commons Licenses (n.d.))*

Icon	Included Conditions	Shortening	Share (copy and redistribute the material in any medium or format)	Adapt (remix, transform, and build upon the material for any purpose)	Commercial Use	Approved for Free Cultural Works
	Attribution	CC BY	√	√	√	√
	Attribution ShareAlike	CC BY-SA	√	√	√	√
	Attribution NoDerivs	CC BY-ND	√	-	√	-
	Attribution NonCommercial	CC BY-NC	√	√	-	-
	Attribution NonCommercial ShareAlike	CC BY-NC-SA	√	√	-	-
	Attribution NonCommercial NoDerivs	CC BY-NC-ND	√	-	-	-
	-	CC0	√	√	√	√

2.6.2. Product Liability

> "Product liability describes an action in which an injured party seeks to recover damages for harm from a seller or manufacturer when it is alleged that the harm resulted from a defective product." (Pine, 2012, pp.94).

In this context, product liability is associated with the occurrence of product defect. The defect can be manufacturer's defect, design defect or a systemic defect (Gookins, 2012). Manufacturer's defect exists during the production process with a deficiency defect (Gookins, 2012). It may be caused by poor materials or human errors in the production process (Pine, 2012). On the other hand, the design defect may consist of incorrect criteria that are taken at the design stage that makes product unsafe and also affects manufacturing. Despite the well manufacturing, the design defect causes the resulting product to be faulty (Pine, 2012). Gookins (2012) explains the last type of defect as systemic defect that involves lack of standards, procedures and insufficient instructions that includes safety warnings. Pine (2012) defines all these as marketing defects. In addition, he mentions a four-stage implementation that can be done separately but sequentially for product liability. The first one is conceptual stage at which design concept is applied. What is meant by design concept is the creation of a process that makes abstraction of the idea of design idea. The second is the pre-production stage, which involves a wide range of issues that must be done before production. Environmental or infrastructural issues, examining of manufacturing processes and materials that will be used for production are done at the second stage, which must be handled before production. Analyzing the development of the pre-production product and prototyping are the activities that are also executed at this stage.

The production stage includes manufacturing and evaluating the product that may cause adjustment to the processes or design before full production. The post-production is the last phase in which revisions of the product that is used in the market correspondingly the evaluation of the processes is done.

The three types of theories that cause an action of jurisdiction of product liability are breach of warranty, negligence and strict liability. The breach of warranty is related to the seller's failure to meet the terms of a promise, claim, guarantee or representation of the product. Negligence occurs when a business does not do or should do something that it should not. Negligence can be done by anyone related with the business, including designer, manufacturer, distributor or seller. If the product defect is in question, strict liability concerns with the manufacturer’s fault.

The fact that the design can be modified or changed in open design makes the end user to share the design responsibility. At the same time, individual production gets the user to involve the manufacturing stage and cause to take the responsibility of it. On the other hand, the designer’s sharing the design online, allowing it to be modified and make it possible to be produced individually, causes not only to share the product design liability but also undertake the responsibility of the distribution part as well.

2.7. Social Aspect of Open Design

In this section, socially responsible design, which is included as a key word in research questions, will be mentioned. Gürdere (2019) gathers the relationship between social problems and related design projects under the title of Socially Oriented Design (SOD). She considers Socially Responsible Design, Design for Social Innovation, Design Activism, Transformation Design and Social Design as approaches under SOD. Among them, Socially Responsible Design and Social Innovation topics are related with open design movement in various aspects and referred briefly in this section.

2.7.1. Socially Responsible Design Approach

The designs that were shaped by the market-driven approach after the Industrial Revolution, addressed human desires rather than meeting human needs (Margolin & Margolin, 2002). This approach, which Thorpe & Gamman (2011) call consumer-led design, evaluates users passively and making production in this direction. In contrast to this design model imposed on large masses, the social dimensions in design are seen in a series of design movements in the 19th century (Davey et. al, 2007). The arts and crafts movement is one of them that was concerned with improving the working conditions of crafts people (Davey et. al, 2007; Gürdere, 2019).

In the following period, alternative approaches were formed against the consumerist approach, in which Papanek (1972) took a prominent role with his discourses. According to Papanek (1972), the designer is the person who recognize, identifies problems that no one notices, provides solutions and develops methods during this process. He mentions that it is a narrow opinion that the designer only designs products for the marketplace. Besides, there should be social and moral judgments about design issue, in this context, there should be concerns about designing something environmental and good for everyone. Focusing on environmental and social issues, this approach differs from the market-based approach and he defines it as designers' responsibility or responsible design. While talking about the responsibilities of the designer, he deals with many issues from transportation to the health sector and speaks of design for needs of people as well as their wants (Papanek, 1972)

Morelli (2007) states that Papanek's (1972) vision is separate from business strategies at the time of the emergence, and from the perspective of the designer, the market-based approach under the influence of the market economy is so dominant that they cannot be close to each other.

On the other hand, in the following years, some developments have caused the views of Papanek (1972) to be raised. The ecological impact of production has led governments to address this issue. Another issue that Morelli (2007) draws attention to is the shift of production and labor force to different regions of the world with the globalization. Unemployment in developed countries has led to an increase in social gaps and inequality, and consequently the emergence of social problems.

Moreover, Margolin & Margolin (2002) state that there are some social needs that are not covered or neglected by market such as eldery needs, health or disability that are described as underserved, vulnerable or marginalized populations. Margolin & Margolin (2002) propose this new paradigm as social design and explains the most important purpose of it as meeting human needs. In this respect, they state that the social approach is not a substitute for the market-based approach, since it concerns socially disadvantaged groups and economically and ecologically weak regions of the world. Morelli (2007) defines this paradigm as socially-responsible design and not only designs but also services contribute to human well-being. Moreover, he points out the potentials of solutions that can provide users with a chance to generate their own solutions. In this context, the goal should be to empower people rather than satisfaction, taking into account the capabilities of users rather than product-based solutions.

Consumers, producers and designers are now being called on to consider the responsibility of their decisions in relation to design objects in a world of diminishing resources and climate change (Melles et al., 2011).

2.7.2. Social Innovation

Among the issues that have been neglected by the design world, design for people with disabilities, and design breakthrough concepts take their part (Papanek, 1972). In this context, he argues that innovative solutions should be sought and gives additive design as an example where additiveness is meant to enhance by making additions to the design

Design practice should become an innovative, creative, interdisciplinary tool that meets the real needs of people. Besides, he also states that design must understand society in many ways and be research-oriented.

On the other hand, Margolin & Margolin (2002), on the basis of the interdisciplinary practice, suggest that the product resulting from the model of social design application meets human needs.

2.7.3. Indications for open design

The relationship of socially responsible design and design innovation with open design can be considered in groups that are interconnected but with different angles.

Free Access

Papanek (1972) states that the most important intervention in social design is to make all kinds of information freely accessible to people, and he also mentioned design participation. In his book, Papanek (1972) did not only mention social responsibility of designers, but also presented one-transistor radio (Tin Can Radio) as an illustrative example (see Figure 2.13.). It is a product that is made by using discarded cans and materials with low budget that can be found in the local area and the construction information is shared. It is a good example of open design in terms of sharing information of design. In addition, it was observed that users also personalized by interfering with the appearance of the product (see Figure 2.14.).

Figure 2.13. One-transistor radio (Tin Can Radio)

Figure 2.14. One-transistor radio with personalization

Individualism

Like the globalizing economy, design cannot deny the impact of individualization (Frascara, 2002). The logic of the market-oriented approach is based on the fact that products are the only tool between manufacturers and users, while the socially responsible design approach is based on a self-serving society in which knowledge and tools work together with those who will use this information to produce their own solutions. In this context, the role of the designer needs to be reassessed and innovative solutions must be produced (Morelli, 2007).

With globalization, large companies have created market segments and directed to local and personal solutions. Morelli (2007) points out that the work of the designers is directed from product design to systematic solutions and emphasized two issues. Morelli's first argument is that design activity is directed towards local solutions, and the second is that designers create new models and provide these solutions. One of these solutions is given as an example of IKEA. The company identified the use as a new stakeholder and handed over the handling and assembly of the product.

Participation

The effect of individuals' participation in the design process has also come to the forefront in socially responsible design as they can convey the needs and experiences of individuals (Caruso & Frankel, 2010). He stated that various systems are needed for the user to benefit from the experience-based knowledge called tacit knowledge.

While Melles et al. (2011) explains the importance of participatory design for socially responsible design, he argues that the ownership of products by designers as well as by users will be more effective in the design solution. The important part is to understand users within their social and economic context.

Many researchers mentioned socially responsible design and addressed social problems and focused on co-design methods (Buchanan, 1992; Caruso & Frankel, 2010). While these methods include interdisciplinary approach, it is also mentioned that users actively participate. Caruso & Frankel (2010) refers to the ‘quality of life’ when referring to design for social need and reminds Buchanan (1992) of the definition that design derives from human dignity and human rights.

On the other hand, Morelli also referred to social quality when talking about social problems. He stated that this can be considered in two groups as the creation of social and individual values and to take an active role in the society and to participate in the development of society. Furthermore, he states that designers can contribute to social and personal development by not being product-oriented but by involving users to the design process.

2.8. Design for Special User Groups

2.8.1. Design Approaches Related with Special User Groups

In the design area, two user groups, called special user groups, are older and disabled; also referred to as unusual or marginal groups (Newell et al., 2011). The place of these user groups in the design process has been discussed under various topics. *Universal design*, *inclusive design* and *design for all* are close to each other and can be considered as understanding the needs of these groups through the design process and the designs can be used by all user groups without modification, adaptation, and specialization (Newell et al., 2011). The fact that the product does not require different designs for user grous can be considered as a cost-effective approach to mass production.

While accessibility is common factor in these concepts, the inclusive design definition states that it meets the needs of the widest or maximum number of people possible (Keates, 2006; Foresight, 2000). What is mentioned here as inclusive design is to design a product that everyone can use instead of a product for everyone and does not require special solutions except in extreme situations. Whereas, design for all adopts one design for all approach (Keates, 2006).

In the universal design process, the product is designed to address the people with the widest range of abilities and to cover the widest possible range of situations (Vanderheiden & Tobias, 2000). Among these, universal design and design for all are seen as to have more add-ons as the needs of specific user groups and addressed more towards the end of the design cycle; however the concept of design for all is not applicable, except for a limited range of products (Newell et al., 2011). Langdon et al. (2014) specify that in order to achieve the quality in the experience of these user groups, product design should be supported as an organizational approach as well as the accessibility of the design. Foresight (2000) adds that a single product for each user may need accessibility features and equipment because it is a difficult target to achieve.

According to Langdon et al. (2014), inclusive design is not only for diversity but also for the fact that design with different groups is effective in guiding users into the design process itself. Interacting with such users can also enrich and inspire the design process (Newel et al., 2011). As another approach, if the product is a prosthesis, 3D printing may be the preferred cost-effective method for customized design.

2.8.2. Using 3D Technology in Prosthesis

Koprnicky et al. (2017) mention that 3D printing manufacturing is increasing in use for prosthetic production since it is customizable, despite having a slower rate than mass production. One of the advantages of using 3D printing techniques in prosthesis production is that it can be obtained quickly by CAD technique. In addition, faulty, defected or spare parts can be reproduced quickly and cheaply (Koprnický et al. 2017). In addition, material quality is also increasing day by day. Prince (2014) also mentions the orthopedics and implant fields as the most promising area of 3D printer technology.

Because each user is unique in prosthetic design, it requires different processes and customization (Elmansy et al.). So mass manufacturing is not needed. Since children as users are constantly growing, prostheses do not allow prolonged use and need to be recovered. Therefore, there is a need for continuous customization and repair, which is even more difficult to achieve in less developed countries because of the narrower possibilities (Elmansy, 2015). Also, the supply of raw materials for 3D printers has been facilitated by internet orders for many regions of the world. In addition, electronic prostheses with complex mechanisms can be difficult to use because of the high weight. Materials used in 3D printers are lighter and cheaper than traditional prostheses. On the other hand, 3D printed prosthesis are less visually developed than traditional prosthesis. As many parts are exposed, they are likely to break or be damaged. The manufacturer's responsibility for the prosthesis produced with open source code is also important and there may be problems in quality control (Elmansy, 2015).

Martinot-Lagarde et al. (2016) state that 3D printed hands fill a large gap despite the need for their improvement. In addition, they also state the psychological and social impact for children aged from 6 to 8-years-old. Childress (2015) emphasizes that having a prosthetic hand increases socialization and confidence by enabling children to perform daily tasks that they cannot do before and to participate in social activities such as athletic exercises. Moreover, the prosthesis acquired at an early age, preferably under 2 years, appears to increase the adoption of the prosthesis in children and perceive it as a part of the body (Ccorimanya, 2019). Ccorimanya (2019) emphasizes that in people with upper limb amputation, feedback shows difficulty in controlling muscle tissue due to a lack of modalities, and therefore early prosthesis contributes to the education of motor control for the child. With all these advantages, 3D technologies and open design can provide suitable solutions for the use of children's prostheses.

CHAPTER 3

METHODOLOGY

3.1. Overview

The literature review has presented content on open design in historical context and in terms of its approaches. On the other hand, to understand how these features and approaches are used and implemented in the real world, it is intended to conduct a case study. It can be defined as a descriptive case study owing to investigating a phenomenon, in this part means using an open design approach in a socially responsible design project, in its real-world context.

In order to find answers to the research questions, the selected field study was conducted with Robotel. Robotel puts open design at the center of the project and develops products with this approach. The open source designs used in the project result in products that benefit the society, thus exemplify a social responsibility design. There is no similar project in Turkey, in which open source design is used, that creates a socially responsible product and contains a development process. Therefore, the study was conducted as a single case via Robotel. Since Robotel interviews were done with experienced people in the project, the information obtained may provide enough evidence for generalization.

Yin et al. (2018) states that the single-case study might be appropriate in some cases and mentioned five rationales that are being critical, extreme and unusual, common, revelatory and longitudinal cases. The first one is selecting a critical case. He referred to the fact that the case in criticism contained elements in terms of the theory or theoretical propositions put forward. However, he also stated that a single-case should be critical in terms of information transfer and supporting theory. It is also important to reach the stakeholders in the project one-to-one, to obtain detailed information about the process and to include the resources to answer research questions as it is a project that combines open design and social responsibility. The second rationale is defined as being an extreme or unusual case. In this sense, the Robotel project using open source code in a social project implemented in Turkey is a rare project. The common feature, defined as the third rationale, describes the situation in everyday life, including situations that may be encountered. The Robotel project uses open source code within the scope of e-NABLE in Turkey. Amniotic Band Syndrome (ABS) is a disease encountered in Turkey as well as all over the world. Therefore, this study also supports the third rationale for the distinction of being common.

In the study, a real-world case that includes a functioning project, the individual stages of the project and the individuals involved in the project and the relationships between them are considered. Thus, it was aimed to be more concrete by moving away from the abstractions mentioned by Yin et al. (2018) (see Figure 3.1.).

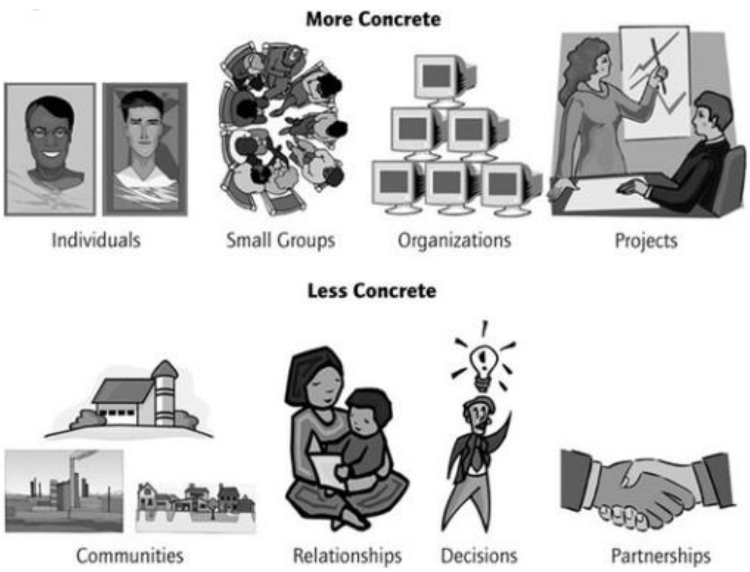

Figure 3.1. Illustrative Cases for Case Studies (Yin et al., 2018)

During the research design, the criteria specified by Yin et al. (2018) (see Table 3.1.) were observed. For this purpose, to provide construct validity, attention was paid to the use of multiple sources of evidence and to ensure reliability, application of case study protocol and creation of a database for all information collected during data collection.

Table 3.1. *Case Study Tactics for Four Design Tests (Adapted from Yin et al., 2018*

	Case Study Tactic	Phase of Case Study in Which Tactic Is Addressed
Construct Validity	use multiple sources of evidence have key informants review draft case study report	data collection
Internal Validity	do pattern matching do explanation building address rival explanations use logic models	data analysis
External Validity	use theory in single-case studies use replication logic in multiple-case studies	research design
Reliability	use case study protocol develop case study database maintain a chain of evidence	data collection

According to Yin et al. (2018), there are six multiple sources of evidence for case studies which are documents, archival records, interviews, direct observation, physical artifacts, and participant observation. Three of the main evidence sources included in the case study plan were used during the study. Documents were collected on the e-NABLE and Robotel official web pages, relevant information, Facebook pages, meeting links, newspaper news, and documents from Robotel. By participating a robot hand family meeting, it was possible to directly observe the relationship between the user and the volunteers. The interviews with the stakeholders in the project took place extensively.

To improve the quality of the case study, some principles should be considered while collecting data. The first principle is using multiple sources of evidence (Yin et al., 2018). Rather than using one reliable source, for triangulation, data collection from different sources makes the work more powerful. In this study, data triangulation has been aimed to be obtained by gathering the information from different sources and interviewing with several stakeholder types.

A case study database aims to help researchers develop a control path from data collection to conclusions through analysis; with the relevant data it contains (Baskarada, 2014). In this research, a case study database, which also the second principle, has been created as an excel file. It stores the resources such as interview questions, interview notes, and files contain the analysis.

Taking into account the other principle of the maintaining chain of evidence, identification of specific data from the case study database is done (see Figure 3.2.).

