EVALUATING ADOPTION OF OPEN SOURCE TOOLS IN INDUSTRIAL DESIGN EDUCATION

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ABSTRACT

EVALUATING AN ADOPTION OF OPEN SOURCE TOOLS IN INDUSTRIAL DESIGN EDUCATION

Open source tools can support industrial designers to follow technology and trends easily. If industrial designers start using open source tools in their design processes, they can overcome difficulties, and make the process easier. The first step of research showed that industrial design students have the difficulties in the specific tasks of design process such as design presentation, design research, design decision, concept generation and design documentation. In addition to difficult tasks, reasons of difficulties were also asked to build a connection between open source tools and the solutions of difficulties. In the second step of research, students' approaches for open source tools' use were analyzed with presentation and feedback session. However, taking feedback with a questionnaire were not enough to analyze their approach. For this reason, three different studies were designed to find the most effective way to see how industrial design students use open source tools in their design processes. The first two studies were accepted as pilot studies which were re-design workshop and open source tools' usage in industrial design studio courses. Due to limitations and insufficient outcomes required the third studies which are simulation of open source community. The study aimed to create an effective environment which offers an experience of open source tools with all the elements such as source, sharing, contribution and community. Introduction to Design Thinking Course' students participated the study in Industrial Product Design Department at Istanbul Technical University. They shared their term project as open source and open source community was created in the classroom. Thus, difficulties of students in the design process were aimed to overcome. The results indicated that students overcome difficulties of "Finding inspiration", "Express concept correctly and quickly", "Changing and developing ideas" and "Decision skills".

Keywords: Open Source, Industrial Design, Education, Community, Adoption

ÖZET

AÇIK KAYNAK ARAÇLARIN ENDÜSTRİYEL TASARIM EĞİTİMİNE ADAPTASYONUNUN DEĞERLENDİRİLMESİ

Açık kaynak araçların kullanımı endüstriyel tasarımcılara teknoloji ve trendleri takip etmelerinde yardımcı olabilirler. Endüstriyel tasarımcılar açık kaynak araçları tasarım süreçlerine dahil ettiklerinde süreç boyunca karşılaştıkları pek çok zorluğun üstesinden gelebilecekleri gibi süreçlerinin de daha kolay geçeceği öngörülebilir. Bu araştırmanın ilk adımı endüstriyel tasarım öğrencilerinin tasarım sunumu, tasarım araştırması, tasarım kararları, konsept geliştirme ve tasarım belgelendirme görevlerinde zorlandıklarını göstermiştir. Bunlara ek olarak, bu zorlukların nedenleri de açık kaynak araç kullanımıyla bağlantı kurmak amacıyla aynı aşamada araştırılmıştır. İkinci aşamada ise öğrencilerin tasarım süreçlerinde açık kaynak araçların kullanımına olan yaklaşımlarını anlamaya yönelik sunum yapılmış ve geri dönüşler ikinci bir anket yardımıyla alınmıştır. Ancak anketle toplanan veriler konuyla ilgili yaklaşımlarının geçerliliğini ölçmek için yeterli değildir. Bu amaçla, ikisi pilot çalışma olmak üzere üç çalışma yürütülmüştür. Pilot çalışmaların ilki tekrar tasarım, ikincisi ise stüdyo projesi süresince araçların kullanımını amaçlamıştır. Ancak gerek sınırlamalar gerek yetersiz çıktılar nedeniyle üçüncü ve asıl olan çalışma tasarlanmıştır. Bu çalışmada açık kaynak topluluk simülasyonu oluşturmak amaçlanmıştır. Böylece öğrenciler açık kaynak araçları bütün bileşenleriyle yani kaynak, paylaşım, topluluk ve katkı sağlama ile birlikte deneyimleme imkanı bulabilirler. İTÜ Endüstriyel Ürün Tasarımı bölümü Introduction to Design Thinking Course (Tasarım Odaklı Düşünce'ye Giriş) dersi öğrencileri çalışmanın bu bölüme katılmışlardır. Dönem projelerini açık kaynak olarak paylaştılar ve açık kaynak topluluğun simülasyonu oluşturuldu. Böylece öğrencilerin tasarım sürecinde karşılaştıkları problemlerin üstesinden gelebildikleri görüldü. Çalışmanın sonucu, öğrencilerin "ilham bulma", "konseptlerini doğru ve hızlı bir şekilde aktarma", "fikirlerini değiştirme ve geliştirme" ve "tasarım kararı" görevlerindeki zorlukların üstesinden geldikleri görülmüştür.

Anahtar kelimeler: açık kaynak, endüstriyel tasarım, lisans, komünite, adaptasyon

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CHAPTER 1

INTRODUCTION

1.1. Definition of Problem

Industrial design studio course is compulsory in each semester. This course aims to make industrial design students gain the specific skills about design presentation, design decision, design research, concept generation and design documentation (Chen, 2015).