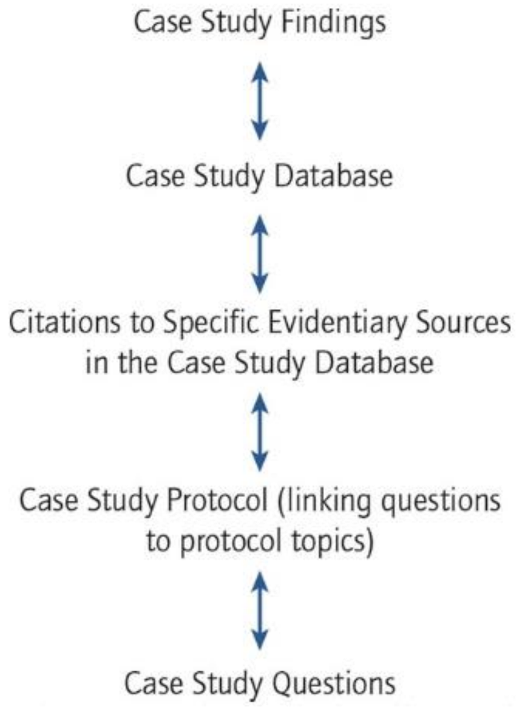

Figure 3.2. Chain of Evidence

3.2. Interviews

Within the case study, three types of stakeholders were selected and data were collected from them by interviewing. Different questions consisting of the topics identified for each stakeholder type were formed (Appendix A, B, C). Interviews are semi-structured and include open-ended questions to enable interviewees respond and to gather detailed information from different perspectives in a conversational manner. The interviews aim to gather information from experiences of stakeholders about open design and their observations about the utilization of it in real life (see Table 3.2.).

In preparing interview questions, attention was paid to focus on research questions and avoid asking leading questions. However, sub-questions were asked if needed during the interview to deepen the response from the interviewee.

Interviews were done face-to-face and conducted in Turkish at offices and comfortable outdoors. At the beginning of the interview, interviewees were asked to read and sign a consent form that explains the study and solicits their participation in the study. However, before the interview started, information about the privacy and confidentiality of the interview was given verbally again. Audio recording was done in each interview to have complete access to information in the analysis process.

Table 3.2. *General Profiles of Interviewees*

Interviewer Code	Gender	Professions	Volunteering Time
Founder	female	Architect	5 years
Volunteer 1	female	Department of Communication Design	4 years
Volunteer 2	female	Electronic Communication Engineering	4 years
Volunteer 3	male	Electrical & Electronics Engineering	3 years
Designer 1	female	Industrial Designer	
Designer 2	male	Industrial Designer	

Hence, Robotel project is selected as the field study and the first interview was conducted with one of the founders of Robotel, ZeynepKaragöz. In addition to being one of the founders of Robotel, she is preferred as an interviewee because of her experiences in the overall process from reaching the users to design, production and delivery. The interview (Appendix A) included 39 questions that were prepared and grouped in 12 main headlines according to their content. The interview was completed in 53 minutes as planned. The second group of interviews was conducted with three volunteers. Volunteers were among the 10 active volunteers working in the Ankara region for Robotel with the most experienced people dominating the process. 14 questions (Appendix B) were prepared and interviews are done at places suitable for them for talking comfortably.

The third group is two industrial design students who made design projects with Robotel from Middle East Technical University Industrial Department. Interviewees were asked 8 main questions (Appendix C) to explain and share their experience during the design process.

The audio recording of all interviews was done with the permission of the interviewees.

3.3. Data Analysis Method

Before proceeding to data analysis, the audio files that contained the conducted interviews were deciphered and turned into text documents and were saved to the case study database.

Two-cycle qualitative research method was preferred during the data analysis of the interviews. In the first cycle, the initial coding method was used. Charmaz (2006) mentions the suitability of the initial coding method for interview transcripts. In the initial coding process, qualitative data are deeply investigated and separate into separate parts (Saldana, 2009). The aim is to highlight the phrases in the document called initial codes.

> "A code in qualitative inquiry is most often a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data." (Saldana, 2009, pp.3)

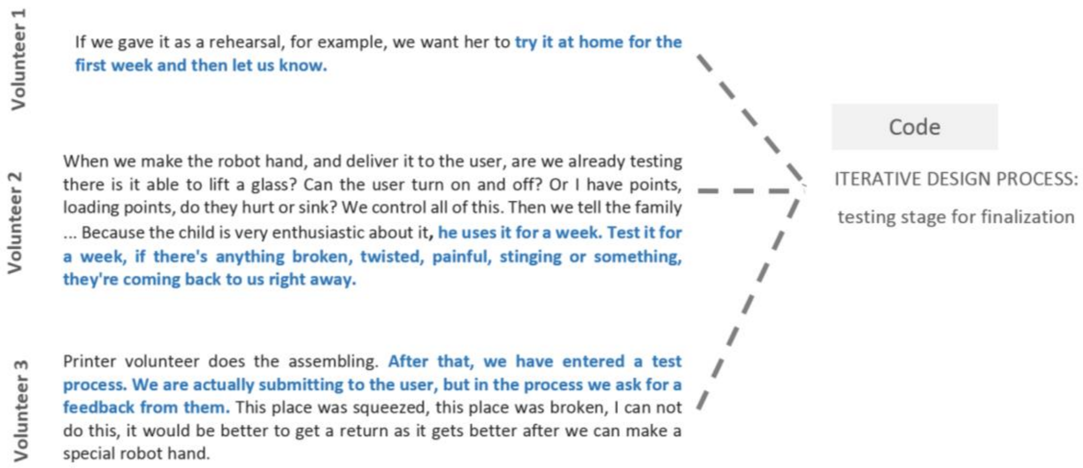

Figure 3.3. First Cycle: Initial Coding Method (Volunteer Interviews)

For this purpose, printed copies of the interview transcripts were obtained and reviewed for the sentences that could refer to initial codes that appeared explicitly (see Figure 3.3. and 3.4.)

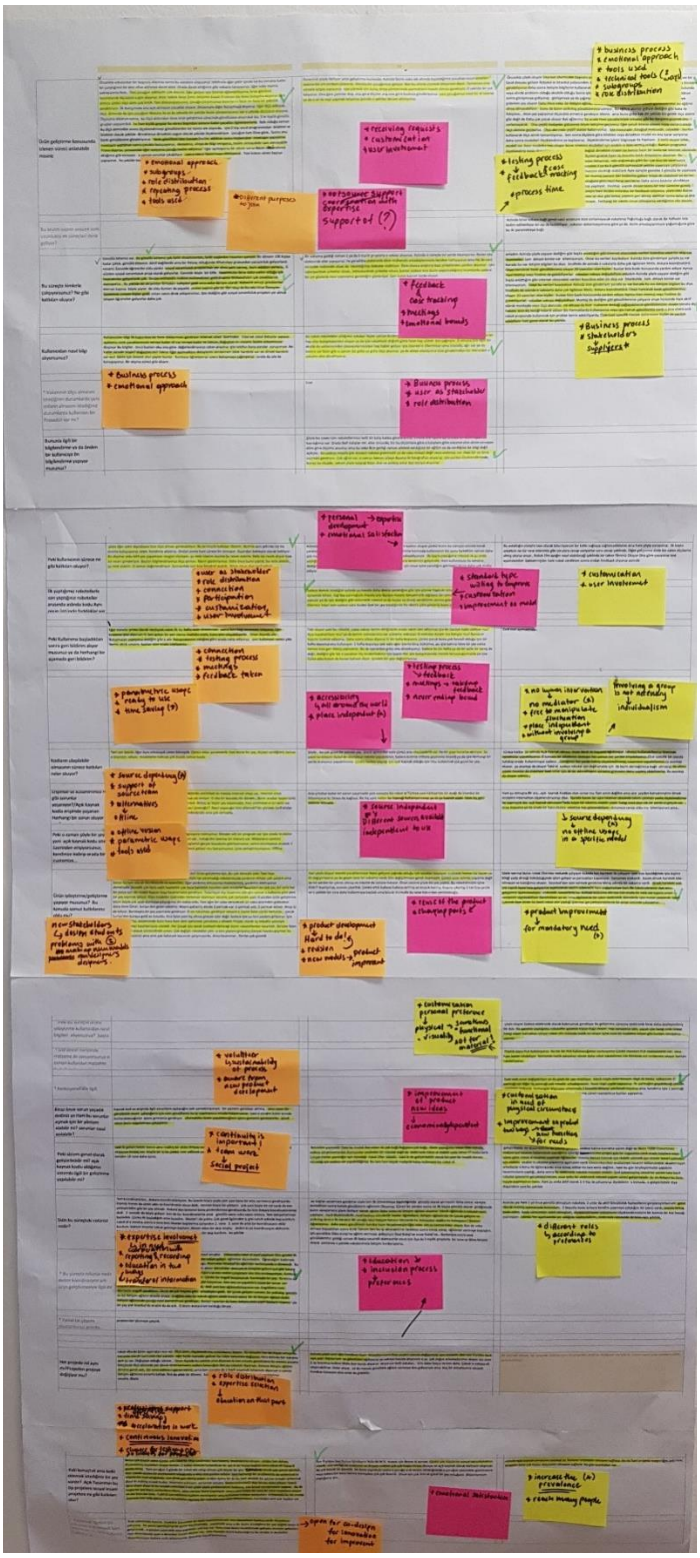

*Figure 3.4.*First Cycle: Initial Coding Method (Volunteer Interviews)

After obtained initial codes were physically marked on the document, a list of these phrases was made. 134 initial codes were obtained from the analyzed text after this process was done one by one for all interview records. Which initial code is extracted from the answer given by the interviewer is marked in the code list (Appendix F).

For the second cycle, the Focused Coding method was used. Saldana (2009) describes Focused Coding as classifying the encoded data, referred to herein as initial code, according to thematic or conceptual similarities to develop categories without drawing attention to their characteristics and dimensions. Therefore, after obtaining the initial codes in the first cycle, they were evaluated according to their contents. Recurrent patterns and codes with associated meanings were identified and sub-themes called categories within the general topic were revealed. 134 codes obtained within the first cycle were collected under 20 categories at this stage (see Figure 3.5.) (Appendix F).

Category:

ITERATIVE DESIGN PROCESS

OBSERVATION: Lack of knowledge about intellectual property rights	√					
PROJECT NEEDS: team for 3d modelling (expertise)	√					
PROJECT NEEDS: documentation	√					
PROJECT NEEDS: education to users' family	√					
PROJECT NEEDS: Lack of Communication channels for feedbacks	√					
PROJECT NEEDS: lack of Tracking mechanism (for users)	√					
PROJECT NEEDS: lack of Tracking mechanism (for volunteers)	√					
PROJECT NEEDS: must be published to enter the literature	√					
OBSERVATION: No publication of a functional design from Turkey	√					
ITERATIVE DESIGN PROCESS: repeating development till robotel fits to user	√			√	√	√
ITERATIVE DESIGN PROCESS: repetition of the needs of the same user	√				√	
ITERATIVE DESIGN PROCESS: taking feedbacks				√	√	√
ITERATIVE DESIGN PROCESS: testing stage for finalization				√	√	√
MOTIVATION: be part of an social organization		√				
MOTIVATION: challenge, willing to improve/develop	√				√	
MOTIVATION: emotional satisfaction	√	√	√		√	
MOTIVATION: social benefit/responsibility	√				√	
PURPOSES: expectations				√		
PURPOSES: motivations (for social responsibility)				√		
OPEN DESIGN: abundance of information			√			

Figure 3.5. Second Cycle: Focus Coding Method –Codes to Categories

After the categories were reviewed, those related to each other in content were grouped among themselves. These groups helped to outline of major and subtitles that form the sections of the field study part (see Figure 8).

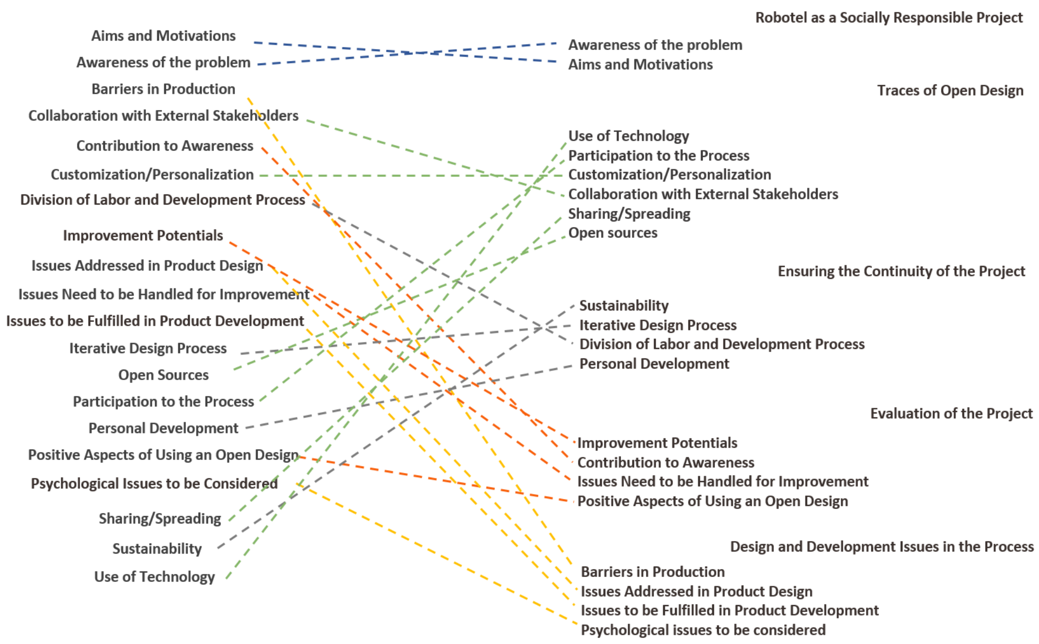

Figure 3.6. Second Cycle: Focus Coding Method – Categories to Outline of Findings

CHAPTER 4

CASE STUDY AND FINDINGS

4.1. What is Robotel?

In 2011, Ivan Owen created a metal, functional puppet hand for a steam punk costume. After posting a video of the hand on YouTube, he got an email from a South African carpenter Richard Van As who had lost his fingers in a woodworking accident. With collaboration on prototypes of a prosthetic hand, they created a replacement finger for him. After Ivan Owen decided to incorporate 3D printing into the design process which paved the way for the creation of the first 3D printed mechanical hand. In the following process, a 3D version of this hand was made for a 5-year-old boy who lives in South Africa who was born with no fingers on his right hand. This inspired the creation of the e-NABLE Community. Instead of patenting his design, Ivan released it to the world with an open source license (Enabling the Future, 2017; Patreon, n.d.).

Robotel is an association that aims to provide 3D printed hands to the needy with a slogan of Turkey's 'Helping Hand' (Robotel, n.d.). While Zeynep Karagöz and her colleagues were investigating how 3D printers known in the community can touch our lives, they came across the 'Enabling the Future' movement.

In 2014, they decided to start the 'Enabling the Future' of the world movement in Turkey. This network takes its name as Robotel Turkey Association in December. The purpose of the association is to provide usable mechanical hands that are produced with 3D printers with special dimensions and qualities for individuals with loss of hand and finger or deformation, especially forchildren withAmniotic Band Syndrome (Sabancı Vakfı, n.d.).

Amniotic Band Syndrome, which prevents the child's congenital limb development, is only one of the orthopedic disorders or accidental limb losses. Prostheses cannot be provided until they are completed because they are an expensive and difficult procedure for children in developmental age. In addition to that, they are constantly developing and the prostheses need to be renewed for this reason. Lack of prosthesis in the developmental age can cause muscle-melting, social, and psychological problems in children.

On the other hand, normal prostheses prevent children from using their muscle strength, causing their limbs to become blunt. Robotel provides a practical, fast and economical solution that mechanically provides finger movement and provides an alternative to prosthesis for children to lead a more comfortable life.

The children move the hands of the robot hand using their wrist and elbow forces. In this way, muscle development is not limited, and even in this way, unused limb pain is reduced over time. Printed in a personalized form from a 3D printer is assembled quickly. There is no medical procedure, the fingers are grasping with the wrist movement.

Robotel Turkey is a non-profit association based in Istanbul. All services are free of charge. The association has nearly 3000 volunteers in different provinces in Turkey (see Table 4.1.). Hands made by Robotel helped to facilitate the lives of about 100 children so far, and they continue to work on many cases (Robotel, n.d.).

Table 4.1. *Enter the Table Caption here*

City	NoV	City	NoV	City	No V	City	NoV
ABD	4	Bartın	1	Hakkari	1	Niğde	5
Almanya	2	Batman	4	Hatay	17	Ordu	4
Aşkabat	1	Bilecik	2	Iğdır	1	Osmaniye	3
Dubai	2	Bingöl	1	Isparta	16	Rize	
Kuzey Kıbrıs	3	Bitlis	1	Kocaeli	79	Sakarya	19
İsviçre	1	Bolu	2	Kahramanmaraş	8	Samsun	22
Toronto	1	Burdur	2	Karabük	23	Sinop	1
Irak		Bursa	54	Karaman	3	Siirt	1
Suriye		Çanakkale	5	Kars	2	Sivas	4
		Çankırı	1	Kastamonu	5	Şanlıurfa	9
Ankara	381	Çorum	6	Kayseri	46	Şırnak	2
İstanbul	1184	Denizli	19	Kırıkkale	4	Tekirdağ	18
İzmir	244	Diyarbakır	12	Kırklareli	4	Tunceli	1
		Düzce	16	Kırşehir	2	Tokat	7
Adana	29	Edirne	13	Konya	16	Trabzon	17
Adıyaman	23	Elazığ	11	Kütahya	9	Uşak	4
Afyon	14	Erzincan	6	Malatya	9	Van	4
Ağrı	2	Erzurum	10	Manisa	21	Yozgat	3
Aksaray	11	Eskişehir	59	Mardin	8	Yalova	4
Amasya	6	Gaziantep	26	Mersin	24	Zonguldak	19
Antalya	53	Gebze	2	Muğla	17		
Aydın	28	Giresun	5	Muş	1		
Balıkesir	12	Gümüşhane	3	Nevşehir	1		

NoV (Number of Volunteers)

4.2. Robotel as a Socially Responsible Design Project

4.2.1. Awareness of the Problem

Robotel started with the search for a project that can serve human benefit with the resources of founders and the potentials they saw in the project. Encountering with the e-NABLE project made them realize that the number of children with Amniotic Band Syndrome in Turkey as high as the number of children in other countries. The physical growth of children with Amniotic Band Syndrome, including adolescence, causes the need for new prosthesis constantly. In Turkey as well as all over the world, high-cost prosthesis is provided after the age of 18. The project aims to solve this problem by assuring 3D printed low-cost prosthesis until the user has his/her permanent prosthesis. Having awareness of the problem is the first step towards responding to human needs, eliminating inequality and thus achieving social quality in the context of a socially responsible perspective.

4.2.2. Aims and Motivations

The project aims to provide temporary prostheses for children in growing age, as well as to make them feel strong by getting them involved in the design process.

> [Founder] [1] Not only meeting their physical needs, but also providing a means to make them feel powerful by coloring those hands and decorating a little in the images of heroes and themes they have imagined; that is our main concern.

Reaching as many children as possible is one of the project objectives. Since the records of children with Amniotic Band Syndrome are not kept, there are difficulties for volunteers to reach children who may be users. On the other hand, to achieve this, potential users can be made aware of the project first. Potential users are reached mostly through the media.

> [Founder] [2] Our primary goal is to make this system efficient and fast, and our secondary goal is to reach as many children as we can.

By increasing the number of educated volunteers and ensuring new volunteers from several cities are also targets for reaching a more organizational structure.

Hatch (2013) associated 'make' and 'change' principals associated with being human in the 'Maker Movement Manifesto'. Moreover, he states that 'sharing' what you make and what you know about making with others is a way of feeling the integrity of a maker.

> [Founder] [3] We, of course, said that we should do this because we can do it.

In this context, the Robotel project includes motivation to share opportunities and resources with others and this provides a significant contribution to the realization of the project.

Moreover, the part that is mentioned in the manifesto is related to the generosity and satisfaction of the human being is the act of 'giving'. ‘Giving’ to someone else is like giving someone a small piece of themselves, which is one of the most valuable products.

> [Volunteer 2] [1] I've been in this project for four years. Because the happiness it gives you rather than the great social responsibility and the saturation point is something very, very different. It is a great beauty to have access to this and everyone as an open source. When you hand over that hand to that child after you do that, the smile or smile on that child's face is more important to me than anything else. Therefore, I think the job we do is a very special and beautiful thing.

On the other hand, being involved in such a project has different purposes from acquiring knowhow to reaching the network in the relevant field.

> [Volunteer 1] [1] Our volunteer audience includes people of different ages from many different disciplines… Usually there were students because there was a condition that the place should be included in the social responsibility project. Because the designers were a little more inclined, the designers came and the mechanical engineers came after that. Also the owners of the printer companies came to search for employees for network purposes. People who have the idea of making prosthesis and want to gain some experience here.

4.3. Traces of Open Design

Robotel is a project initiated by adopting open design and expanded based on its principles. This section focuses on the traces of open design in the project.

4.3.1. Use of Technology

e-NABLE is Robotel's first starting point and used as a source and developed as an open source project. The prosthetic hand designs that are developed by e-NABLE are available as open source at the community's web page and can be produced based on 3D printer technology. Using technology is one of the goals for Robotel.

> [Founder] [4] We were using the 3D printer making several applications, but actually, we were seeking for projects that would demonstrate how this technology is revolutionary and how it will affect the human life.

In the literature chapter, the power of 3D technology over maker movement and open design is mentioned. This is because it has become conducive to personal production. The original design is provided as open source from e-NABLE project and the production is based on 3D printer technology.

Development begins with a preparatory work that includes taking photos of physical characteristics of the user (see Figure 4.1.). Documents obtained by this process are used for modeling and followed by production. Production not only includes printouts from 3D printers but also assembly of them. Because users have physical differences, product development does not end with the emergence of the product. The process is repeated until the adaptation of the product to the user becomes perfect (see Figure 4.2.).

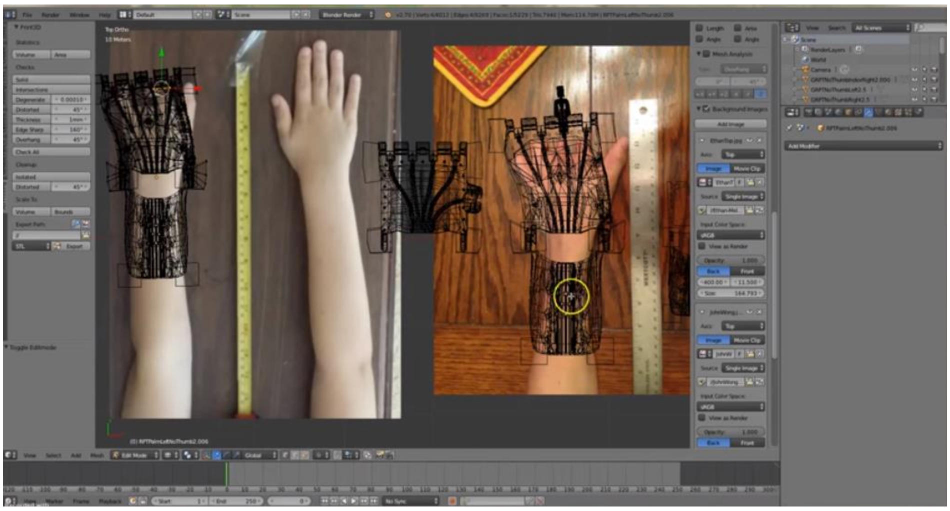

Figure 4.1. Picture of User Taken

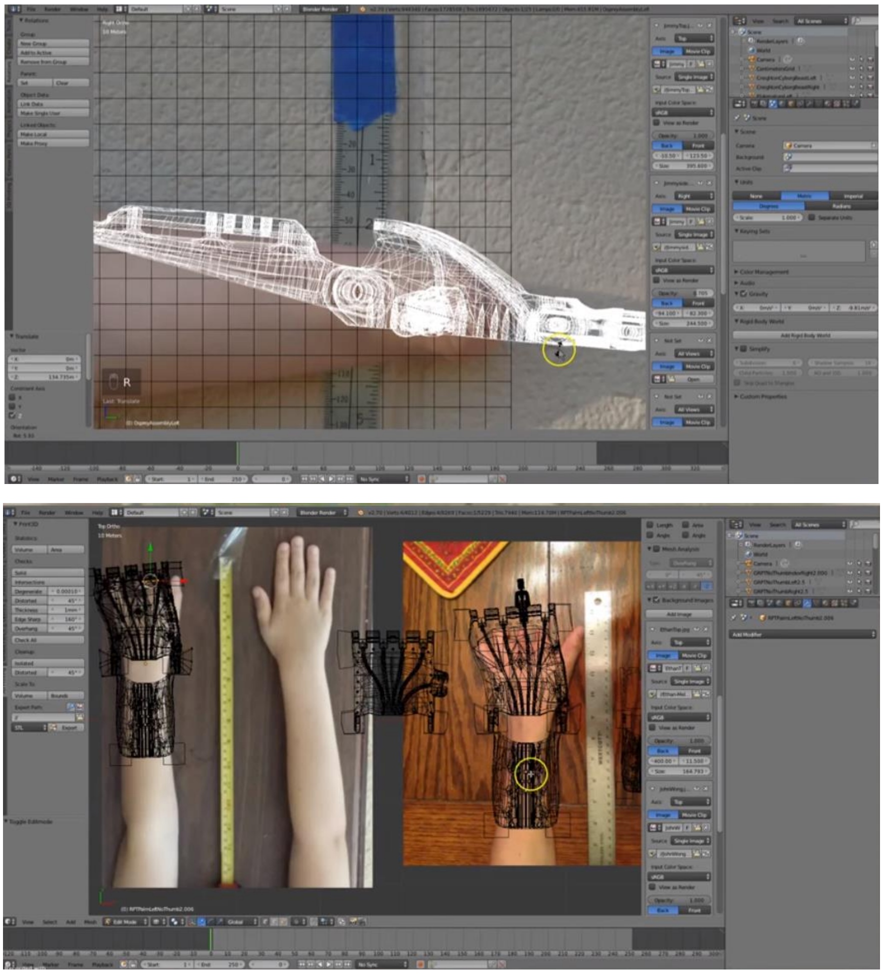

Figure 4.2. 3D Modelling

Another issue related to technology is internet usage. In this context, the internet has made a two-way contribution for Robotel. The first is volunteers’ usage the open design sources of e-NABLE over the internet. Secondly, the internet is also a media channel for reaching new users by publicizing the project and spreading by gaining new volunteers.

> [Founder] [5] If the families allow us to record and share an image or video when we share those it grabs everyone's attention and people want to share them.

Moreover, the internet is also the main resource for finding new open source designs and searching robotic hand topics.

4.3.2. Participation to the Process

Participation in the process is encountered in two different ways. First of them is involving of the user in the part of the process at which visual design decisions are made. This stage is, at the same time, the process of personalizing the product. In addition, the user can also make requests for functionality that can affect design decisions.

> [Volunteer 1] [2] He says his color, I want that color on top of that picture. Maybe he's taking a picture, sending us a picture. We inform from the beginning while taking the measurement, we show the picture. We've done this before, it can be this color, and it can be that color. Then he evaluates. Then he can send us a photo.

The second participation can be observed at the stage in which expert opinion is needed during the product development process. For instance, in the electronic robot hand development process where technical information is needed, experts in the relevant field can contribute to the process by sharing their expertise.

> [Volunteer 2] [2] Sometimes we make electronic hands. And we usually discuss electronic hands with our engineers, but no matter how many engineers we have, we can get stuck. When we do, we seek help from some companies. Whether it's the companies in the Cyberpark or the companies in the Technocity, they just show us the way we can't, and show us how to do it.

4.3.3. Customization/Personalization

As in the Robotel project, it is crucial to customize the products that are used by adapting to the body of the user. There are three main reasons for this situation. First, even in its simplest form, the product needs to meet the basic needs, and for this, its physical size must be suitable for the user. Therefore, it is necessary to determine the type of prosthesis that users need. Besides, e-NABLE (n.d.) states that users must have some physical competence to ensure that the device they design is working properly.

Figure 4.3. Wrist Actuated Type (Enabling the Future, 2018, June 6).

Figure 4.4. Elbow Actuated Type (Enabling the Future, 2018, June 6).

For most design variants, it requires a functional wristband that can be bent at least 30 degrees either direction with a full or partial palm (see Figure 4.3.). The community also provides a small number of designs for those who do not have a functional wrist or a palm (see Figure 4.4.). To achieve this, the product needs to be personalized by a scale taken from the user (see Figure 4.6. and Figure 4.7.).

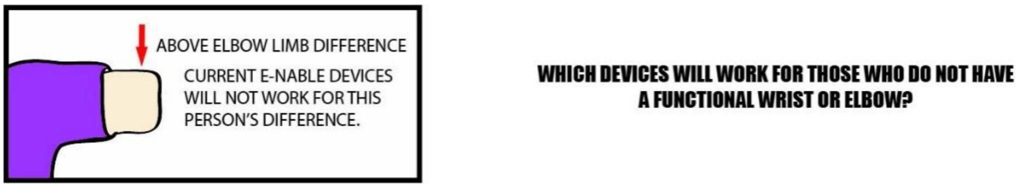

Figure 4.5. Unsupported Type (Enabling the Future, 2018, June 6).

e-NABLE does not have a design for particular situations like above elbow limb differences. At this stage, the community presents alternative solutions regarding other projects like Limbitless Solutions. (n.d.), Open Hand Project (n.d.) and HACKberry (n.d.) (see Figure 4.5.).

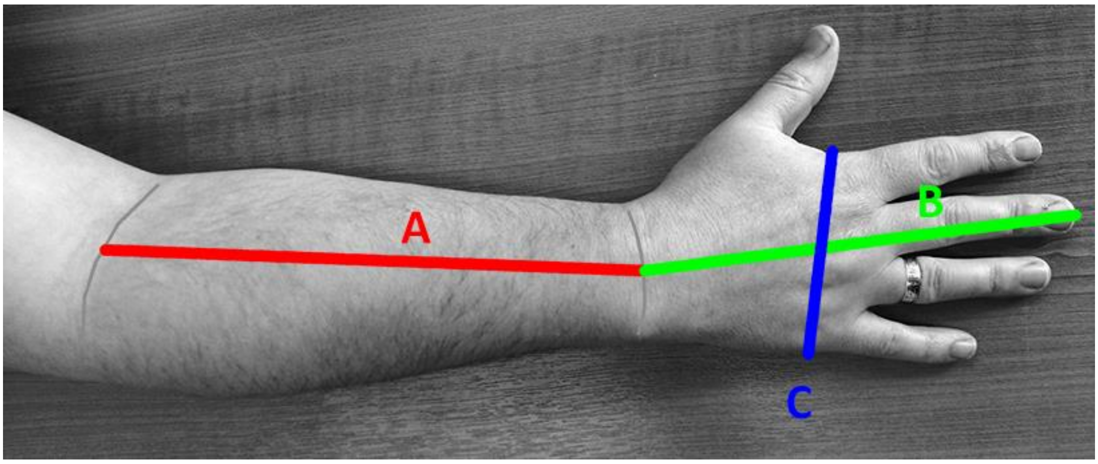

Figure 4.6. Scaling parameters (Robotel n.d.).

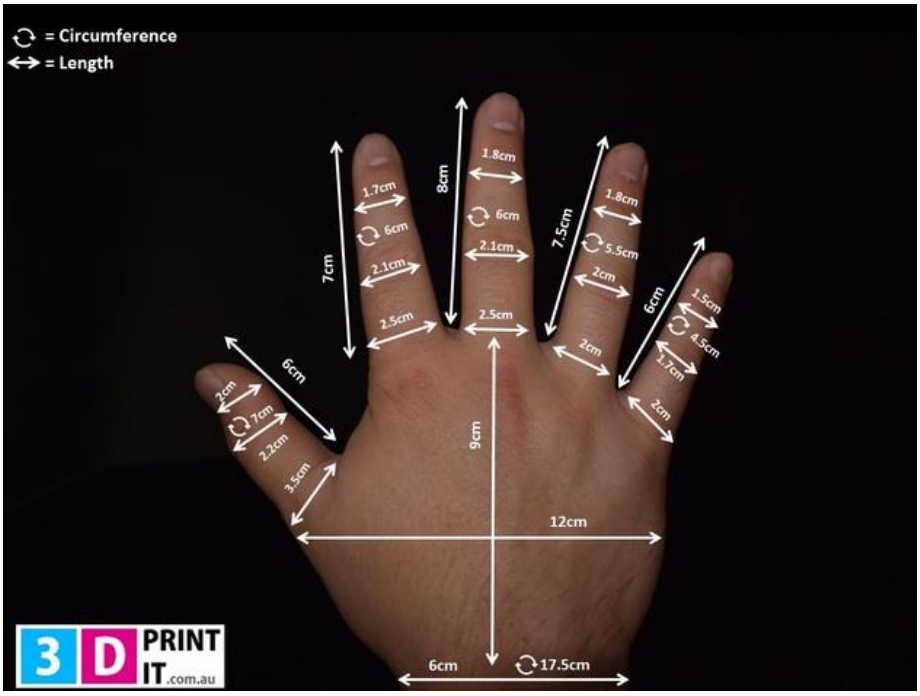

Figure 4.7. Scaling Example (Robotel n.d.).

Moreover, some of the users may not only have physical deficiencies but also abnormal differences. In such cases, the standard model may need to be changed and re-designed to suit the user's form.

> [Founder] [6] He had two fingers in one hand but as they weren't where they should be… A special design was made.

> [Volunteer 3] [1] They can change or something. He has two fingers, not the classic deformation. We do not shape the 3-D file in any fully computerized computer environment so that it can cross two fingers, but we organize it so that we can cross two fingers ourselves.

> [Founder] [7] They saw the 3D printer, they saw the hands, the videos. We talked, chatted and developed a relationship. Eight out of nine changed. We had a 13-year-old girl who didn't want to give video or anything; she wanted skin-tone and had a white skin-colored one made for her. One became Iron Man, one became "My Dear Brother", and one

became Spiderman.

Another issue is the feedback of the user, which allows the development of the product at the design stage. In this part, the user can participate the design process with his/her choices like color, a visual change that can resemble a comic hero or functionality as an idea generation (see Figure 4.8.).

[Volunteer 2] [3] We draw the way procedure according to the request of our children. For example, a child is coming. He says that I want to swim with my hand. We're doing something entirely for him. To swim, you need to have your fingers closed in a stroke. We want a way that way. We take drawings, take measurements and send him to print. In other words, whatever kind of hand our child wants or what he wants to do with that hand, we actually carry on.

[Founder] [8]Yes, I mean for example, one of them wanted it Besiktas-themed. Oooh the black eagles were made, colored, and the hand itself was black and white. Someone wanted Iron Man which was made in bright yello and red. There was one who wanted Fast and Furious; we were confused what to do. In the end made it gray with lightning, on top of it. One of them was a Fenerbahçe fan, so we put yellow and navy blue velcros etc. that kind of stuff...

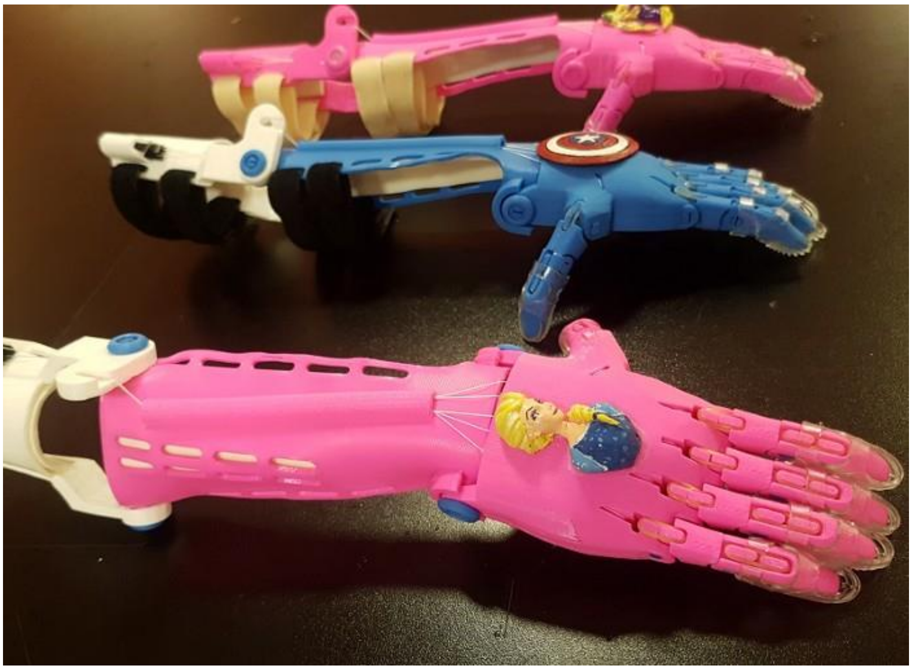

Figure 4.8. Comic Figures Attached Hands (Ideanest, n.d.).

Also, the user can be allowed to intervene himself/herself.

> [Founder] [9] We didn't paint, they painted those themselves. We told them we make it but you paint it, they like that, especially the little ones.

In addition to the need for personalization in this project, some benefits emerge in this process. One of them is user participation that ensures product ownership. Users who make their own choices can adopt the product more quickly. This also reduces expectations and increases the confidence in the product. A kind of co-creation process that is done with the user at the design stage helps to discover new areas and possibilities of usage that provides product diversification.

4.3.4. Collaboration with External Stakeholders

As stated in the literature part, the open design approach involves not only sharing the details of the design but also the design process. Robotel team comes together with different groups in several projects and shares ideas and experiences. These groups can be university communities that choose Robotel as their project (see Figure 4.9, 4.10, 4.11.). Moreover, communities at İstanbul Sabahattin Zaim University and İstanbul Technical University are also collaborating with Robotel to carry out development.

Gebze Technical University (GTU) Student Community members, with the support of Robotel Turkey Platform, have enabled 11-year-old Ali to achieve a Robotel which is a mechanical robot hand.

Figure 4.9. Newspaper article (Özgür Kocaeli, 2018, March 31).

While sharing knowledge and experience during collaboration, technical resources such as 3D printers owned by the Robotel team are also offered if needed. Besides, space sharing can also be done if there is a need for a working environment.