Industry develops day by day as much as technology, and it needs employees who track technology, learn and apply it to industry. However, industrial design graduates are mostly not trained to track and adapt technology this fast. Being open to learning new technologies and following trends with designer perspective can be advantageous for industrial design students in addition to school education. Moreover, the curriculum of industrial design departments have already included many standard courses and busy schedules based on their capacities, so these may not allow adding new courses as much as that that technology develops.

Industrial designer Ronen Kadushin mentioned open design for the first time as a term (2004). When he started to work on the open design, he noticed that many other design areas like graphic design, game design, etc. use the internet to support their creativity. However, there was no sign from industrial designers about using the internet to support their works. Except that, they are looking for reference knowledge. In society, people are divided into categories like tech-savvy or social ones. Open source tools aim to build interaction between these two sides, while people gain other side's perspective. Besides, it requires not only technical skills to use technological tools but also social skills to use communication tools. In addition to this, similar aspect is available in education, too. For example, a media student can take degree without producing anything or make any product by her/his own, or spend all time playing a game without trying making or learning to make a game (Stikker, 2011). Industrial design is related to production and making as a profession. ID/IDP studio courses as the most similar course to professional practice, so students learn to practice their profession in these courses. Due to this relationship between professional

practice and production, courses in the industrial design department may be the place where students can gain these skills.

While development speed of technology increases day by day, openness is one of the trends. In openness, users are also developers, so technology starts to evolve for who use it. There are many tools and platforms which are maintained by open source philosophy. However, limited use of them by industrial designers does not allow to evolve them for industrial designers. Furthermore, issues of today's world are more complex than solving by designing form and function of a product. New skills and new areas of design such as interaction, service, and experience should be embraced. Today, from toaster to wall switch are all working by communication modules. Thus, industrial designers need to learn microcontrollers, processors, actuators or sensors. Programming, interaction, and human cognition are skills which industrial designers should have as much as drawing, forming or molding skills. Moreover, knowledge of social and behavioral sciences, experimental design, some statistics, rapid prototyping and user testing are the must. In addition to the need of change, current courses or subjects cannot be added industrial design curriculum directly, because it has own unique requirements. Furthermore, the main components of design should not be neglected, and still, its artistic side is important. There is need of industrial designers who are not scientist or engineers (Norman, 2010). At this point, industrial designers may get benefits from open source tools to learn these new skills, and contribute their design process as much as open source tools itself.

1.2. Objective of the Study

Objectives of study can be listed as following:

- The introducing term of open source to industrial design students, and showing them use in their design processes.
- Designing the way through workshops make industrial design students contribute open culture and make them engage students and open source community.
- Evaluating students' design process while they are using open source tools to understand impacts of them.

1.3. Research Questions

To reach the objectives which were mentioned in previous part to solve defined problems, following research questions are built:

- How should industrial design students be introduced to open source?
- Which stage of the design process are needed to be supported by open source tools?
- What is students' approach to using open source tools in their design process?
- How can design students engage with open source tools and community?
- What are the results of open source tools used by industrial design students in their design process?

1.4. Research Methodology

In this study, to create adoption of open source tools into industrial design education, the first step was analyzing difficulties in the design process of industrial design students. Then, solutions with open source tools are offered to students to support the engagement between them and the tools. After that, the most effective way of teaching open source tools was searched through pilot studies and primary research. For these purposes, quantitative and qualitative methods are used together.

As seen Figure 1, after data analysis of questionnaires, the little lecture is designed to introduce the open philosophy and its tools to industrial design students. According to gathered data in the feedback session, pilot studies were made to reach the best environment to observe students' use of open source tools. Then, primary research which is a simulation of open source community was designed.

In this study, both quantitative and qualitative methodologies are used to develop research. As the first step of research, the quantitative methodology is followed with survey method to collect data from the student. The survey is prepared to learn difficult tasks and their reasons for industrial product design students and their awareness about open source tools. In the second phase of the study, qualitative methodology is followed to take feedback

on the proposal of open source use in industrial design studio course with case studies. The simulation is followed as a qualitative methodology with mostly observations and taking verbal feedback.

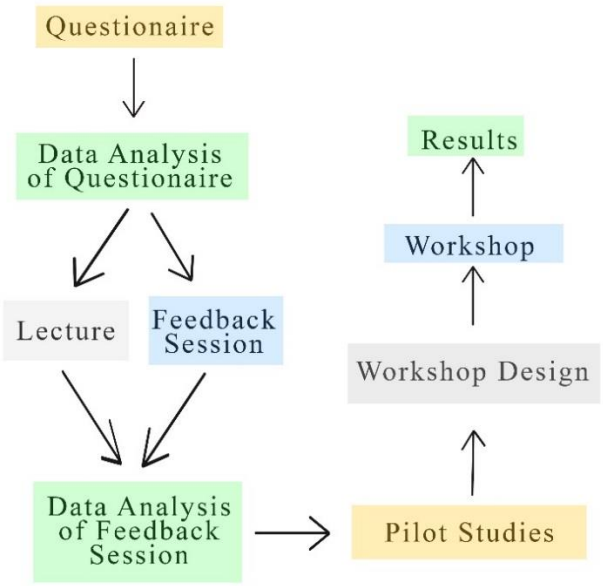


Figure 1. Map of Research Methodology.