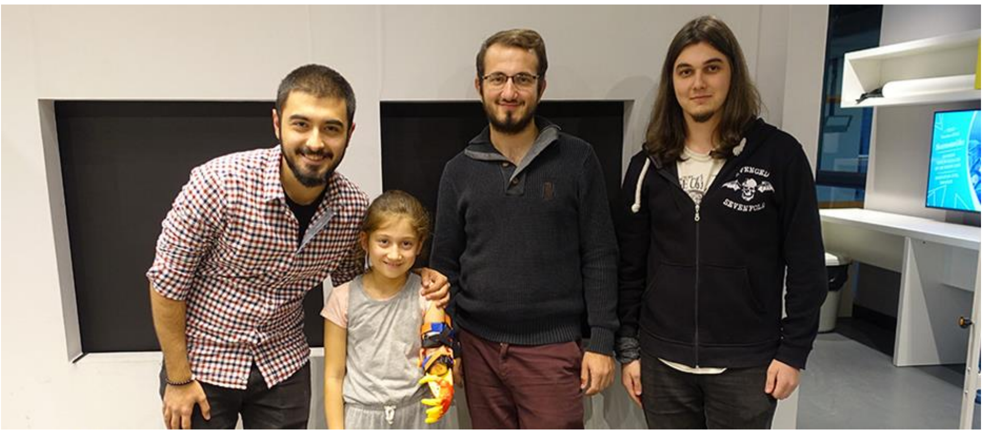

Figure 4.10. The Robotel Project with the contributions of TED University (Corpcom, n.d.).

Figure 4.11. Denizli Newspaper (Denizli Gazetesi, 2018, July 3).

Collaboration is not a unilateral flow; Robotel team is also receiving external support. The increase and improvement of the technical resources used by the Robotel team can be met through activities, campaigns and donations.

[Founder] [10] Apart from that, as I said, last year two graduation projects in METU Industrial Design Department were done about Robotel. At TOBB University, 3rd-grade students designed Robotels for one semester under the leadership of 11 teachers.

[Volunteer 3] [2] Our collaboration in the industrial design department of TOBB University had an application like Sweet finishing project. There, students who had made robotic hand design by hobbies or function. For example, it can be to hold the violin, it can be to swim, it can be to play the drums.

It was stated in the interviews that the collaboration was also with the works carried out with the design departments. Design students working on the Robotel project not only provides detailed information about the project but also raises awareness about humanitarian projects and open design approach.

Since it is a voluntary project, some stakeholders support them using their expertise in different stages and subjects. For example, there are university instructors who volunteer at the Robotel and mentor Robotel volunteer teams or other teams with whom the Robotel cooperates. On the one hand, Robotel project also takes its place in the literature by supporting academic studies.

As mentioned earlier, Robotel is also involved in donation campaigns. Collaboration with various organizations can be done for fundraising campaigns; Türkiye Teknoloji Geliştirme Vakfı (TTGV) is one of them. Robotel took part in the launch projects of IDEANEST which is a donation-based mass funding platform created by TTGV for technology and innovation-based projects (see Figure 4.12.). Platforms such as the IDEANEST can also be used to raise funding opportunities for new projects, such as the purchase of new 3D printers.

Fikir Yorumlar 1 Bütçe Takım 1 İş Takvimi Referanslar Haberler Destekçiler 18 Ayni İhtiyaçlar

DESTEĞİNİZLE EL ELE: ROBOTEL

Biz hiçbir zaman engellerin önümüzü kesmesini sevmedik. Ya üstünden atladık ya eğildik altından geçtik ya da üstesinden gelmenin başka bir yolunu bulduk. Ne olursa olsun mücadeleyi hep çok sevdik. İşte bu ruhu, tüm engelli vatandaşlarımızın yaşam kalitelerini yükseltecek bir fikirle buluşturarak bugün karşınıza çıktık.

Gelişen teknolojiyle engellerin üstesinden gelinebileceğini göstermek için yola koyulduk. Gönüllülerden oluşan ve kısa sürede büyüyen ailemizle; el ve parmak deformasyonu olan çocuklarımıza Robotel dediğimiz mekanik uzuvları 3 boyutlu yazıcılar (3D printer) ile üreterek tamamen ÜCRETSİZ biçimde teslim etmeye başladık.

Bugün, ülkemizin her köşesindeki ihtiyaç sahiplerine, özellikle de çocuklara ulaşıyoruz. Çocuklarımızın yanı sıra; mülteci ve gazilerimizin de içinde bulunduğu yetişkin yaştaki ihtiyaç sahiplerinin taleplerini karşılamak için var gücümüzle çalışıyoruz. Küresel bir hareketin Türkiye ayağı olarak yürüttüğümüz çalışmalarla; proteze erişimi olmayan vatandaşlarımızın hayatlarını kolaylaştırmayı, kendilerini eksik değil 'özel' hissetmelerini ve yaşama sıkı sıkıya tutunmalarını amaçlıyoruz.

Ancak mevcut 3D yazıcılarımız sadece çocukların kullanımına uygun boyutlarda robot el yapmamıza olanak sağlıyor. Daha fazla sayıda ihtiyaç sahibinin derdine derman olabilmemiz için büyük boyutlarda ürün elde edebileceğimiz 3D yazıcılara ihtiyaç duyuyoruz.

Engellerin ortadan kaldırılmasında sosyal sorumlu bir çalışma olan projemize desteklerinizi bekliyoruz.

Robot Ellerle Engeller Ortadan Kalkacak...

Doğuştan gelen uzuv bozuklukları ya da kaza sonucunda oluşan el ve parmak kayıpları nedeniyle pek çok kişi proteze ihtiyaç duyuyor. Özellikle çocukların 18 yaşına kadar protez ele erişimi oldukça sınırlı. Üstelik, çocuğun gelişimiyle birlikte sık sık protez değiştirme zorunluluğu, gelir seviyesi düşük aileleri oldukça zorluyor. Gelişimini tamamlayana kadar çocukların protezden yoksun kalması ise pek çok fiziksel ve sosyal problemi beraberinde getiriyor.

Figure 4.12. Article https://ideanest.org/projeler/robotel-dernegi-icin-3d-yazici-/detay

In the legal field, there are volunteer lawyers who support especially Creative Commons related issues. Assistance is provided for usage or ownership rights other than those specified in Creative Commons.

In addition, some outsourcing experience may be needed in product development. Technical and mechanical solution support can be obtained from companies in related fields (See [Volunteer 2] [2]).

4.3.5. Sharing and Spreading

Since it is a voluntary movement, information sharing takes an important place in Robotel. In this context, Robotel provides basic lectures about developing a robot hand to new volunteers and provides information sharing within the project. Also, the transfer of know-how among volunteers can be considered within the scope of sharing information.

Volunteers create awareness in high schools and universities by organizing activities that explain the project, its content, and processes, while enabling new volunteers to participate and become widespread.

On the other hand, Robotel also shares open source products and videos containing instructions about robot hand make processes on the official website. Besides, knowledge they share, offering them to use Robotel’s facilities and resources like 3D printers with other groups working on robot hands.

4.3.6. Open Sources

The effects of open source usage are observed on the part of both volunteers and designers. The use of the Internet provides convenience for accessing open sources, as well as a variety of auxiliary sources such as videos and e-books. Besides the abundance of resources, the ease of following new developments is one of the opportunities presented by the internet.

Owing to open sources, many alternative design and auxiliary resources can be found and new developments can be followed, while support is also provided among those interested in the same issue.

4.4. Ensuring the Continuity of the Project

4.4.1. Sustainability

The issue of sustainability was discussed in four main groups. These are human resources, financial resources, product tracking, and materials used. The first issue is the evaluation of the use of human resources. Separating volunteers into groups in each case ensures the use of labor that is more efficient and continuous. This business model increases the sustainability of the process.

[Founder] [11] So, the localization once in terms of sustainability issues, I think we have a pretty good role model in e-NABLE side. Because, disassembling the work, increasing the volunteer units and the number of cases we reached within the conditions in Turkey in particular. I think it is an important model in terms of sustainability, but this coordination puts a lot of burden.

The second issue is the search for a more sustainable structure in terms of earning income as a non-governmental organization. By this way, delays due to financial reasons can be prevented.

There is no feedback mechanism after the product is delivered to the user. Therefore, the product is monitored through the individual efforts of the users' families and volunteers. A sustainable structure is needed for product tracking.

[Volunteer 3] [3] We actually deliver it to the user, but in the process we want feedback from them.

[Volunteer 2] [4] We never leave the users we have already received from Robotel. I mean, we do the hand and hand it over, but we always have family meetings once a month, or families are always calling us. Even if it is not a mishap, we always hear from our parents, Zeynep's limb has grown, pain or stinging. Then we either go and take the measure or tell the family to send it to us, we are correcting the hand of that case again.

[Founder] [12] For example, there is no place in our system for now, so if the volunteer follows the case or the case applies to us again, what happened when we went and ended? Is it extended? Is it broken? Does he use? We don't have such a feedback mechanism.

In the project, they use recyclable PLA as the Food and Drug Administration (FDA) approved food material for print. Since there are no tools to produce filament from the material used, they cannot do recycling at this stage.

> [Volunteer 3] [4] We use PLA as plastic. We don't ask what kind of PLA we're going to use. Because we have the standard PLA material.

The fact that only the required part of the robotic hand can be produced is an ecologically sustainable solution.

> [Volunteer 2] [5] We didn't need to change the hand. Because the limb did not actually grow, it was a protrusion from somewhere, and the robot hand hurt on top. We did something like this, we cover the inside of our robotel with eva, we took out its eva. Because it was crushed and became thin. We took out the eva and laid three layers eva and he used it for a while.

4.4.2. Iterative Design Process

The first cycle encountered in the product is presented to the user at the stage where the initial model is made and tested. After the user has experienced the product for about a week, s/he continues with the product if appropriate, if not, with the new robot hand made according to the feedback given.

> [Volunteer 3] [5] After the montaging, we have entered a test process. We deliver the case but in the process we ask for a feedback from us. This place is squeezed, this place is broken, I can't do that, it would be better if it was added. After receiving the return, we can better make a special robotel or return to him, if there is any problem, we continue to give the hand.

Product follow-up can also be carried out through intermittent meetings with families and children. Feedback can be received from users who have experienced the product for a while, and new hand needs can be learned from physically grown users (see [Volunteer 2] [4]).

4.4.3. Division of Labor and Development Process

Volunteers

The development includes encountering users, documentation of physical appearance, assembly, checking for compatibility of the product with the user. Several groups of volunteers carry out these process phases. At this point, it differs from similar works. In the projects that are carried out in other countries, a single group undertakes all the development stages of the product, while in the Robotel project, volunteers take part in a stage according to their chosen field of expertise. This ensures ownership of the product acquisition stages.

Before the role distribution, sub-groups are formed and these groups are assumed to undertake the whole process. The first role in the process is to record the demand at the Robotel center and to create a profile that specifies the characteristics of the user. The volunteers reach the user with the information in this file and confirm the physical characteristics and deficiencies of the user.

> [Volunteer 3] [6] Following the application, an Excel file comes from Robotel s Istanbul branch. We can see the age of the user in advance by looking at this screen file. We then contact the user using their contact information. The questions we ask, which is the lack of arm or hand problem. Then we get them to confirm how old they are.

After the demand is received, a series of different processes and defined roles for each process emerge and each role is performed by a different volunteer. The stage at which volunteer will take part is determined according to needs and their decisions. The processes are taking measurements, scaling/preparing print files, printing, assembly and delivery respectively.

> [Volunteer 1] [3] In the robot hands we have stages. Taking measurements, scaling, modeling, printing. We give these processes to each person.

> [Volunteer 3] [7] We complete the measure-taking. Then we decide whether

to model the wrist or elbow according to the measurements. Then we start to scale the models. Scaling is done with the computer. There are two kinds of wrist model is our ready-made models, e-NABLE gave us for wrist models. We program them and print them to scale. By entering the measurements, we get ready three-dimensional print files. After receiving these files, we forward them to our 3D printer volunteer. After the prints are taken, three-dimensional printer printer volunteers are assembled. After the assembly is done, we have entered a test process; in fact, we deliver it to the case.

In the process, the so-called test phase consists of testing the robotic hand that is produced and delivered to the user for a week. During this period, the user gives feedback on whether s/he is physically comfortable, able to adapt or not. Accordingly, if there are problems, the process starts again from the scaling process. In addition, feedbacks are received also during family reunions.

[Volunteer 3] [8] Although they do not actively take part in the assembly or taking measurements, we have volunteers who can provide us with material support. For example, the dentist supplies us dental tires; we use them on the fingers. Or if we had a surgeon volunteer, he could provide us with probes for use in the electronic robot project.

Some volunteers provide 3D printer and material support even if they are not actively involved in the process. For instance, when a dentist supplies the dental rubber that is used on the fingers, a Surgeon can provide probes for the use in an electronic robot project.

User

Taking and photographing the user's hand or arm takes the first place in the construction of the robot hand. At this stage, relatives of the user can take the responsibility of taking measurements and photographs of the arm to overcome the time problem caused by the intensity of work of the volunteers or not being in the same city. In this way, they get involved at the beginning of the process with a new role.

[Volunteer 1] [4] If the user is out of town, s/he may need to take measurements. This could be one of his greatest contributions.

[Volunteer 2] [6] For example, we could not go to the user because we are too busy, or the user is not available or we are in a hurry. It needs to be done as soon as possible. He has a lot of pain, then we immediately tell the family that we send the photos, here scaling, here and to this extent, holding the ruler or something and telling us they are sending the measure.

4.4.4. Personal Development

The personal development of the volunteers is another issue that plays a positive role in the continuity of the project. One of them is that volunteers gain experience for their preferred subjects, as stated in the division of labor.

[Volunteer 2] [7] The robotel that we did in the first place and of course the robotel that we do now, of course, is the same but of course we have developed a lot on ourselves.

In addition to the development training they received before taking part in the project, communication training is also covered under this topic.

[Volunteer 2] [8] When you enter voluntarily, our processes proceed as follows: technical training and then communication training. In technical training, how to make that robot hand, how to scale it, how to send it to print, in communication training, how to communicate with a child with child development and psychologists. Sitting down? Standing up? We learn these.

4.5. Evaluation of the Project

An evaluation of Robotel project in terms of both the open design approach and socially responsible design perspective is handled in this section.

4.5.1. Improvement Potentials

DIY was considered one of the open design approaches in the literature. Robotel project also aims to improve the project by enabling production to be performed on the user's side.

In addition to improvements in the structure of the project, the product can also be improved. For this reason, studies are being carried out on the development of artificial intelligence and product matching model. However, the design of the product in pieces provides an advantage. In this way, designs can be made for different usage areas.

> [Founder] [13]Nowadays, children need a conductive finger because of the use of tablets, and to one of our children’s prosthesis we applied conductive wire, touching his skin. Prostheses are not conductive because they are plastic, children cannot use tablets and phones, but when we made the thumb conductive, they became usable. There was such a demand and we did.

Not only the parts needed for physical activity but also the parts needed for the use of technology are improved. Besides, since it is an open-source project, developments in the world are followed and product development is provided by adapting these improvements to the product. These innovations can be both visual and functional.

4.5.2. Contribution to Awareness

Robotel has beendealing with children who have Amniotic Band Syndrome, but the records of them are not kept in Turkey. Therefore, it is necessary to raise awareness to increase the number of children that can be reached and helped.

For this purpose, volunteers at Robotel are trying to raise awareness through various activities. They participate in seminars and charity campaigns. On the other hand, they create teams in the institutions they collaborate with, as well as increasing awareness and the number of volunteers.They provide information and material resources for several projects, from academic studies to technological research at universities.

[Volunteer 2] [9] I started to give trainings. Here I am usually going to give lectures to METU College, Final College, Sınav College ...

In addition to explaining the project in every field they communicate, they provide information about the open-source structure that they use and raise awareness in this direction.

[Founder] [14] We, our friends, are telling Robotel where we are called. I mean, if they want us to call for design, or they want to call for training, if they want a 3D printer...

4.5.3. Issues Need to be Handled for Improvement

It is stated that some issues within the project can be improved. The first of these is a monitoring and control system in which the users can follow the status of the users after the product delivery and the processes performed by the volunteers. It can also be useful to identify those who can support and allocate time during the process of having a systematic environment where volunteers can be contacted.Robotel users need a new hand as they grow physically over time. There is a need for a systematic structure where such a process can be followed and feedbacks can be taken. Therefore, the monitoring mechanism is important for both user and volunteer monitoring.

[Founder] [15] As we have difficulty in the continuity and time allocation of our volunteersresponsible for coordination, we are experiencing clogging on the other sides because there is no automatic system. Let us assign this case to this volunteer manually one by one, in what condition at the moment? It has been two months, still no sound…Let's send mail, do not respond again…We need to go after the volunteers as well as the users. That makes us waste a lot of time.

One of the issues needed for support throughout the project is the volunteers who can make 3D modeling. Moreover, there is a need for volunteers who will present a functional new design and enter the literature.It is also expected that it will be an open-source product to be developed by Robotel and that it will find a place in this sense.

> [Founder] [16] Our goal is to see a Turkish design in the list I said, it does not. So we want it…

On the other hand, the shortage of resources is another barrier. Such as, 3D printers capable of producing small sizes are sufficient for younger children, while a larger size printer is needed for the prosthesis of older teens. However, resource needs such as these are met by participating in various campaigns.

4.5.4. Positive Aspects of Using Open Design

The use of open design in the project is positively observed in many aspects. First and foremost, being able to access a wide variety of resources enables independent selection.

> [Designer 2] [1] Since it is an open design subject to the process, it has become much easier to research. In general, the material on the subject is an open source, providing an incredible abundance of resources.

The fact that the open design (at Thingiverse web site) is available with design-ready features makes it easy to manipulate, speed up the work and, on the other hand, time-saving. It also permits that only the required parts of the design can be modified and produced. The same design can be produced as many times as desired provides an important convenience in this project where the user has a test process and need to reproduce.

> [Volunteer 1] [5] Because you have models designed by a very serious team. These are models that have been seriously thought of in every detail, something that speeds up the process. If a person makes a robot hand from start to finish, it will finish in 3 days. So it's a great thing that the child has a robot hand in three days.

This provides a suitable environment for individuals to educate themselves for personal development, to make or improve designs and production who are not involved in the project. However, it increases the project's prevalence differently.

The openness of the design not only allows improvement, but also creates new opportunities for innovation, and, if desired, by adding other stakeholders to co-design.

4.6. Design and Development Issues in the Process

4.6.1. Barriers in Production

Various barriers are encountered in the processes covering the general operation and product development stages of the project. Barriers in product development are based on various reasons such as physical appropriateness for the prosthesis. Lack of the wrist or elbow joint interferes with the suitability of the product. In such cases, it is not possible to make a prosthesis for the user. The physical differences of the users affect the difficulty of the design and therefore the time of completion.

The coordination of the volunteers has an important role in the overall operation of the project in terms of continuity and integrity of the development. In a voluntary project, the time spent by individuals and the resulting delay can be overcome by ensuring coordination between the groups, otherwise, it remainsas a barrier affecting the whole development process.

The economic resource of the project is also an obstacle to be overcome from time to time.Moreover, the fact that the potential users are not recorded also constitutes another situation that needs to be solved which is tried to be overcome by reaching them using various media channels.

4.6.2. Issues Addressed in Product Design

Before designing a whole or part of a product based on open design in this project, detailed user analysis and investigation for understanding user needs must be done because of the user's special situation.

> [Designer 2] [2] I have tried to make a product that can be fitted with a different product for every different use case, for the need. I wanted to design a product where the fingers could be used in a removable way so that they could wear different apparats that they could use while riding bicycles, swimming, or holding cups, playing cards while holding cards, playing cards, and solving problems.

Since children are concerned, finding solutions to their problems and needs and providing functionality are evaluated and taken into consideration in the design process. In terms of usage, both the robot hand and its designed parts are easy to put on and off. Besides the user side, the production is done using 3D printers has also affected the design decisions from various angles.

> [Designer 1] [1] For example, there was an apparat that helped to make printing, and there were apparatuses that could shape the dough while playing. All children can use on their own without the help of their families…

Considering that the production is done individually, examining the 3D production techniques, designing the parts that can be easily produced and assembled, and investigating the effect of the properties of the raw material used within the production are the subjects considered from the perspective of the designer.

It is stated that individual production and usage of 3D printer production techniques are determining factors in design decisions. Moreover, it provides personal development for the designer.

[Designer 1] [2] I also learned a lot about production using 3D printer user.

[Designer 2] [3] I can tell you that it is very efficient for children to produce a product that they can use one-on-one and which they can consume and change very quickly, and especially to define the place of 3D printers in open design. The entering of 3D printers into our lives is a very critical point of open design, because it allows people to produce something in the house to share the resources of the production at home, it was very productive information for me and in general I had the chance to test it personally.

[Designer 2] [4] But as I said, if it is something that the end user cannot produce, it is very difficult to find a place in the system because doing open source will not make a huge profit for any party.

4.6.3. Issues to be Fulfilled in Product Development

The first stage of the development process is to obtain user information from the coordination center in İstanbul. The first meeting for taking measurements is carried out by volunteers who have received communication training considering the vulnerability of the user. Choosing the appropriate design for the user depends on the physical conditions of the user. Besides, visual preferences are taken from the user.

After the product is tested by the user for a week, feedback is received, if the product does not fit the user, the scaling process is repeated and the production process is performed. However, some physical conditions do not allow the product to be used, thus preventing product development. Visual preferences may lead to changes in the product, while physical properties may require improvements.

It has been shown by the fact that many different designs are available, in which some cases lead to information pollution and that unapproved (unsuccessful or designed by inexperienced people) designs lead to failure of the final product. It is stated that design models used in development are standard models chosen by them.

[Volunteer 1] [6] We do not print unless you approve e-NABLE. There are open source sites that try any asisstant device from those sites and if you try to download them, you will probably have problems. One part does not fit the other; you are having a problem with the installation. We already have a model that we use as Ankara. Initially, we tried other models. We have chosen the model that we think is the most polite, the lightest, the most similar, the most likely to the real hand.

Moreover, the importance of determination of standards like PLA usage as a flament and control mechanism has importance for a successful development.

4.6.4. Psychological Issues to be Considered

The awareness of users' vulnerability is also a matter of psychological importance. The fact that the user is a child has necessitated the consideration of the psychological effects of both the design of the product and the development process.

[Volunteer 1] [7] We meet the user we invited. If the user is positive, the child's approach is very important to us. If he can come and have fun with us, if we get a little closer, we will take his measure that day. But we looked a little challenging, connection was off, then we're throwing the second meeting because the taking of the measure is very critical. So you touch it, you draw the bier to the child; it requires a lot of intimacy. There are children who are not open to her on her first date.

The fact that the product design is not in real hand form is emotionally acceptable to the user against environmental interpretations, which has influenced the design.

[Designer 1] [3] I spoke with an academician who is a child psychiatrist. What you need to pay attention and so on, this kind of a research. How it is acceptable to children, or how friends can react to something that doesn't look like a hand. That's why I wanted to see a psychiatrist.

The awareness of the vulnerability of the users when volunteers are first contacted with the user is also a matter of psychological importance. For this purpose, the volunteers who will contact the user first are required to receive communication training prepared by the Ankara team as a local solution. Relevant training is provided by a psychologist who is also a volunteer and she participates in the project in this way.

> [Volunteer 1] [8] When the volunteers contact the child, s/he freezes near the child. Look at the child's hand and why that prosthesis does not work, can not even examine it, is afraid. Because the university student, s/he does not know what to do... Because encountering a disabled person is a different thing. When I said I have such a problem with, what I can do, a psychologist volunteer said I'll come. She examined, said that training was needed. With a child development specialist, a psychologist volunteer, we have added communication training. There are two trainings, one technical training and one communication training. In communication training how to treat children is told.

4.7. Discussion

Findings from the interviews have made some subjects more prominent than others and have given some insights. These issues will be discussed below.

Sharing

Share, give, participate and support are among the principles in the *Maker Manifesto* mentioned in the literature, which can touch on socially responsible design.

Table 4.2. *Indications of Sharing*

	F	D1	D2	V1	V2	V3
SHARING: giving lectures at schools					√	
SHARING: sharing knowhow in person				√	√	
SHARING: sharing knowhow with reporting and recording method				√		
SHARING: sharing design as open-source	√					
SHARING: sharing facilities and resources with other groups working on robot hands	√					
SHARING: sharing knowledge with other groups working on robot hands	√					

In the interviews conducted, sharing is encountered in various ways (see Table 4.2.). Four of these are on the transfer of the know-how. In addition to this, sharing of the spaces and resources such as 3D printer and open design are mentioned.

Meta Design

While mentioning about the positive aspects of open design, Mul (2011) mentions that, the designer should redesign not only the design but also the design activities themselves. In this context, he defines the future designer as a database designer called meta-designer who is more than designing an object. A meta designer can make the user become a co-designer by shaping environments where even if unqualified users can design their own objects (Mul, 2011). However, Fisher and Scharff (2000) state that meta design includes activities that allow users' participation and contribution to personally meaningful activities. In addition, talking about the concept of meta design, they stated that open systems are evolvable.

Table 4.3. *Related Codes with Meta Design*

	F	D1	D2	V1	V2	V3
COLLABORATION: get support from design owner team				√		
CUSTOMIZATION/PERSONALIZATION: usage of parametric design				√	√	√
OPEN DESIGN: accelerating in work				√		
OPEN DESIGN: allows individual development without being included in a group						√
OPEN DESIGN: enables continuous innovation				√		
OPEN DESIGN: free to everyone					√	√
OPEN DESIGN: free to manipulate						√
OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√
OPEN DESIGN: open for innovation				√	√	
OPEN DESIGN: ready to use				√		
OPEN DESIGN: time-saving				√		

In Robotel project, an interface provided by Thingiverse (see Figure 4.13.), in which parametric input allowed, is used for scaling the design for customizing and obtaining the print file. In this sense, the owners of the design provided the environment for users, in this case volunteers, in which they can change the design in detail and give support in case of need.

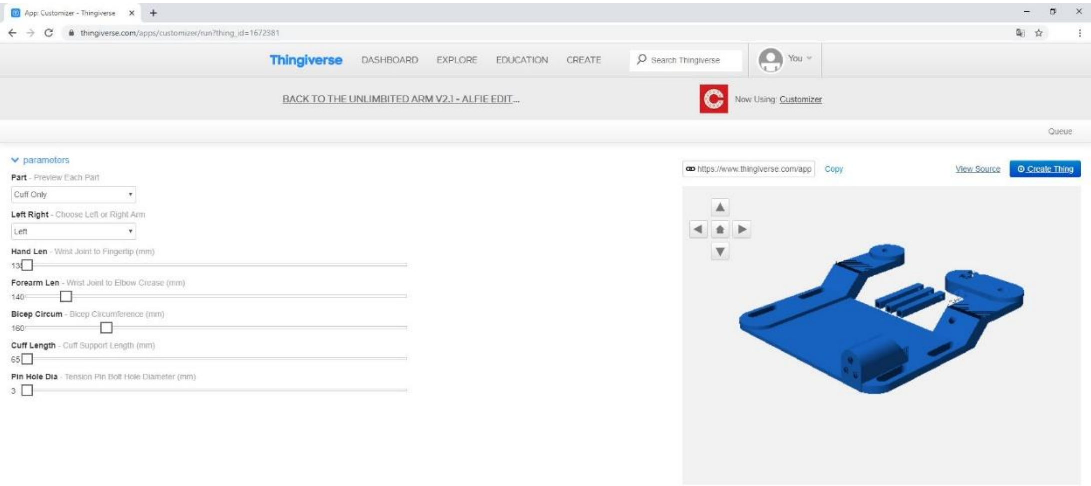

Figure 4.13. Thingiverse web page where parameter entries are made

In this context, design products supplied by e-NABLE project are a kind of meta-design concept. Besides, Robotel volunteers aim to improve the existing ones and develop new products, which can be done using the enhanceable feature of meta-design (see Table 4.3.).

Most Rated Codes

Table 4.4. shows the codes used four times and over. According to this, among the volunteers and designers within the project, the most mentioned codes are to make

customization/personalization according to the visual and functional preferences of the user and associate open design with improvement.

Table 4.4. *Most Rated Codes*

	F	D1	D2	V1	V2	V3	
OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√	5
CUSTOMIZATION/PERSONALIZATION: Visual and functional preferences	√	√		√	√	√	5
DIVISION OF LABOR: role distribution among volunteers	√			√	√	√	4
IMPROVEMENT: new functions, physical restrictions, new physical needs, new model		√	√	√		√	4
ITERATIVE DESIGN PROCESS: repeating development till robotel fits to user	√			√	√	√	4
MOTIVATION: emotional satisfaction	√	√	√		√		4
STAKEHOLDER: donators	√			√	√	√	4
TEAMWORK/SUBGROUPS: creating subgroups for each user	√			√	√	√	4
TECHNOLOGY USAGE: using open sources on the internet	√			√	√	√	4

In addition, the organizational structure in the development process is included in the codes 'DIVISION OF LABOR: role distribution among volunteers' and 'TEAMWORK/SUBGROUPS: creating subgroups for each user'. 'DIVISION OF LABOR: role distribution among volunteers' is to create a division of labor within these groups, taking measurements, scaling using open design, printing, and delivery. 'TEAMWORK/SUBGROUPS: creating subgroups for each user' for each user mentioned in the development process of the average of four groups of sub-groups to create the product until the delivery of all stages is provided by the volunteers in this group. The repetition of this process is indicated in the 'ITERATIVE DESIGN PROCESS: repeating development until robotel fits to user ' code.

Fisher and Scharff (2000) state that it requires motivation from being active in information sharing communities, taking part in activities such as the desire to participate in design activities that shape lives. This motivation exists for volunteers who take on the role of design because of Robotel's being an association.

‘MOTIVATION: emotional satisfaction’ code that draws attention to the table is also a. According to this, emotional satisfaction stands out as a socially responsible design project compared to other subjects.

In an open design project, the use of technology is inevitable, as shown in the code 'TECHNOLOGY USAGE: using open sources on the internet'.

Open Design and Ease of Access

Volunteers mentioned that the use of open design is easily accessible on the internet; while it is stated as easy access to information and support for designers under open source (see Table 4.5.).

Table 4.5. *Connection between Open Design and Ease of Access*

	F	D1	D2	V1	V2	V3
OPEN DESIGN: ease of access through the internet	√				√	
OPEN SOURCE: easy to reach information and support		√	√			

Related Codes with Open Design

The topic of open design was associated with the codes shown in table 4.6. among the interviewees within the Robotel project, and it was most likely to be open to improvement by the ‘OPEN DESIGN: open for improvement, provide product improvement potential’ code.

Table 4.6. *Related Codes with Open Design*

	F	D1	D2	V1	V2	V3	
OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√	5
OPEN DESIGN: availability of information covering different aspects		√	√				2
OPEN DESIGN: Ease of access through the internet	√				√		2
OPEN DESIGN: free to everyone					√	√	2
OPEN DESIGN: no human intervention					√	√	2
OPEN DESIGN: open for innovation				√	√		2
OPEN DESIGN: space independent access					√	√	2
OPEN DESIGN BENEFIT: reproduction as required				√			1
OPEN DESIGN/OBSERVATION: increase the project's prevalence						√	1
OPEN DESIGN: abundance of information			√				1
OPEN DESIGN: acceleration in work				√			1
OPEN DESIGN: allows individual development without being included in a group						√	1
OPEN DESIGN: alternative sources				√			1
OPEN DESIGN: educational for individual production						√	1
OPEN DESIGN: emerging new open sources (like books)				√			1
OPEN DESIGN: enables continuous innovation				√			1
OPEN DESIGN: free to manipulate						√	1
OPEN DESIGN: independency of using different sources				√			1
OPEN DESIGN: open for co-design				√			1
OPEN DESIGN: ready to use				√			1
OPEN DESIGN: time-saving				√			1

Indications of Innovation and Improvement

As in the Robotel project, sharing and openness are of great importance in a project based on open design. As Mul (2011) underlines, open design is closely linked to the rise of computers and the internet. The use of the internet provides the opportunity to improve by the connection with both the e-NABLE project on which the project is based and the new technologies that can be used in the project (see Table 4.7.).

Table 4.7. *Indications of Open Design for Innovation and Improvement*

	F	D1	D2	V1	V2	V3	
OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√	5
OPEN DESIGN: open for innovation				√	√		2
OPEN DESIGN: enables continuous innovation				√			1
OPEN DESIGN: free to manipulate						√	1

Indications of Tracking

Using open design has allowed Robotel to assume the role of the user while at the same time being the designer of the product. In addition to the development advantage mentioned above, it can reveal some issues taken into consideration. As the ownership of the product belongs to the user, it is also the responsibility of the development. The realization of the two is closely related to the motivation of the designer involved in the project and the success of the product development process. At this point, as Robotel aims, a sustainable business model for communication is needed (see Table 4.8.).

Table 4.8. *Indications of Tracking*

	F	D1	D2	V1	V2	V3
PROJECT NEEDS: Lack of Communication channels for feedbacks	√					
PROJECT NEEDS: lack of Tracking mechanism (for users)	√					
PROJECT NEEDS: lack of Tracking mechanism (for volunteers)	√					
PROCESS TIME: depends on time allocated by volunteer and complexity of the case						√
BARRIERS IN PROJECT: Limited time allocated by volunteers	√					
BARRIERS IN PROJECT: Problems in coordination	√					
BARRIERS IN PROJECT: delays in communication among volunteers	√					

DIY for Families

DIY was considered one of the open design approaches in the literature. Robotel project also aims to improve the project by enabling production to be performed on the user's side (see Table 4.9.).

Table 4.9. *Related Code with DIY for Families*

	F	D1	D2	V1	V2	V3
PROJECT NEEDS: education to users' family	√					

In addition to improvements in the structure of the project, the product can also be improved. For this reason, studies are being carried out on the development of artificial intelligence and product matching model. However, the design of the product in pieces provides an advantage. Not only the parts needed for physical activity but also the parts needed for the use of technology are improved (see Table 4.10.).

Indications of Improvement and Innovation

Besides, since it is an open-source project, developments in the world are followed and product development is provided by adapting these improvements to the product. These innovations can be both visual and functional (see Table 4.11.).

Table 4.10. *Indications of Improvements on Product*

	F	D1	D2	V1	V2	V3
CUSTOMIZATION/PERSONALIZATION: intervention for needs	√					√
IMPROVEMENT: for making revisions				√		
IMPROVEMENT: new functions, physical restrictions, new physical needs, new model		√	√	√		√
IMPROVEMENT: new versions of the products				√		√
MOTIVATION: challenge, willing to improve/develop	√				√	
OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√

Table 4.11. *Codes Related with Following Innovations*

	F	D1	D2	V1	V2	V3
OPEN DESIGN: finding alternative sources				√		
OPEN SOURCE: availability of different sources, additional open sources(videos)				√		√
OPEN SOURCE: easy to reach information and support		√	√			

Barriers Associated with Online Systems

As mentioned before, e-NABLE website provides open-source models and an interface where the measurement information of the user is entered parametrically and scaled. In this context, the Robotel volunteer who plays the role of the user is presented with a system that he can design from a design. However, since this system is online, Robotel is also affected by any kind of interruption (see Table 4.12.).

Table 4.12. *Barriers Associated with online Systems*

	F	D1	D2	V1	V2	V3
BARRIERS IN DEVELOPMENT: no offline usage in some models						√
BARRIERS IN DEVELOPMENT: online source dependency				√		√

Participation and Collaboration

The participation mentioned in the literature chapter appears in many ways in the Robotel project (see Table 4.13.). The first is the relationship with the user of the product. At this stage, the user participates in the product with the needs arising from physical differences and personalization preferences. Moreover, if the user is in another city or there is a time constraint, he is also involved in the measurement part.

Table 4.13. *Codes Related with Participation*

	F	D1	D2	V1	V2	V3
PARTICIPATION: user including with actions like painting	√					√
PARTICIPATION: user				√	√	√
DIVISION OF LABOR: user taking measurements				√	√	
CONNECTION WTH USER: receiving needs				√	√	√
CUSTOMIZATION/PERSONALIZATION: Visual and functional preferences	√	√		√	√	√

Secondly, the product's openness to development makes it easier for people from different disciplines to contribute. In the process of designing until obtaining a physical product, we encounter the concept of openness at various stages. Openness to the product helps people with technological infrastructure to improve the product in this direction. Adding AI technology is an example of this. Persons and institutions that support the proper usage and use of CC licenses also participate in the project with their expertise (see Table 4.14.).

Table 4.14. *Codes Related with Collaboration*

	F	D1	D2	V1	V2	V3
COLLABORATION: experts of intellectual property rights	√					
COLLABORATION: get support from design owner team				√		
COLLABORATION: universities /design students	√			√		
COLLABORATION: with other communities	√					
STAKEHOLDER: expertise support in different parts	√			√	√	
STAKEHOLDER: donators	√			√	√	√

CHAPTER 5

CONCLUSIONS

This chapter presents an overview of the study and reveals conclusions based on the research questions. Besides, the limitations of the research and recommendations for further work are mentioned at the end of the chapter.

5.1. Overview

In this thesis, firstly, an overview of industrial revolutions, the place and development of open design was examined based on the literature. Furthermore, the existing approaches and features have been grouped and reviewed to understand the concept of open design. The effects of open design were evaluated in the context of intellectual property and product responsibility.

Following the literature review, a case study was presented. In this part, interviews were conducted to investigate how open design is handled in a project in which socially responsible design is used. Interviews findings were evaluated and used in qualitative data analysis. The main topics that emerged from the data evaluated with two-stage cycle were examined with an open design approach in order to find answers to the following questions.

How can open design be utilized in socially responsible design projects?

The most intersecting part of socially responsible design and open design is that one aims to benefit people and the other creates a suitable environment for it. As seen in the discussion section, Robotel project contains the principles specified in the literature. It was observed in the project that access to resources is open and reproducible due to openness and sharing principles. Besides, the resource used can be changed to some extent and allow customization to allow users to reflect different physical characteristics and personal preferences. In terms of the digital technologies used (3D printing, internet network), it provides an alternative that facilitates sharing and reproduction, since it allows small-scale production and provides a resource that is understandable to those who are familiar with the technology used. In these senses, open design offers an alternative that can be evaluated in terms of social responsibility and facilitates its applicability.