CHAPTER 2

LITERATURE

2.1. Definition of Open Design and Terms

The term of "open" was seen since the late of the 20th century as a response or resilience to the division of labor which was seen more aggressively through the progress of industrialization. It means each person has knowledge and practice about only one specific task. The internet caused differentiation in this situation. With it, people reached more knowledge and discovered beyond their education at schools or tasks in the job. Moreover, they started connecting and interacting with others, also share many things like knowledge feelings, experience, etc. The first, copyrights violated easily; then common was included to the world to limit the accessibility of user engagement and manipulation of everyday things. As a result, open become resistance and a move to reclaim the user's access to the everyday. The words of Make Magazine "if you cannot open it, you do not own it.". As noted by management theorist Micheal Avital, there is a general mega-trend which has been shaped by open ideology. This mega-trend is called as "The Rise of Open-X" where everything is almost open before produced exclusively by professionals (Avital, 2011). In Avital's logic, not only software and hardware, but also culture, society, and consumption can be open. Subcultures give acceleration to this approach like hacker culture, as an example Urban Exploration (Ninjalicious, 2005). Today, people live in the free market environment. However, even this times, daily life and its environment look like closed and locked. Thus, open ideology in a reaction to this life and its environment.

Open ideology causes to form new markets and new opportunities for collaboration. In addition to these, it produces new activity types like zeitgeist, modern modes of production. Open ideology also merges another line of development in the area of design which engaging users with the design process. This involvement is named as co-design or co-creation. There are two types of user involvement; the first one is unpaid and unrecognized labor like IKEA, and the second one is designing together, more user. The

second type may cause problems like that designers do not take responsibilities for specific feature or design and may say that “user wanted that.”.

In addition to art, dark matter is used as a term which indicates contributions of amateurs with production activities to the economy. The Internet offers a collaborative environment and knowledge exchange. As noted by economist Benkler, the dark matter of our economic production universe is affected by immaterial and collaborative labor and information and social production (Benkler, 2006).

The ruling class seeks always to control innovation and turn it into its ends, depriving the hacker of control of her or his creation, and thereby denying the world as a whole the right to manage its own development (Wark, 2004).

The term of open use as a mean of better, cheaper and faster. The base of openness is accessibility which means people can access to view, modify and use of something. People should share content of something to view by other people. Also, labor sharing refers to modify and to share ownership of something refers to use (Avital, 2011)**.**

Internet gave momentum to open design and its other elements like open innovation, open source hardware, software, etc. because it makes sharing possible from anywhere and easier. Sharing supports to accessibility, so does openness.

There are some differences between open innovation, open source, and open design which explained Avital's table of Archetypes of Open-X regarding value proposition and thrust, core openness and facet and prime actors.

Value proposition and thrust are about to how open-x is functioning. Open innovation is based on the distribution of knowledge. Leaders of industry use open innovation to find the best idea from the sources from inside and outside to make their business better. This requires making boundaries disappear between the company and outsources so that knowledge can flow between them. In open source, the main function is developing together which refers to the distribution of development. Anyone can contribute to a source with his or her knowledge and experience; it is ended with building something together. Third open-x is an open design which has characteristics of distributed manufacturing regarding value proposition and thrust. In open design, consumers are not dependent on companies, producers or others; they are interested in fabrication directly.

Each of open innovation, open source, and open design refer to one of the steps of accessibility which are a view, modify, and use. These three explain the capability of each open-x. The capability of view belongs to open innovation, because of transferring knowledge. In open source, people modify the source which was modified by previous one, so its main capability is a modification. Use is emphasizing the open design, because it includes using tools and producing something.

Table 1. Archetypes of Open-X (Avital, 2011).

	Open Innovation	Open Source	Open Design
Value Proposition and Thrust	Distirbuted Knowledge	Distributed Development	Distributed Manufatcuring
Core Openness Facet	View	Modify	Use
Prime Actors	Organizations	Developer Communities	Consumers

Prime actors explain which open-x is influenced by which actors. All open-x has relation with each actor, but one of them is more influential to function it. Organizations are the prime factor for open innovation, due to their aim of using knowledge to do better business, and building a bridge between internal and external sources. Because its contributors shape open source, so its prime actors are developers. While designer should be thought as a prime actor of open design, also consumers are another actors of open design, because consumers do distribution and manufacturing of design, even though design blueprints are produced and released by designers.

In history, movements for design started with industrialization, then followed by post industrialism with global settings and finally mass customization and open design. In the end, these make amateurs engage with design and do it yourself culture. In addition to the new form of design, a new form of labor is another result of this era.