What are the potentials of open design approach from the standpoint of social responsibility?

Using personalization not only meets the users' needs but also the physical needs that emerge lay the groundwork for new design ideas. This provides the development of the designs that are openly used and then shared with similar projects and users later. This supports innovation and improvement of life for the human being, which is targeted by the socially responsible design. Another potential issue in the project is co-design, which involves sharing the resources mentioned in the literature, such as facilities and knowhow, as well as saving time.

How can open design approach be improved from the standpoint of social responsibility?

A certain level of technical knowledge and skills required for the use of digital production tools distracts from the claim that open design is accessible to all. As a result of the research, it was observed that this was also evaluated by the project team and for this purpose, first of all, training was provided to volunteers. Moreover, it is stated that the training for the user families has been put forward as a target.

The use of open design through digital network has the advantage of space-independent access to the product information, while at the same time necessitating the availability of the resource at all times. In case the resource is not available or inaccessible, interruptions may interfere with product development. As a result, the design can remain open as well as the open source of design remains open.

Participation in different roles, and some cases geographically separated locations, requires a sustainable business model. At the same time, additional factors can be envisaged depending on the time required for each product or the availability of production resources. If these are organized in a systematic way, more efficient production can be achieved.

Who are the main stakeholders of open design and in which ways are they involved in a socially responsible project?

In the literature chapter, the roles of the designer, the client and the user that are explained in the old view are strictly separated (see Figure 2.11.). In the new view (see Figure 2.12.), the responsibilities of the roles are diversified and the distinction has become blurred. In the Robotel project, we see the role changes mentioned in the literature in the process of product creation and it shows that new roles and processes defined in the implementation of the open design model are possible, such as the participation of users in the design process or volunteers' use of resource design as a user. At this point, Robotel side uses open design models that are supported by e-NABLE as a user. Then, redesigns, improves in the development process as a designer, manufactures, and delivers the physical product as a client. We see that the user takes on the role of co-designer in the design stage and the user's family participate in the process in the measurement part in case of need (see Figure 5.1.).

On the other hand, open design makes an open-ended product description that changes in the hands of different actors in the process and thus does not end with the design stage. The first thing encountered in the project is the distribution of roles among the volunteers in the emergence of the product. Secondly, it has been observed that the collaboration created with the local and global relations network supports the opportunity for the realization of the open design model.

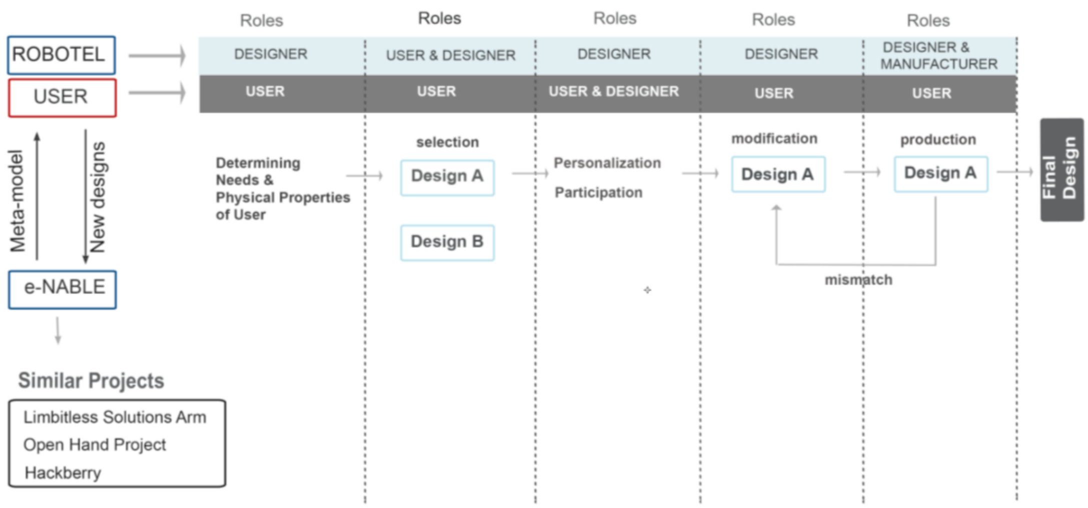

Figure 5.1. Development Process

5.2. Limitations and Recommendations on Further Work

The interview for the case study covers the Robotel project. Robotel is an association that studies in Turkey. This research collected information on how socially responsible project and open design could be carried out together and the interviews conducted for this purpose was supported by various evidence. In this context, users can also be included to the research or a comparative research with similar projects in the world besides Robotel can be done as a further research.

REFERENCES

Abras, C., Maloney-Krichmar, D., Preece, J. (2004). *User-Centered Design. In Bainbridge, W. Encyclopedia of Human-Computer Interaction*. Thousand Oaks: Sage Publications.

Abdelkafi, N., Blecker, T. and Raasch, C. (2009). "From open source in the digital to the physical world: a smooth transfer?", *Management Decision*, Vol. 47, pp. 1610-1632.

Aitamurto, T., Holland, D. & Hussain, S. (2013). Three layers of openness in design: Examining the open paradigm in design research. *In Proceedings of ICED 2013* (August 19–22, 2013) (ed. U. Lindemann et al.), 1, 179–190.

Aitamurto, T., Holland, D., & Hussain, S. (2015). The open paradigm in design research. *Design Issues*, 31(4), 17-29.

Al-Ahmari, A. M. (2017). Direct Digital Manufacturing. *J. King Saud Univ. - Eng. Sci.*, 29(3), 203.

Aliverti P., Maietta, A., & Justo, P. D. (2015). *The Maker's Manual*. San Francisco, CA: Maker Media, Inc.

Anderson, C. (2012). *Makers: The New Industrial Revolution* (pp. 17-19). New York: Crown Business.

Atkinson P. (2006). Do It Yourself: Democracy and Design, *In Journal of Design History*, 19(1), 1–10.

Avital, M. (2011). The generative bedrock of open design. *Open design now: why design cannot remain exclusive* (pp. 48-58). Amsterdam: BIS Publishers.

Balka, K, Raasch, C, & Herstatt, C. (2009). Open source enters the world of atoms: a statistical analysis of open design. *First Monday,* 14(11).

Benton, C. (2000). *Design and Industry*. In Kemp, Martin (ed.) (pp. 380–383). The Oxford History of Western Art. Oxford: Oxford University Press.

Berman, B. (2012). 3-D printing: The new industrial revolution. *Business Horizons*, 55, 155-162.

Björgvinsson, E., Ehn, P., & Hillgren, P-A. (2012). Design things and design thinking: Contemporary participatory design challenges. *Design Issues*, 28(3), 101–116.

Boisseau, É., Omhover, J. F., & Bouchard, C. (2018). Open-design: A state of the art review. *Design Science*, 4. doi: 10.1017/dsj.2017.25

Bonvoisin, J. & Boujut, J.-F. (2015). Open design platform for open source product development: Current state and requirements. *In Proceedings ICED 2015* (July 27–30, 2015) (ed. Weber, C. et al.), vol. 8, pp. 11–20.

Buchanan, R. (1992). Wicked Problems in Design Thinking. *Design Issues*, 8(2):5–21.

Burke, J. J. (2014). *Makerspace: a practical guide for librarians* (pp 11). Lanham: Rowman & Littlefield.

Caldwell, G. A., Foth, M. (2014). DIY media architecture: open and participatory approaches to community engagement. *Proceedings of the 2nd Media Architecture Biennale Conference: World Cities*, 1-10. doi: 10.1145/2682884.2682893

Caruso, C., & Frankel, L. (2010). Everyday People: Enabling User Expertise in Socially Responsible Design. *Paper presented at Design Research Complexity*, Montreal, July 7–9.

Childress, G. (2015, December 23). Prosthetic hand helps teen's confidence soar. Herald-Sun, The (Durham, NC). Retrieved from: http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=n5h &AN=2W62829042662&site=eds-live

Chun, A. M. S., & Brisson, I. E. (2015). *Ground Rules in Humanitarian Design* (pp. 14). London: Wiley Press.

Cruickshank, L., & Atkinson, P. (2014). Closing in on Open Design. *The Design Journal*, 17(3), 361-377.

Ccorimanya, L. (2019). Design of a myoelectric 3D-printed prosthesis for a child with upper limb congenital amputation . *41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC).*

Davey, C. L. (2005). 'Design for the Surreal World?: A New Model of Socially Responsible Design', *Euro- pean Academy of Design Conference,* Bremen, Germany, March 29-31.

De Couvreur, L. & Goossens, R. (2011). Design for (every)one: co-creation as a bridge between universal design and rehabilitation engineering. *CoDesign*, 7(2), 107-121.

Dougherty, D. (2012). The Maker Movement. Innovations*: Technology, Governance, Globalization*, 7(3), 11-14.

Elmansy, R. (2015). Designing the 3D-Printed Prosthetic Hand. Design Management Review 26, 1 (2015), 24–31.

Frascara, J. (2002). *Design and the social sciences: making connections*. London: Taylor & Francis.

Fjeldsted, A.S., Adalsteinsdottir, G., Howard T.J. and McAloone, T.C. (2012). *Open Source Development of Tangible Products-from a business perspective, NordDesign 2012*, Aalborg, Dennmark, 22-24 August.

Ford, S., & Despeisse, M. (2016). Additive manufacturing and sustainability: an exploratory study of the advantages and challenges. *Journal of Cleaner Production*, 137, 1573-1587.

Foresight. (2000). The age shift—Priorities for action. London: Department of Trade and Industry.

Galloway, A., Brucker-Cohen, J., Gaye, L., Goodman, E., & Hill, D. (2004). Design for Hackability. *In Proceedings of the 5th conference on Designing Interactive Systems* (ACM), 363–366.

Gookins, E. (2012). *Achieving a Safe and Reliable Product. A Guide to Liability Prevention* (pp xiii). Milwaukee, Wisconsin: ASQ Quality Press.

Gorenflo, N. (2011). Shareable. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Gürdere, S. (2019). *Socially Oriented Design Practices in Turkey: A Critical Analysis of Participation and Collaboration*. Unpublished doctoral dissertation, Middle East Technical University, Ankara.

Hartman, P. (2011). Do It With Already Made Stuff. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Hatch, M. (2013). *The Maker Movement Manifesto: Rules for Innovation in the New World of Crafters, Hackers, and Tinkerers* (pp. 11-31). New York, NY: McGraw-Hill Professional.

Honey, M., & Kanter, D. E. (2013). Design, make, play: Growing the next generation of science innovators. *Design. Make. Play. Growing the next generation of STEM innovators* (pp. 1–6). New York, NY: Routledge.

Hu, S. J. (2013). Evolving Paradigms of Manufacturing: From Mass Production to Mass Customization and Personalization, *Procedia CIRP*, 7, 3-8.

Huybrechts, H., Dreessen, K. & Schepers, S. (2013). The role of 'openness' in participatory design research. *10th European Academy of Design Conference*, 17 - 19 April 2013, Gothenburg, Sweden, 1- 13.

Jiao, R. J. (2011). *Prospect of design for mass customization and personalization. In Proceedings of the ASME 2011 international design engineering technical conferences & computers and information in engineering conference* (IDETC/CIE 2011), Washington, DC, USA, 625–632.

Kalil, T. (2013). Have fun-learn something, do something, make something. *Design, make, play: Growing the next generation of STEM innovators* (pp. 12–16). New York, NY: Routledge.

Katz, A. (2011). Authors and Owners. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Keates, L.S. (2006). *Designing for Accessibility: a Business Guide to Countering Design Exclusion*. CRC Press, Boca Raton.

King, S., & Chang, K. (2016) *Understanding Industrial Design: Principles for UX and Interaction Design* (1st ed.) (pp. 2). Sebastopol: O'Reilly Media.

Kohtala, C. (2015). Addressing sustainability in research on distributed production: an integrated literature review. *Journal of Cleaner Production*, 106(2015), 664-668.

Koprnický, J., Najman, P. and Šafka, J. (2017). 3D printed bionic prosthetic hands,. *2017 IEEE International Workshop of Electronics, Control, Measurement, Signals and their Application to Mechatronics (ECMSM).* Donostia - San Sebastian: IEEE, May 2017, pp.1-6.

doi: https://doi.org/10.1109/ecmsm.2017.7945898

Langdon, P.M, Lazat, J., Heylighen, A., Dong H. (2014). *Inclusive Designing: Joining Usability, Accessibility, and Inclusion.* London: Springer; 2014.

Lasi, H., Fettke, P., Kemper, H. G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. Business & Information Systems Engineering, 6, 239-242. Doi: 10.1007/s12599-014-0334-4

Luck R. (2003). Dialogue in participatory design. *Design Studies*, 24(6), 523-535.

Maria, N. (2011). (UN)Limited Design Contest. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Margolin, V. & Margolin, S. (2002). A "Social Model" of Design: Issues of Practice and Research. *Design Issues*, Vol. 18, No. 4 (Autumn, 2002), pp. 24-30

Martin, L. (2015). The Promise of the Maker Movement for Education. *Journal of Pre-College Engineering Education Research* (J-PEER), 5(1), Article 4.

Martinot-Lagarde, C., Quintero-Prigent,N., Brennetot, N., Chapuy, M., Fiat, M., Fahmy, M., & Fitouss, F. (2016). Latest trends in upper limb prothesisfor children with agenesia. *Annals of Physical and Rehabilitation Medicine*, Vol 59, 11–14.

Melles, G., de Vere, I. & Misic, V. (2011). 'Socially Responsible Design: Thinking beyond the Triple Bottom Line to Socially Responsive and Sustainable Product Design', *CoDesign*, 7/3-4: 143–54.

Morelli, N. (2007). Social Innovation and New industrial Contexts: Can Designers 'Industrialize' Socially Responsible Solutions?. *Design Issues*, 23(4): 3–21.

Mourtzis, D., & Doukas, M. (2014). Design and planning of manufacturing networks for mass customisation and personalisation: Challenges and outlook, *Procedia CIRP*, 19, 1–13.

Mulder, B. (2011). Design and Government. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Newell, A., Gregor, P., Morgan, M., Pullin, G., & Macaulay, C. (2011). User-Sensitive Inclusive Design. *Universal Access in the Information Society*, 10, 235-243.

O'Duinn, F. (2012). Tinkers: Maker culture for librarians. *In: Information today. Computers in Libraries Conference 2012, 21-23 March 2012*. Washington D.C.: United States.

Papanek, V. (1972). *Design for the Real World: Human Ecology and Social Change*. New York: Random House.

Pine, T.A. (2012). *Product Safety Excellence: The Seven Elements Essential for Product Liability Prevention* (pp 94). Milwaukee, Wisconsin: ASQ Quality Press.

Prince, D.J. (2014). "3D printing: an industrial revolution", *Journal of Electronic Resources in Medical Libraries*, Vol. 11 No. 1, pp. 39-45.

Rejeski, D., Zhao, F., Huang, Y. (2018). Research needs and recommendations on environmental implications of additive manufacturing. *Additive Manufacturing*, 19, 21–28.

Rosner, D., & Bean, J. (2009). Learning from IKEA Hacking: "I'm Not One to Decoupage a Tabletop and Call It a Day". *Proceedings of CHI'09*.

Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., & Harnisch, M. (2015). Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries. *Boston Consulting Group*. Vol. 9. (2015, April 9). Retrieved from

https://www.bcg.com/publications/2015/engineered_products_project_business_industry_4_future_productivity_growth_manufacturing_industries.aspx

Saakes, D. (2011). Ikea hackers: The Lampan - Opportunities for “New” Designers Bring Challenges for “Old” Designers. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Sanders, E. (2002). From user-centered to participatory design approaches. *Design and the Social Sciences: Making connections*, (pp.1-8). London: Taylor & Francis. doi: 10.1201/9780203301302.ch1

Staed, K. C. (2017). *Open Source Download Mishaps and Product Liability: Who Is to Blame and What Are the Remedies?* 36 St. Louis U. Pub. L. Rev. 169-191.

Stappers, P.J., Visser, F.S., & Kistemaker, S. (2011). Creation & CO: User Participation in Design. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

Thorpe, A., & Gamman, L. (2011). Design with society: why socially responsive design is good enough, *CoDesign*, 7:3-4, 217-230.

doi: 10.1080/15710882.2011.630477

Tseng M. M., Jiao R. J., Wang C. (2010). Design for mass personalization. *CIRP Annals-Manufacturing Technology*, 59(1), 175–178.

Rijken D. (2011). Design Lıteracy: Organizing Self-Organization. *Open Design Now: Why Design Cannot Remain Exclusive*. Amsterdam: BIS Publishers.

van Abel, B., Evers, L., Klaassen, R. & Troxler, P. (2011). "Open Design Now. Why Design Cannot Remain Exclusive". *Creative Commons Netherlands, Premsela, the Netherlands Institute for Design and Fashion and Waag Society*.

Vanderheiden, G., Tobias, J. (2000). Universal design of consumer products: current industry practice and perceptions. *Proceedings of the International Ergonomics Society/Human Factors and Ergonomics Society Congress 2000*, pp. 19–22.

Venable, J.R., Pries-Heje, J., Bunker, D. & Russo, N.L. (2011). Design and diffusion of systems for human benefit: toward more humanistic realisation of information systems in society. *Information Technology & People*, 24(3), 208-216.

Wolf, P., Troxler, P., Kocher, P. Y., Harboe, J., & Gaudenz., U. (2014). Sharing Is Sparing: Open Knowledge Sharing in Fab Labs. *Journal of Peer Production 5*. Accessed March 24, 2017.

Cards Against Humanity. (n.d.). Retrieved June 3, 2019, from https://cardsagainsthumanity.com

Creative Commons Licenses. (n.d.). Creative Commons Licenses. Retrieved June 1, 2019, from https://creativecommons.org/share-your-work/licensing-types-examples/

Diatom. (n.d.) SketchChair. Retrieved June 3, 2019, from http://diatom.cc/sketchchair

Instructables. (2017, November 5). Mouse for People With Hand Disabilities. Retrieved from https://www.instructables.com/id/Mouse-for-people-with-hand-disabilities/

SketchChair by Diatom Studio. (n.d.). Design Library. Retrieved June 3, 2019, from http://www.sketchchair.cc/designs

Participate in Design. (2017, February 6). Why Participatory Design? Retrieved from http://participateindesign.org/approach/why

WikiHouse. (n.d.). About. Retrieved August 1, 2019, from https://www.wikihouse.cc/About

WikiHouse. (n.d.). Resources. Retrieved August 1, 2019, from https://www.wikihouse.cc/Resources

Wikipedia. (n.d.). Open Source. Retrieved 7 August 2019, from https://en.wikipedia.org/wiki/Open_source

APPENDICES

A. INTERVIEW QUESTIONNAIRE (FOUNDER)

PROJE HAKKINDA GENEL

- ‘Robotel’ projesine nasıl başladınız? Hikayesini anlatabilir misiniz?
- Nasıl bir ihtiyaçtan doğdu?
- Proje sürecinin aşamalar nelerdir?
- Enable projesinin bir parçası olduğu düşünülürse, projenin uygulanmasında Türkiye koşulları için özel durumlar gerçekleşti mi?