The starting point of open was with open source software as the most known form. This form contains a distribution of software freely and using developers' collaborative skills to the program. As Eric Raymond said, "Given enough eyeball, all bugs are shallow.". In addition to fixing bugs, open source software succeeds collaborative projects like LINUX, or GDL, etc. According to (Scharff, 2002), open source (OS) has no single definition, but some certain characteristics make the source available for any system and open to change who wants to make. Due to the prevalence of open source software, another definition of open source is software code which can be copied freely, redistributed and modified by users. There are three components of OS as collaborative innovation: knowledge sharing, ongoing contribution, and distribution. If the active contribution is explained regarding software, it is producing codes and modification them. In addition to it, providing feature list, reporting bugs, and distributing to others are defined as a passive contribution. The second component of OS is knowledge sharing which has three subcategories: knowledge dependence, knowledge independence, and knowledge interdependence. If one of the contributors has a lack of knowledge to succeed the task, then knowledge dependence can be mentioned. In knowledge independence, each user can access others' knowledge. As a last sub-category, knowledge interdependence mean that contributors share their knowledge and collaborate with each other actively (Messica, 2009).

Open source hardware or software has many benefits like

- Source codes are available online and user-friendly, so customers can easily use them and modify according to their needs.
- Customers can reach software which they need free of charge, and also they are aware of software design, utilize it easily.
- When a user of open source software or hardware make any changes or development on it, they upload, and it may help to other users.
- In open source culture, there is no restriction for any design. The user only needs to use design, all details and information are available freely if the user wants to make any change or development.
- Many users can use the same thing at the same time, and they can share their experience, and their development on it (Trivedi, Vijay, & Awad, 2013).

Open innovation is another form of open. It also defines as the democratization of innovation. This form encourages people to be creative and solve problems with the hands-on method. Users and production process are connected to produce quickly and more dynamically, so user-generated products were formed. Crowdsourcing (Howe, 2006) is another form of similar approach which is opening a specific task to contribute by people. All these are results of networking economies which are developed or developing with working the same logic as outsourcing of industrial labor. Also, the internet and increasing velocity of spreading globalization were an impulsive force for all these.

Open design is the reflection of a new way of thinking. Developments in the last few decades lead to this new way which includes collaborative networks. When the world started to change, it affects daily life and causes new developments in domestic design. New design terms refer to fix bugs and old failures here.

> *"Open design is a catchall term for various on- and offline design and making activities. It can be used to describe a type of design process that allows for (is open to) the participation of anybody (novice or professional) in the collaborative development of something. As well as this, it can mean the distribution and unrestricted use of design blueprints and documentation for the use by others." (Tooze et al., 2014, p. 538).*

Not only software but also hardware was affected by an open movement which is Open Design. Besides, manufacturing techniques were affected by open design, too. In the last decade, these effects gained momentum. Amateur users were defined as prosumers because tools usage moved from factories to the hand of amateurs (Toffler, 1980). A new generation of designers today may not feel alienated from open software of open design. Open is the ideology of our time. However, the proximity of young generation is feeling material with their hands. Moreover, they are willing to use functional tools of software and programs as well as their creative outcomes, and this makes them blind to the protocols and hardware which make openness itself possible. This is the irony of our era (von Busch, 2012).

Table 2. Existing terms which are related to open design (Tooze et al., 2015)

Term	Definition
Co-creation	the generation of anything by more than one person.
Co-design	the design of something by more than one person.
Open Innovation	being open to and seeking out contributions of others outside of an organization for the purposes of bringing in new ideas.
Open Source Innovation	the open sharing of design information or knowledge by an organization with collaborators as part of open innovation.
Open Design Solution	a set of plans and instructions that enable others to make use of the design information in making or modifying the 'design solution' without restriction. A design solution is something that can be acted on directly and in the context of physical things, be made.
Open Design Contribution	any contribution, in any format, to a design process that is made available for use by others without restriction.
Open Design Process	the development of a design solution or solutions that are created by the input of open design contributions and results in an open design solution or solutions.
Open Designing	engaging in the design of anything by an open design process.
Open Design Project	any project that follows an open design process

2.2. Development of Open Through Projects and Products

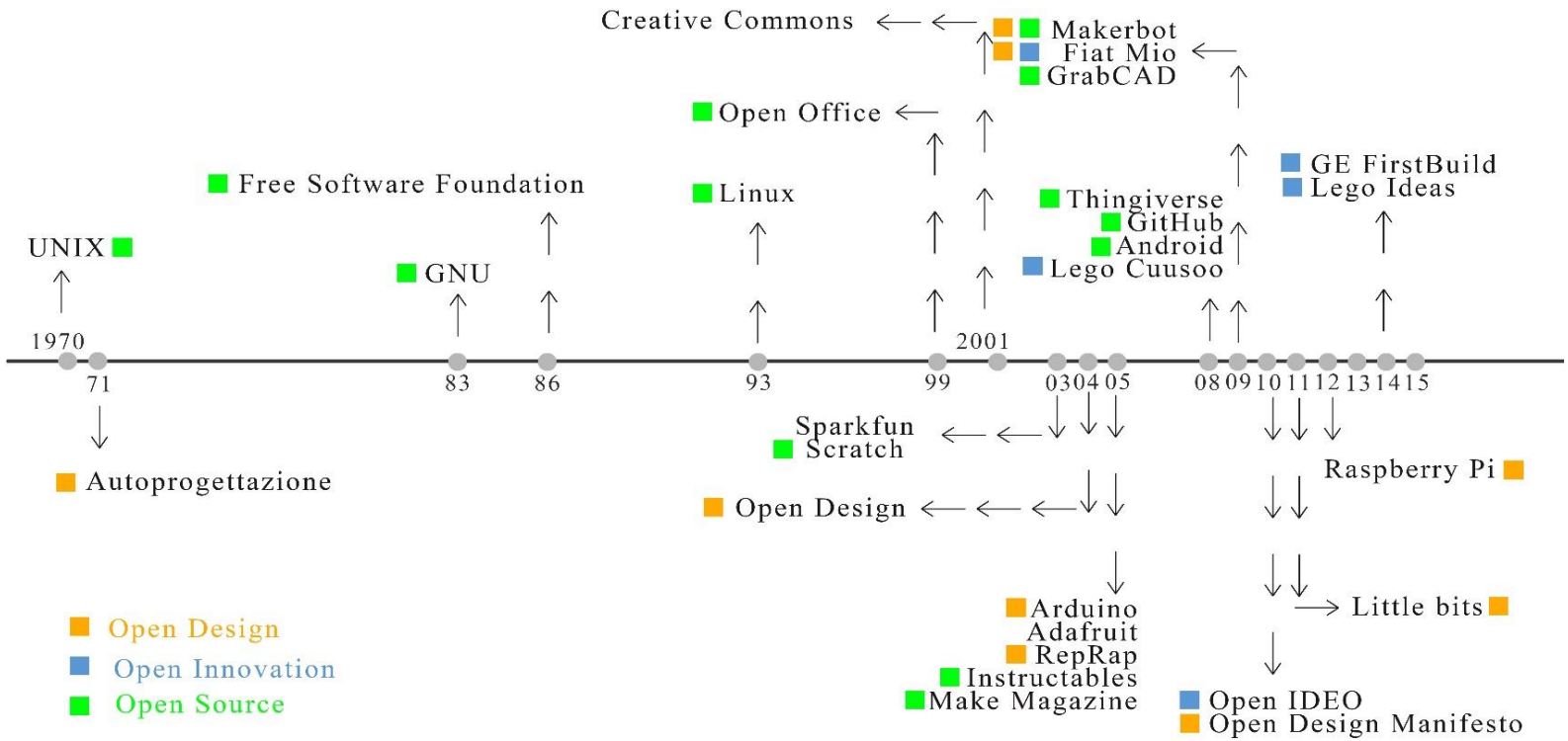


Figure 2. Timeline of Open-X (Aykul, 2016)

The earliest example of openness belongs to open source with UNIX which is multiuser and multipurpose operating system developed by Bell Laboratories. It was mainly developed for software developers. The project was started at the end of the 60s, and it became popular in 80's. The main role behind its popularity, especially in an academic world, was its openness. It could be used in any scientific area for calculations, database and many other functions (UNIX, 2016).

The open publication of designs, in the form of plans and instructions, and is not a new thing. In 1971, Italian industrial designer Enzo Mari began a project that rebelled against what he saw as the shallow and status-driven product design being created by his contemporaries for mass manufacture. Autoprogettazione, which roughly translates as 'self-design,' is a set of instructions for 19 pieces of self-made furniture (Mari, 2002). Mari offered the plans for his wooden furniture to anyone who sent him a self-addressed envelope. In effect, they were free except for the means of delivery, which can be seen to be comparable to paying for internet access when downloading open designs online. Mari's work can be seen as an example of democratizing access to the work of designers, in that he considered accessibility, tools, and materials that are available to the average person and that the products were within their capabilities to construct (Tooze et al., 2015).