PAYDAŞLAR

- Proje sürecinin tamamlanmasında ihtiyaç duyulan paydaşlar kimler oldu?
- Bu paydaşlarla iletişimi nasıl sağladınız?
- Enable haricinde başka projelerle işbirliği yaptınız mı?

TOPLUMA FAYDA

- Robotel projesi ile hem bireylere hem topluma sağlamayı hedeflediğiniz katkılar/faydalar nelerdir?
- Nasıl bir deneyim yaşadınız? Edinilen fayda anlamında bir değerlendirme yapabilir misiniz?

HEDEFLER

- Projenin geldiği noktada hedeflere ulaşma konusunda değerlendirme yapabilir misiniz?
- Ulaşamadıklarınız var mı? Varsa nedenleri hakkında bilgi verebilir misiniz?
- Projenin bundan sonra nasıl geliştirileceğine yönelik hedefleriniz nelerdir?

ÜRÜN TASARIMI

- Projenin ürün tasarımı boyutu nedir?
- Tasarımcıların bu süreç boyunca nasıl rol aldılar?
- Katkı düzeyleri arttırılabilir mi?
- Tasarımcıların yer aldıkları süreçte inovasyon bağlamında çıktıları oldu mu?

SÜRDÜRÜLEBİLİRLİK

- Bu proje kapsamında sürdürülebilirlik konusu değerlendirebilir misiniz?
- Projenin topluma ve bireye sağladığı faydanın sürdürülebilirliğini değerlendirebilir misiniz?
    - Ürün geliştirme aşamasında sürdürülebilirlik
    - Kullanım ve sonrasındaki sürdürülebilirlik
    - Malzeme seçiminde sürdürülebilirlik
    - Dijitalleşmeyi küresel sürdürülebilirliğin hizmetine sunmak
    - Temiz ve verimli teknoloji uygulaması
    - Tüketimi azaltmak
- Sürdürülebilirlik bakış açısından, var olan sisteme sürdürülebilirlik ilkelerini entegre etmek yerine ekonomik ve üretim yöntemi olarak alternatif bir yaklaşım sundunuz diyebilir miyiz? Bununla ilgili görüşleriniz nelerdir?

KİŞİSELLEŞTİRME

- Bir ürünün ortaya çıkışında kullanıcının ihtiyaç ve ilgi duydukları konuları ele aldığınızı biliyoruz. Bunu kişiselleştirme olarak düşünebilir miyiz? Hangi açılardan?
- Bununla ilgili olarak kullandığınız bir sistem ya da metot var mıdır? (içerik, kullanıcı deneyimi ve ya fonksiyonelliğe göre değişkenlik gösteriyor mu? Seviyeleri var mıdır?)
- Ürünleri farklılaştırırken bir sınırınız var mı? (Materyal, tasarım, içerik...)
- Bu sınırı belirleyen dış etkenler var mı? Nelerdir? (Malzeme, insan faktörü..)

KATILIMCI TASARIM

- Ürün geliştirmede katılımcı tasarım(participatory design) metodunu uyguluyor musunuz?
- (Uygulanıyorsa) Ürün sahipliğine olan etkileri nelerdir?
- Ürüne güvenilirlik, beklentiler konusunda etkileri nelerdir?
- Ürünün gelişmesine yönelik katkıları oluyor mu?

ÇIKTILARIN AÇIK OLMASI

- Örnek aldığınız ve tavsiye ettiğiniz modellerin açık kaynaklarını internet sayfanızda sunuyorsunuz. Bireysel olarak bu tip bir ürünü elde etmenin zorlukları var mıdır?
- İndirilebilir ürünlerle ilgili yaşanan zorluklar neler olabilir?
- Varsa çözümleri neler olabilir? (ürün tasarımında dikkat edilecekler, talimatlar...)

FİKRİ HAKLAR

- Fikri haklar politikanız nedir?
- Çıkan yeni fikirleri korumayı hedefliyor musunuz?
- Açık tasarım bağlamında fikri hakların korunması sorun oluşturuyor mu?

ÜRÜN SORUMLULUĞU

- Bu proje kapsamında 'Ürün Sorumluluğu' ile ilgili belirlediğiniz kriterleriniz veya kurallarınız nelerdir?
- Bu sınırları ya da kriterleri belirleyen faktörler nelerdir? (zaman, kullanım sıklığı, kullanım hatası...)

YENİ PROJE FİKİRLERİ

- Bu proje yeni proje fikirleri doğurdu mu?
- (Varsa)Bunlar arasında topluma fayda anlamında potansiyel olanlar var mı?
- Açık tasarım bağlamında nasıl gerçekleştirilebilir? Yeni ihtiyaçlar doğar mı?

- Açık tasarım kavramının bu projeye ne tür katkıları oluyor?

B. INTERVIEW QUESTIONNAIRE (VOLUNTEER)

PROCESS AND PARTICIPATION

- Genel olarak ürün geliştirme konusunda izlenen süreci anlatabilir misiniz?
- Bu süreçte kimlerle çalışıyorsunuz? Ne gibi katkıları oluyor?
- Ürün iyileştirmede somut katkılarınız oluyor mu? Örnek verebilir misiniz?
- Kullanıcıdan nasıl bilgi alıyorsunuz?
- Kullanıcının sürece ne gibi katkıları oluyor?
- Geri bildirim alıyor musunuz?

OPEN SOURCE AND ACCESSIBILITY

- Kaynaklara nasıl erişiyorsunuz?
- Sizce bu kodların ulaşılabilir olmasının sürece katkıları nelerdir?
- Erişimde ve kullanımda ne gibi sorunlar yaşanıyor?
- Sizce bu sorunlar nasıl aşılabilir?
- Bu sistem geliştirilebilir mi?

ROLES

- Sizin bu süreçteki rolünüz nedir?
- Her projede bu rol aynı mı? Projeden projeye değişiyor mu?

OPEN DESIGN

- Açık tasarımın bu tür projelere katkısı nedir?

C. INTERVIEW QUESTIONNAIRE (DESIGN STUDENT)

DESIGN PROCESS/OPEN DESIGN

- Açık tasarım üzerine bir projede yer almışsınız bu ürünle ilgili biraz bilgi verebilir misiniz?
- Ürünü tasarlarken nasıl bir süreç izlediniz?
- Açık kaynak kullanımı tasarım kararlarını nasıl etkiledi?
- Tasarım kararlarını alırken herhangi bir kısıtlayıcı ya da yardımcı olan bir yönü var mıydı?
- Kullanıcı araştırmasını nasıl yaptınız?
- Bu süreç size neler öğretti?

OPEN SOURCE/DESIGN

- Açık kaynak kullanımı ile ilgili tasarıma potansiyel sağlayabilecek yerler var mı?
- Bir tasarımcı gözüyle proje ile ilgili eklemek istediğiniz birsey var mı?

D. CONSENT FORM

CONSENT FORM

Araştırma konusu:

Açık tasarımın ortaya çıkış, gelişim ve türlerinin incelenmesi: sosyal sorumlu tasarım yaklaşımı ile ilgili bir vaka çalışması

Araştırmacı: Hale Altınova, Yüksek lisans öğrencisi, Orta Doğu Teknik Üniversitesi

Bu araştırma Orta Doğu Teknik Üniversitesi Endüstri Ürünleri Tasarımı Bölümü yüksek lisans tezi kapsamında yapılmaktadır. Araştırmanın amacı, Açık Tasarım'ın ortaya çıkış, gelişim ve türlerinin incelenmesi ve sosyal sorumlu tasarım yaklaşımı ile analizinin yapılmasıdır. Görüşme sırasında elde edilen veriler yalnızca bilimsel amaçlı yayımlarda, tez araştırmalarında ve sunumlarda kullanılacaktır. Görüşme sırasında konuşulanları daha sonra tam olarak hatırlayabilmek, gözden geçirebilmek ve veriye dökebilmek amacıyla ses kaydı yapılacaktır ve bu ses kaydı sadece benim ve tez danışmanım tarafından dinlenebilecektir.

Bu formu imzalayarak yapılacak araştırma konusunda size verilen bilgiyi anladığınızı ve görüşmenin yapılmasını onaylamış oluyorsunuz. Bu formu imzalamış olmanız yasal haklarınızdan vazgeçtiğiniz anlamına gelmemektedir. Görüşme sürecinin başlangıcında veya herhangi bir aşamasında açıklama yapılmasını veya bilgi verilmesini isteyebilirsiniz. İstediğiniz zaman gerekçe belirtmeksizin görüşmeyi sonlandırmayı talep edebilirsiniz.

Araştırmaya katkıda bulunduğunuz için teşekkür ederim.

Katılımcının Adı Soyadı	**İmza**

Araştırmacı:	**Tez Danışmanı:**
Hale ALTINOVA	Prof. Dr. Gülay HASDOĞAN
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E. QUOTATIONS AND CONVERSATIONS (TURKISH)

[Founder] [1] Sadece fiziksel ihtiyaçlarını karşılamakla kalmayıp bir yandan da hayal ettikleri kahramanlarda, temalarda, şekillerde o elleri renklendirerek, biraz süsleyerek kendilerini hakikaten güçlü hissetmeleriiçin bir araç sağlamak derdimiz bu.

[Founder] [2] Bu sistemi verimli ve hızlı çalıştırmabirinci hedefimiz, ikinci hedefimiz de ulaşabildiğimiz kadar çok çocuğa ulaşmak.

[Founder] [3] Biz tabii dedik ki biz zaten yapabiliyor olduğumuz için yapmalıyız.

[Founder] [4] Üç boyutlu yazıcıyı teknoloji olarak kullanıyorduk bir takım uygulamalar yapıyorduk ama insanlara aslında bu teknolojinin nasıl devrimsel olduğunu, insan hayatını nasıl etkilediğini gösterecek proje bakıyorduk.

[Founder] [5] Eğer aileler izin verirse görüntü aldığımız zaman paylaştığımız zaman herkesin çok dikkatini çekiyor paylaşmak istiyor.

[Founder] [6] Bir elinde iki parmağı vardı ama onlar olması gereken yerlerde değildi.Özel bir tasarım yapıldı.

[Founder] [7] Üç boyutlu yazıcıyı gördüler, elleri gördüler videoları gördüler. Konuştuk, sohbet ettik, biraz ilişki kurduk, dokuzun sekizi değişti. Bir tane 13 yaşında görüntü ve şey vermek de istemeyen bir kızımız vardı, o ten rengi istedi ona ten rengi beyaz yapıldı. Bir tanesi Iron Man oldu, bir tanesi Canım Kardeşim oldu, bir tanesi Spiderman oldu.

[Founder] [8] Evet yani mesela biri Beşiktaş temalı istedi. Ooo karakartallar yapıldı, onlar boyandı, elin kendisi siyah beyaz yapıldı.Biri Iron Man istedi, parlak sarı kırmızı eller yapıldı.Fast and furious isteyen vardı, ne yapacağımızı şaşırdık. Üstüne gri yapıp, şimşekler koyduk, Biri de Fenerbahçeliymiş, sarı lacivert cırt cırtlar koyduk falan gibi şeyler yapıldı…

[Founder] [9] Biz boyamadık onların kendileri boyadılar. Dedik ki biz yapalım, sen boya, onların hoşuna gidiyor, özellikle ufaklıkların.

[Founder] [10] Onun dışında dediğim gibi ODTÜ endüstri tasarım ürünleri bölümünde Geçen sene iki tane bitirme projesi robotel ile ilgili yapıldı.TOBB Üniversitesi Üniversitesi'nde 3. sınıf öğrencileri, 11 öğretmenlerinin liderliğinde bir sömestir boyunca boyunca robotel tasarımı yaptılar.

[Founder][11] Yani sürdürülebilirlik konusu açısından bir kere lokalizasyonda oldukça iyi bir rol modeli olduğumuzu düşünüyorum e-NABLE tarafında. Çünkü işi parçalamak, gönüllü adedini arttırmak ve ulaştığımız, özellikle Türkiye şartlarında ulaşabildiğimiz vakaları artırmak için çok iyi bir şekil oldu. Sürdürülebilirlik açısından da bence önemli bir model fakat bu koordinasyon çok yük bindiriyor.

[Founder] [12] Mesela şimdilik bizim sistemimizde yer bir şey yok yani yapan gönüllü takip ederse veya vaka bize tekrar başvurursa hani biz gidip ne oldu işte bitti mi? Uzadı mı? Kırıldı mı? Kullanıyor mu? Öyle bir geri bildirim mekanizmamız yok.

[Founder] [13] Günümüzde çocukların tablet ve şey kullanımından dolayı iletken parmak ihtiyacı doğdu ve çocuklarımızdan bir tanesinde uyguladık iletken telle, onun tenine değen… Bunlar plastik olduğu için iletken değil tablet ve telefon kullanmıyorlar ama baş parmağı iletken hale getirdiğimiz zaman kullanabilir hale geldiler. Öyle bir talep oldu ve yaptık.

[Founder] [14] Biz bütün arkadaşlarımız, çağrıldığımız her yerde robotel anlatıyoruz. Yani bizi isterlerse tasarım için çağırsınlar, isterlerse eğitim için çağırsınlar, isterse üç boyutlu yazıcı...

[Founder] [15] Koordinasyondaki gönüllerimizin sürekliliği ve zaman ayırmasında sıkıntı yaşadıkça diğer taraflarda tıkanma yaşıyoruz çünkü otomatik bir sistem yok.Gönüllülerin formları talepler bir tabloya düşüyor. Tek tek manuel olarak bu vakayı bu gönüllüye atayalım, şu anda ne durumda, iki ay olmuş hala bir ses çıkmamış. Mail atalım, cevap vermiyor tekrarlayalım. Peşine düşmemiz gerekiyor hem gönüllülerin hem de vakaların. O da bize bayağı bir zaman kaybettiriyor.

[Founder] [16] Bizim hedefimiz o dediğim listede bir tane de Türk tasarımı görmek, o yok. Onu istiyoruz yani…

[Volunteer 1] [1] Gönüllü kitlemiz çok farklı disiplinlerden farklı yaşlarda insanları içeriyor…Genelde öğrenciler oldu çünkü yerin işte sosyal sorumluluk projesinde yer alması gibi bir şart varmış. Tasarımcılar biraz daha yatkın olduğu için tasarımcılar geldi geliyor çok bundan sonra makine mühendisleri geldi. Bir de printer firmalarının sahipleri geldi ama onlar da tam olarak yani network amaçlı şirketlerine eleman kapma. Protez yapma gibi bir fikri olup da burada biraz deneyim kazanmak isteyen kişiler.

[Volunteer 1] [2] Rengini söylüyor, şu renk isterim üstüne şu resmi isterim. Belki bir resim atıyor, bize bir resim gönderiyor. Baştan bilgilendiriyoruz ölçü alırken, resim gösteriyoruz. Daha önce bunu yaptık, bu renk olabilir, şu renk olabilir. O zaman değerlendiriyor. Sonrasında işte bize fotoğraf gönderebilir.

[Volunteer 1] [3] Robot ellerde bizim aşamalarımız var. Ölçü alımı, ölçeklendirme, modelleme, basım.Bu süreçleri her bir kişiye veriyoruz.

[Volunteer 1] [4] Eğer şehir dışındaysa bize ölçü alması gerekebiliyor. Bu en büyük katkıları olabilir.

[Volunteer 1] [5] Çünkü çok ciddi bir ekip tarafından tasarlanmış modelleriniz oluyor. Cidden her detayı düşünülmüş modelleri oluyor bunlar. O kadar süreci hızlandıran bir şey ki. Bir kişiye baştan sona robot eli yapsa 3 günde bitirir. Yani çocuğun 3 günde bir robot ele sahip olması çok büyük bir şey.

[Volunteer 1] [6] e-NABLE onaylamadıkça biz basmıyoruz. Açık kaynak siteler var o sitelerden herhangi bir asisstant device deniyor bunlara indirip de denerseniz büyük ihtimal sorunları çıkar. Bir parçası diğerine uymuyor, montajda kesin sorun yaşıyorsunuz. Bizim de Ankara olarak kullandığımız bir model var zaten. Başlangıçta denedik, diğer modelleri de denedik. En kibar, en hafif, en ele benzer, olabilitesi yüksek olduğunu düşündüğünüz modeli seçtik.

[Volunteer 1] [7] Davet ettiğimiz vakayla tanışıyoruz. Eğer vaka olumlu yaklaşıyorsa bize, yani çocuğun yaklaşımı çok önemli. Eğer geliyor işte bizimle eğlenebiliyorsa, biraz gönlünü kazandıysak ölçüsünü o gün alıyoruz. Ama baktık biraz zorlu, iletişime kapalı, o zaman biz ikinci buluşma atıyoruz ölçü alımını çünkü ölçü alımı çok kritik.Yani dokunuyorsunuz, çocuğa çiziyorsunuz biyerlerini, fazla bir yakınlık gerektiriyor.İlk buluşmada ona açık olmayan çocuklar oluyor.

[Volunteer 1] [8] Gönüllüler çocukla iletişime gelince donup kalıyor çocuğun yanında, hata çıkıyor, çocuğun eline bakıp işte o protez neden çalışmıyor, onu bile inceleyemiyor, korkuyor. Çünkü üniversite öğrencisi, o da bilmiyor ki ne yapacağını...Çünkü bir engelli ile karşılaşmak bambaşka bir şey. Yani onu da deneyeyimleyince, tam o dönemde psikolog gönüllüsü çıktı karşımıza. Ben ona ne yapabiliriz böyle bir sorun var deyince dedi ki ben bir geliyim. Geldi gördü biraz inceledi, dedi yani ben eğitime ihtiyacınız var. Bir çocuk gelişimi uzmanı, bir psikolog gönüllü ile biz iletişim eğitimi ekledik.İki eğitim oldu, bir teknik eğitimi dedik bunun adına, bir de iletişim eğitimi dedik. İletişim eğitiminde çocuğa nasıl davranılması gerekiyor anlatılıyor.

[Volunteer 2] [1] Ben 4 yıldan beri bunun içindeyim Hala da iyi ki bunun için deyim diyorum. Çünkü çok büyük bir sosyal sorumluluktan ziyade size verdiği bir mutluluk ve doyum noktası çok çok başka birşey. Bunun ve açık kaynak olarak herkesin ulaşması da çok büyük bir güzellik. Siz bunu yaptıktan sonra o çocuğa o eli teslim ettiktiğinizde o çocuğun yüzündeki gülümseme veya tebessüm bana kalırsa herseyden çok çok önemli. Onun için çok özel ve güzel bir şey olduğunu düşünüyorum yaptığımız işin.

[Volunteer 2] [2] Bazen işte elektronik eller yapıyoruz. Ve genellikle elektronik elleri mühendis arkadaşlarımızla beraber tartışıyoruz ama ne kadar mühendis olsak da tıkandığımız noktalar olabiliyor. Öyle olunca araştırıp bazı şirketlerden yardım alıyoruz. İşte cyberparktaki şirketler olsun, teknokentteki şirketler olsun, bunlar sadece bize bizim yapamadığımız kısımlarda sadece bir yol gösterip nasıl yapmamız gerektiğini gösteriyor.