In 70's, Richard Stallman started working at MIT Artificial Intelligence Laboratory, there was a computer which was worked with the open operating system, they did not use open as a term at those times, but research group and Stallman were named as hackers to make systems developable and open to making changes. They used the name of hacker as a person who loves programming and makes changes on it. Also, free software was another term for them. However, free did not mean to no price; it referred to the word of independent. After changes in laboratories, people started used completely closed system computers. These were modern computers for the public, and when anyone bought one of them, then they should have signed and non-disclosure agreement. It meant that no one could help their neighbor if there were any trouble. Then, Stallman quitted his job at the university to develop free and open processes for any coding language to prevent that university could take his work as its own and limited publishing his work. A project of GNU was started in 1983, and it means that GNU is not UNIX. It aimed to provide freedom of copying, developing,

redistributing and modifying of software for all computer users. In 1993, GNU will have reached to success with LINUX (Stallman, 1999). Free Software Foundation (FSF) was found to support a project of GNU as a civil society organization (CSO) in 1986 by Richard Stallman. The organization aims that everyone can use the free operating system and software on his or her computer in works or personal life. According to FSF, if people want to modify and share software which they are using, then software should allow this.

OpenOffice.org was established in 1999 by German Company StarDivision which was acquired by Sun Microsystems for $59.5 million. The purpose of austerity to buy Microsoft Office for 42000 staff (Hillesley, 2012). In 2000, the company made source code open to building open source development community and offer an open and free alternative to MS Office. It became default office software for LINUX users, and by 2004, it achieved 14% market penetration. Moreover, OpenOffice.org had already reached irreversible installed user base (Casson & Ryan, 2006).

Creative Commons (CC) was founded as a founding in 2001 with the help of the Center for the Public Domain. In 2002, the first copyright licenses were published for free to public use. Its functions are similar to FSF GNU GPL, but CC is not for software developers. It aims to protect artists, designers, engineers, makers, etc. while making their works more accessible. Furthermore, CC has a project of the lowering barrier which affects scientific studies negatively to make data and materials more accessible and easier to find and use for research. Another lowering barrier work of CC is for education materials, and with this work, the aim is providing sharable and reusable education material. Between 2003 and 2005, the number of licenses was increased from 1 million to 20 million, and according to the last released number in 2009, there is 350 million CC (Creative Common, 2016).

Scratch provide the visual environment and online community to the fact that people can write their code, stories, make animations and share them with others as seen Figure. Scratch encourage young people to think more analytical, creative and systematical, and also work collaboratively. It is a project of Lifelong Kindergarten group at MIT Media Lab and was started in 2002. The 2nd version of Scratch which is used today was released in 2013. Until now, over 17 million projects were shared, more than 13 million users were registered, approximately 100 million comments were posted. The target user is 6-14-year-old children,

but many adults use Scratch as an educator, parent or just for personal needs. Scratch gives the idea of co-creation and sharing to children (MIT, 2016).

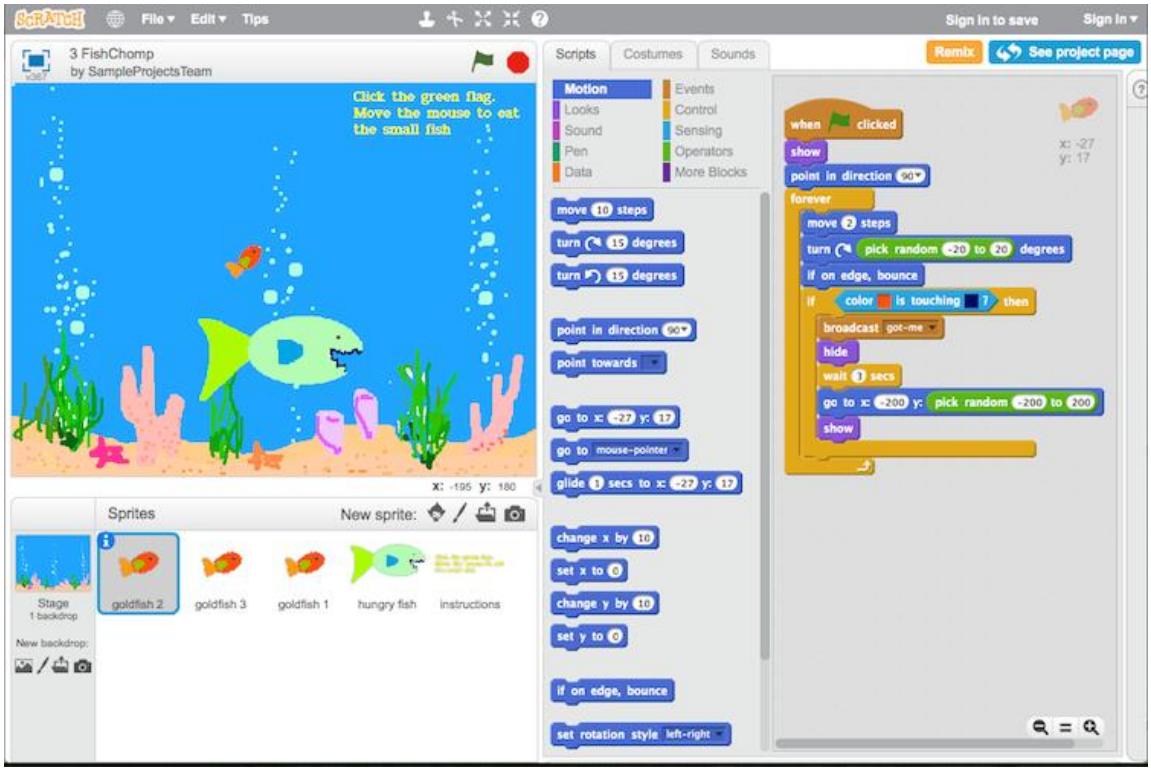


Figure 3. Scratch's visual developer environment (MIT, 2016)

SparkFun is an online retail store which is founded in 2003. However, there is a difference between SparkFun and any other retail stores. The difference is SparkFun releases all electronic pieces as open source. They noted that "open source tech encourages innovation and creativity while helping empower individuals to build the projects they want.". Employees of SparkFun are also customers of SparkFun at the same time like an artist, designers, makers, craftsman, etc. In addition to the online retail store, SparkFun has a department of education which provides tutorials and online classes to educate individuals (SparkFun Electronics, 2016).

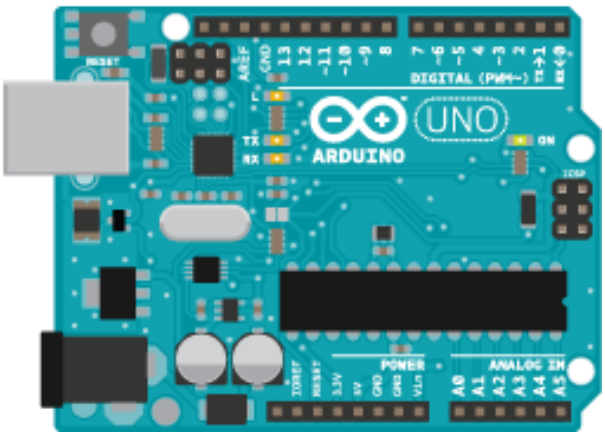


Figure 4. Arduino Scheme (Arduino, 2016)

Arduino is open source hardware which enables to make anybody interactive projects with electronics thanks to easy to use boards. Arduino can turn inputs which are taken by the environment by sensors into outputs like actuating motors or blinking a LED. Arduino is a microcontroller which can be programmed by Arduino IDE. Users can build thousands of projects from everyday objects to complex scientific instruments. Due to its simple and accessible user experience, from beginners to professionals use Arduino to make their prototypes. Thanks to the worldwide and multidisciplinary community, there are many example projects and users to help new ones (Arduino, 2016).

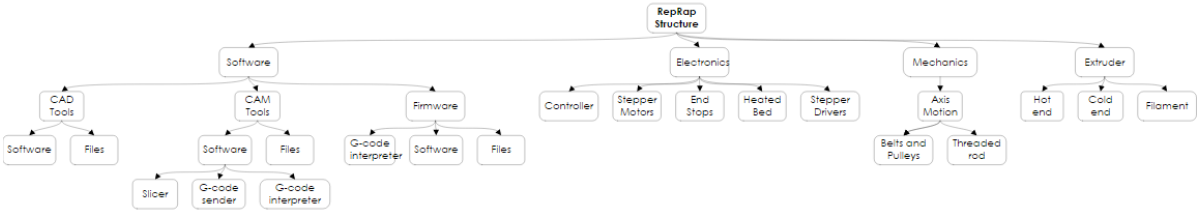


Figure 5. RepRap component structure (RepRap, 2014).

RepRap aims to offer a set of instructions and bill of material to build a manufacturing machine like 3D printing. The difference of it is to use another 3D printer to build a 3D printer. RepRap is an open source community project and the first in the 3D printing area. It offers low-cost 3D printers for the first time. As seen in Figure 7, RepRap's structure is mainly separated into four different areas which are software, electronics, mechanics, and

extruder. The software is developed regarding CAD tools, CAM tools, and Firmware. Electronics parts are also listed according to their features places where users can supply them. In the extruder part, not only mechanics or electronics are considered, but also filaments are considered (RepRap, 2016).

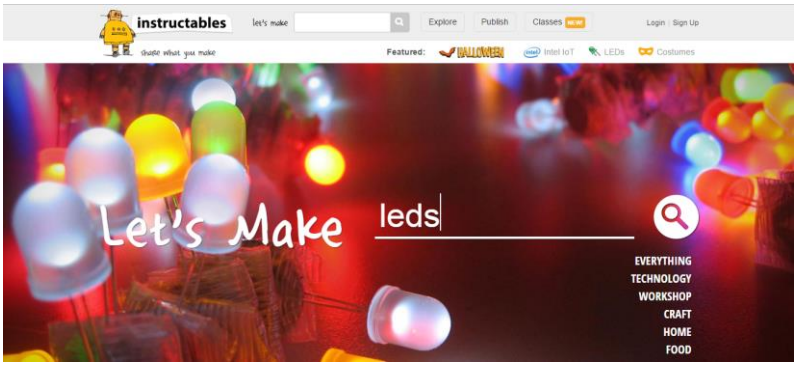


Figure 6. Instructables homepage (Instructables, 2016).