[Volunteer 2] [3] Çocuklarımızın istekleri üstüne biz yol yordam çiziyoruz. Mesela bir çocuğumuz geliyor. Ben bu elimle yüzmek istiyorum diyor. Tamamen ona yönelik birşey yapıyoruz. Yüzmek için kulaç atma yönteminde parmakların kapalı olması gerekiyor. O şekilde bir yol istiyoruz. Ona göre çizimler alıp, ona göre ölçüler alıp, ona göre baskıya gönderiyoruz. Yani çocuğumuz nasıl bir el isterse ya da o eli ile neyi yapmak istiyorsa aslında o şekilde devam ettiriyoruz.

[Volunteer 2] [4] Biz zaten robotelden aldığımız vakaları hiçbir zaman bırakmıyoruz. Yani eli yapıp teslim ediyoruz ama hep zaten ayda bir hep aile buluşmalarımız oluyor ya da işte vakamızın doğum günü falan hep aileler bizi çağırıyor. O olmasa bile eğer bir aksilik de velilerimizden ebeveynlerimizden hep haber geliyor, Zeynep'in elinin uzvu büyüdü, ağrı var ya da batma var gibi. O zaman biz gidip ya gidip ölçü alıyoruz ya da aileye söylüyoruz bize gönderin diye, biz tekrardan o vakanın elini düzeltiyoruz.

[Volunteer 2] [5] Elini değiştirmeye gerek duymadık. Çünkü aslında uzvunda büyüme değil de bir yerden bir çıkıntı olmuş ve robot el de üstüne batıyor. Onun üstüne şöyle bir şey yaptık. Biz robotelimizin içine eva kapliyoruz, evasını çıkarttık. Çünkü artık kullana kullana ezilmiş ve incecik kalmış. Evasını çıkartıp 3 kat eva serdik ve o şekilde bir süre daha kullandı.

[Volunteer 2] [6] Mesela çok doluyuz vakaya gidemedik ya da vaka müsait değil veya acelemiz var. Hani bir an önce yapılması gerekiyor. Çok ağrısı var, o zaman hemen aileye diyoruz ki, fotoğrafları atıyoruz, işte şuraya ölçeklendirmede, burayı bu ölçüde, cetveli şöyle tutarak falan diye ve anlatıp onlar bizi ölçüyü atıyorlar.

[Volunteer 2] [7] İlk başta yaptığımız robotel ile şu anda yaptığımız robotel tabii ki de aynı ama tabii ki de üstüne çok fazla kendimizi geliştirdik.

[Volunteer 2] [8] Gönüllü olarak girdiğinizde bizim süreçlerimiz şöyle ilerliyor, teknik eğitim daha sonra da iletişim eğitimi alıyoruz. Teknik eğitimde o robot el nasıl yapılıyor, nasıl ölçeklendirilir, nasıl baskıya gönderilir bunlar öğreniliyor, iletişim eğitiminde de çocuk gelişimi ve psikologlarımız ile beraber bir çocuğa nasıl iletişim kurulur. Oturarak mı konuşulur? Ayakta mı konuşulur? Bunları öğreniyoruz.

[Volunteer 2] [9] Yavaş yavaş eğitimler vermeye başladım. İşte genellikle ODTÜ

Koleji'ne eğitim vermeye gidiyorum final Koleji'ne, sınav Koleji'ne...

[Volunteer 3] [1] Onlar değişebiliyor ya da şöyle bir şey olabiliyor. Klasik deformasyon değil de 2 parmağı var diğer üç parmağı yok mesela arkadaşımızın, buna özgü şeyler yapıyoruz. İki parmağını geçebileceği şekilde tamamen mekanik herhangi bir bilgisayar ortamında 3 boyutlu dosyayı şekillendirmiyoruz ama kendimiz 2 parmağı geçebilecek şekilde düzenliyoruz.

[Volunteer 3] [2] Bizim TOBB Üniversitesi endüstriyel tasarım bölümünde yaptığımız işbirliği Sweet bitirme projesi gibi bir uygulama vardı. Orada hobilere veya işleve göre robot el tasarımı yapmıştı öğrenciler. Mesela keman tutmak için olabilir, yüzmek için olabilir bateri çalmak için olabilir.

[Volunteer 3] [3] Aslında vakaya teslim ediyoruz ama bu süreçte biz de onlardan bir feedback istiyoruz.

[Volunteer 3] [4] Plastik olara PLA kullanıyoruz.Ne tür bir PLA kullanacağımızı sormuyoruz.Çünkü standart PLA malzememiz var.

[Volunteer 3] [5] Montajı yapıldıktan sonra bir test sürecine girmiş oluyoruz aslında. Vakaya teslim ediyoruz ama bu süreçte hani bizden onlardan bir feedback istiyoruz. Burası sıktı, burası koptu şunu yapamıyorum, bu eklense daha iyi olur gibi. Geri dönüş aldıktan sonra daha iyi ona özel bir robotel yapabiliyoruz ya da geri dönüşü olmuyor, herhangi bir sıkıntı sorun olmuyorsa verdiğimizi elle devam ediyor.

[Volunteer 3] [6] Başvurunun ardından bize bir Excel dosyası geliyor Robotel in İstanbul şubesinden. Biz bu ekran dosyasına bakarak vakaların yaşını durumunu önceden görebiliyoruz. Daha sonra iletişim bilgilerini kullanarak vaka ile iletişime geçiyoruz. Sorduğumuz sorular, hangi kolunda veya elinde problem olduğu eksiklik olduğu. Sonra işte yaşının kaç olduğu onları teyit ettiriyoruz.

[Volunteer 3] [7] Ölçü alımlı tamamlıyoruz.sonra ölçülere göre bilekten veya dirsekten model mi ona karar veriyoruz. Daha sonra modelleri ölçeklendirmeye başlıyoruz. Ölçeklendirme işlemi bilgisayar ile yapılıyor. İki türlü oluyor bilek modeli ise hazır modellerimiz oluyor, bilekten modelleri için e-NABLE ın bize vermiş olduğu. Bunları programla ölçeklendirip baskı dosyalarına alıyoruz. Ölçüleri girerek hazır üç boyutlu baskı dosyalarını alıyoruz. Bu dosyaları aldıktan sonra 3 boyutlu yazıcı gönüllümüze iletiyoruz. Daha sonra baskılar alındıktan sonra üç boyutlu yazıcı yazıcı gönüllüsü montajı yapılıyor. Montajı yapıldıtan sonra bir test sürecine girmiş oluyoruz aslında, vakaya teslim ediyoruz.

[Volunteer 3] [8] Aktif olarak montajda veya ölçü alımında rol almasa da bize malzeme desteği sağlayabilecek gönüllülerimiz oluyor. Mesela diş hekimi bize diş lastiği tedarik ediyor, biz parmaklarda kullanıyoruz. Veya cerrah gönüllümüz vardı, o bize elektronik robot projesinde kullanmak için problar temin edebiliyordu.

[Designer 1] [1] Mesela baskı çalışması yapmaya yardımcı olan bir aparat vardı, hamur oynarken hamura şekil verebilecekleri aparatlar vardı. Tamamen çocukların kendi kendilerine kullanabilecekleri ailelerinden yardım almadan kullanabilecekleri…

[Designer 1] [2] 3 boyutlu yazıcı kullanıcı kullanarak üretim yapılması konusunda da bir sürü şey öğrendim.

[Designer 1] [3] Bir tane çocuk psikiyatristi bir hoca ile görüşmüştüm. Nelere dikkat etmek gerekir vesaire gibi. Bu şekilde bir araştırma. Çocuklar tarafından kabul edilebilirliği ne derece olur ya da arkadaşları bu tarz el görünümünde olmayan bir şeye nasıl tepki verebilir gibi. O yüzden bir psikiyatristle de görüşmek istedim bu konuda.

[Designer 2] [1] Sürecte tabi açık tasarım olduğu için araştırma yapması çok daha kolay bir hale geldi. Genel olarak konu ile ilgili materyal açık kaynak olduğundan dolayı inanılmaz bir kaynak bolluğu sağlıyor.

[Designer 2] [2] Her farklı kullanım vakası için, ihtiyaç için, farklı bir ürün takılabileceği bir ürün yapmaya çalışmıştım. Parmakların olduğu yerin çıkarılabilir bir şekilde kullanılabileceği böylece de işte bisiklete binerken, yüzerken, ya da bardak tutarken, kart oyun oynama kartları tutarken oyuncak tutarken kullanabileceği farklı farklı aparatlar takabileceği, bu aparatlar sayesinde de problemleri çözebileceği bir ürün tasarlamak istemiştim.

[Designer 2] [3] Çocuklara bire bir kullanacakları ve çok hızlı bir şekilde tüketip değiştirebilecekleri bir ürün üretmek ve özellikle 3 boyutlu yazıcıların açık tasarımdaki yerini tanımlamak açısından çok verimli olduğunu söyleyebilirim. 3 boyutlu yazıcıların hayatımıza girmesiyle açık tasarımın çok kritik bir noktasını oluşturduğu, insanların evinde bir şey üretebilmesini sağladığı için evdeki üretimin kaynaklarını açık bir şekilde paylaşıyor olmaları, çok verimli bilgiydi benim için ve genel olarak bunu birebir elden test etme şansım oldu.

[Designer 2] [4] Ama dediğim gibi eğer son kullanıcının üretemeyeceği bir şeyse açık kaynaklı bir çalışma yapmanın hiçbir taraf için çok büyük bir kar sağlamayacağı durumu olduğu için sistemde yer bulması çok zor.

F. CODES AND CATEGORIES

CATEGORIES	CODES	F	DS1	DS2	V1	V2	V3
Aims and Motivations	PROJECT DECISIONS: disassemble the development into subgroups	√					
	PROJECT DESICIONS: Application differences in different countries	√					
	PROJECT DESICIONS: power of spreading the union	√					
	SOCIAL RESPONSIBILITY: opportunity for social responsibility	√					
	SOCIAL RESPONSIBILITY: unmet needs from health support services	√					
	MOTIVATION: be part of an social organization		√				
	MOTIVATION: challenge, willing to improve/develop	√				√	
	MOTIVATION: emotional satisfaction	√	√	√		√	
	MOTIVATION: social benefit/responsibility	√				√	
	PURPOSES: expectations				√		
	PURPOSES: motivations (for social responsibility)				√		
Awareness of the problem	BENEFITS of having a robot hand: not losing senses untill age of having real prostetic hand	√	√				
	SOCIAL RESPONSIBILITY: awareness of the problem	√					
Barriers in Production	BARRIERS IN DEVELOPMENT: no offline usage in some models						√
	BARRIERS IN DEVELOPMENT: online source dependency				√		√
	BARRIERS IN DEVELOPMENT: Physical appropriateness of user	√			√		
	BARRIERS IN DEVELOPMENT: shortage of resources(finding high volume printers)	√					
	BARRIERS IN PROJECT: delays in communication among volunteers	√					
	BARRIERS IN PROJECT: Difficulty of reaching the needy	√					
	BARRIERS IN PROJECT: economically dependent (to make innovation)					√	
	BARRIERS IN PROJECT: Limited time allocated by volunteers	√					
	BARRIERS IN PROJECT: Problems in coordination	√					
Collaboration with External Stakeholders	COLLABORATION: experts of intellectual property rights	√					
	COLLABORATION: get support from design owner team				√		

	STAKEHOLDER: donators	√			√	√	√
	COLLABORATION: universities /design students	√			√		
	COLLABORATION: with other communities	√					
	OBSERVATIONS: immaturity of newly developed solution (design students)				√		
	STAKEHOLDER: expertise support in different parts	√			√	√	
Contribution to Awareness	SOCIAL RESPONSIBILITY: raising awareness	√					
Customization/Personalization	CUSTOMIZATION/PERSONALIZATION - OBSERVATION: increase product ownership	√					
	CUSTOMIZATION/PERSONALIZATION: contribution of designer's imagination	√					
	CUSTOMIZATION/PERSONALIZATION: intervention for needs	√					√
	CUSTOMIZATION/PERSONALIZATION: usage of parametric design				√	√	√
	CUSTOMIZATION/PERSONALIZATION: Visual and functional preferences	√	√		√	√	√
Division of Labor and Development Process	DIVISION OF LABOR: expertise selection (volunteers)				√	√	√
	DIVISION OF LABOR: role distribution among volunteers	√			√	√	√
	DIVISION OF LABOR: user taking measurements				√	√	
	OBSERVATION/TEAMWORK/SUBGROUPS: forming teams is efficient	√					
	OBSERVATION: teamwork increases productivity				√		
	TEAMWORK/SUBGROUPS: creating subgroups for each user	√			√	√	√
	TEAMWORK/SUBGROUPS: more than 4 people decrease efficiency						√
Issues Need to be Handled for Improvement	OBSERVATION: Lack of knowledge about intellectual property rights	√					
	PROJECT NEEDS: team for 3d modelling (expertise)	√					
	PROJECT NEEDS: documentation	√					
	PROJECT NEEDS: education to users' family	√					
	PROJECT NEEDS: Lack of Communication channels for feedbacks	√					
	PROJECT NEEDS: lack of Tracking mechanism (for users)	√					
	PROJECT NEEDS: lack of Tracking mechanism (for volunteers)	√					
	PROJECT NEEDS: must be published to enter the literature	√					
	OBSERVATION: No publication of a functional design from Turkey	√					

Iterative Design Process	ITERATIVE DESIGN PROCESS: repeating development till robotel fits to user	√			√	√	√
	ITERATIVE DESIGN PROCESS: repetition of the needs of the same user	√				√	
	ITERATIVE DESIGN PROCESS: taking feedbacks				√	√	√
	ITERATIVE DESIGN PROCESS: testing stage for finalization				√	√	√
Open sources	OPEN DESIGN: abundance of information			√			
	OPEN DESIGN: availability of information covering different aspects		√	√			
	OPEN DESIGN: educational for individual production						√
	OPEN DESIGN: enables continuous innovation				√		
	OPEN DESIGN: finding alternative sources				√		
	OPEN SOURCE: availability of different sources,additional open sources(videos)				√		√
	OPEN SOURCE: easy to reach information and support		√	√			
Participation to the Process	PARTICIPATION - OBSERVATION: reduces expectations and increase confidence in product	√					
	PARTICIPATION: user				√	√	√
	PARTICIPATION: user including with actions like painting	√					√
Personal Development	PERSONAL DEVELOPMENT: training for development, communication				√	√	
	PERSONAL DEVELOPMENT: volunteers' gaining expertise				√	√	
	VOLUNTEER QUALIFICATIONS: awairness of new developments				√		
Positive effects of Using an Open Design	OPEN DESIGN BENEFIT: reproduction as required				√		
	OPEN DESIGN/OBSERVATION: increase the project's prevalence						√
	OPEN DESIGN: acceleration in work				√		
	OPEN DESIGN: allows individual development without being included in a group						√
	OPEN DESIGN: ease of access through the internet	√				√	
	OPEN DESIGN: emerging new open sources (like books)				√		
	OPEN DESIGN: free to everyone					√	√
	OPEN DESIGN: free to manipulate						√
	OPEN DESIGN: independency of using different sources				√		
	OPEN DESIGN: no human intervention					√	√
	OPEN DESIGN: open for co-design				√		

	OPEN DESIGN: open for improvement, provide product improvement potential	√		√	√	√	√
	OPEN DESIGN: open for innovation				√	√	
	OPEN DESIGN: ready to use				√		
	OPEN DESIGN: space independent access					√	√
	OPEN DESIGN: time saving				√		
	OPEN DESIGN: unlimited resource for reproduction, redesign, partial redesign			√			
Issues Addressed in Product Design	DESIGN DECISIONS: child as a user - easy to use			√			
	DESIGN DECISIONS: concerns about individual production			√			
	DESIGN DECISIONS: effect of production techniques			√			
	DESIGN DECISIONS: effects of material on design (cost, PLA..)		√				
	DESIGN DECISIONS: putting together parts of product easily		√				
	DESIGN DECISIONS: taking different stakeholder views		√				
	DESIGN DECISIONS:particular attention on psychological side		√				
	DESIGN DEVELOPMENT: detailed user analysis		√				
	DESIGN DEVELOPMENT: examining production methods		√	√			
	DESIGNER QUALIFICATIONS: learning 3D production methods		√	√			
	DESIGNER QUALIFICATIONS:investigation for understanding user needs		√	√			
	PERSONAL IMPROVEMENT as a DESIGNER: meet different production methods		√				
Issues to be Fulfilled in Product Development	CONNECTION WTH USER: awairness of users' vulnerability (communication training)				√		√
	CONNECTION WTH USER: meeting - taking feedbacks				√	√	
	CONNECTION WTH USER: must have communication training						√
	CONNECTION WTH USER: receiving needs				√	√	√
	DEVELOPMENT DECISIONS: choosing appropriate model according to physical situation	√					√
	DEVELOPMENT DECISIONS: using standart model				√		
	LIMITATIONS OF DEVELOPMENT: users' physical state	√			√		
	OBSERVATION: avoid from newly developed solution				√		
	PROBLEMS: unapproved models (non designers)				√		

IMPROVEMENT POTENTIALS	PRODUCT DEVELOPMENT: importance of determination of standards and control mechanism	√					
	PROCESS TIME: depends on time allocated by volunteer and complexity of the case						√
	IMPROVEMENT: for making revisions				√		
	IMPROVEMENT: new functions, physical restrictions, new physical needs, new model		√	√	√		√
	IMPROVEMENT: new versions of the products				√		√
Psychological Issues to be Considered	CONNECTION WTH USER: awairness of users' vulnerability (communication training)				√		√
	DESIGN DECISIONS:particular attention on psychological side		√				
Sharing/Spreading	OBSERVATION: sharing provides improvement ad progress	√					
	SHARING: giving lectures at schools					√	
	SHARING: sharing design as open source	√					
	SHARING: sharing facilities and resources with other groups working on robot hands	√					
	SHARING: sharing knowhow in person				√	√	
	SHARING: sharing knowhow with reporting and recording method				√		
	SHARING: sharing knowledge with other groups working on robot hands	√					
	SPREADING: using internet sources	√					
Sustainability	EXPECTATIONS FOR OPEN DESIGN: contributions of the academy	√		√			
	SUSTAINABILITY/OBSERVATION: sustainability of open design approach			√			
	SUSTAINABILITY/PROJECT NEEDS: Project sustainability in terms of product tracking and feedbacks	√					
	SUSTAINABILITY: creating subgroups affects positively	√					
	SUSTAINABILITY: permanent volunteers				√		
	SUSTAINABILITY: reuse of product (changing parts)					√	
	TRACKING: keeping track of each user				√		
Using Technology	OBSERVATIONS: lack of ability of families using technology	√					
	TECHNOLOGY USAGE: 3D technology's affecting life	√					
	TECHNOLOGY USAGE: achieving better things using technology	√					
	TECHNOLOGY USAGE: publicity the project through the internet	√					

	TECHNOLOGY USAGE: using different media channels for spreading	√					
	TECHNOLOGY USAGE: using digital technology for advertise	√					
	TECHNOLOGY USAGE: using internet sources for spreading	√					
	TECHNOLOGY USAGE: using open sources on the internet	√			√	√	√