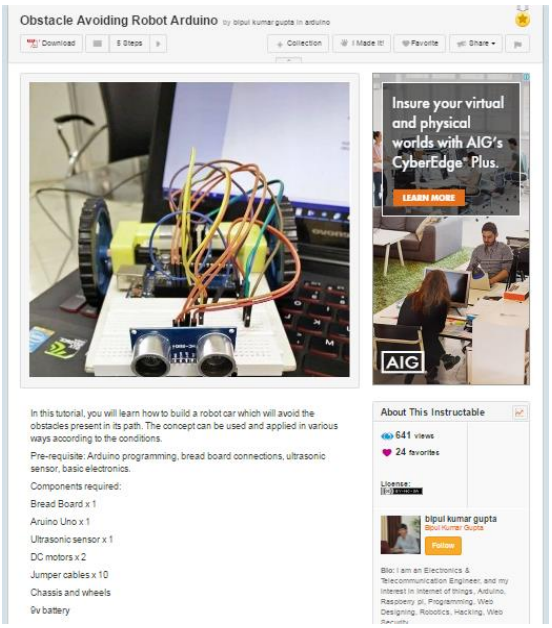


Figure 7. Instructables sample project page. (Gupta, 2016)

Instructables was a web platform where people can share their creations, explore and contributes others'. It was founded by Autodesk in 2005. As seen in Figure 6, people can find any instructions about many areas such as food, home, craft, and technology. When a person shares own creation, there is a bill of material, instructions,

visuals of production or assembly, video in Instructables page. Moreover, how many people also made it, and their feedbacks and problems are placed on the page (Figure 7).

Make Magazine is also founded in 2005 by Maker Media. The aim was connecting makers with each other's, products and services. Maker community grows day by day, and they should bring a DIY mindset to technology. Maker magazine contains much knowledge about makers and their projects regarding creativity and technology (Figure 8). It also supports the transformation of innovation, culture, and education by maker movement. Not only with magazines, but also with getting started guides and kits aim to teach technology to makers (Maker Media, 2016).

Figure 8. Make Magazine February 2015 cover (Advancertech, 2015).

Thingiverse is another web platform which people can share their design of 3D printable things, discover and make others. It is the world's largest 3D printing community. The aim is encouraging people to create, mix things and make their needs by 3D printers. The platform wants to engage novice and professional users of 3D printers with spirits of open, so all design is licensed under CC. Even Thingiverse was founded before Makerbot; it is run by Makerbot (Thingiverse, 2016).

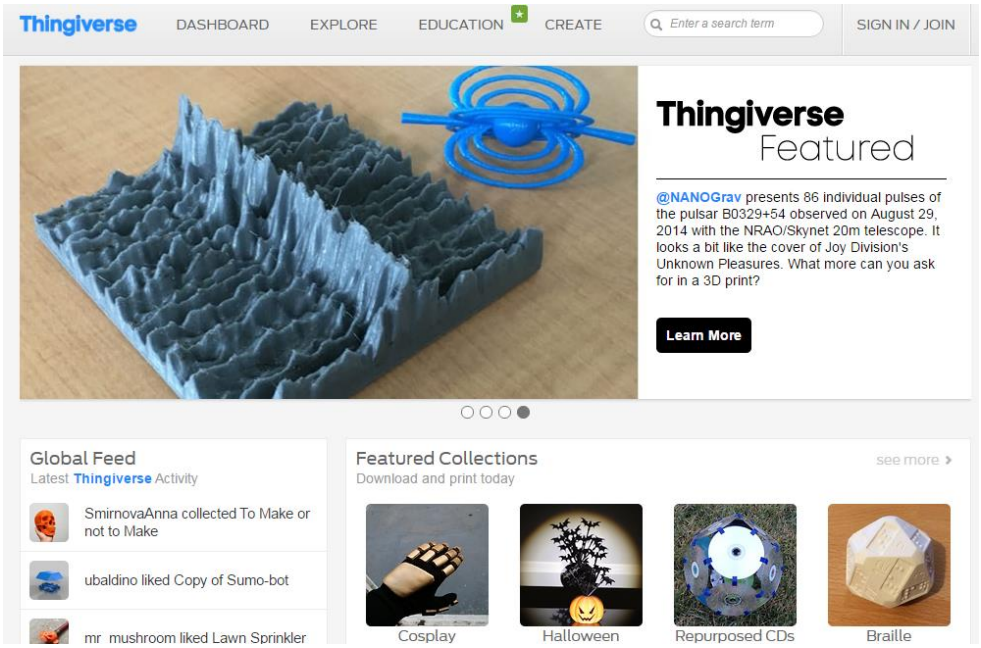


Figure 9. Thingiverse homepage (Thingiverse, 2016)

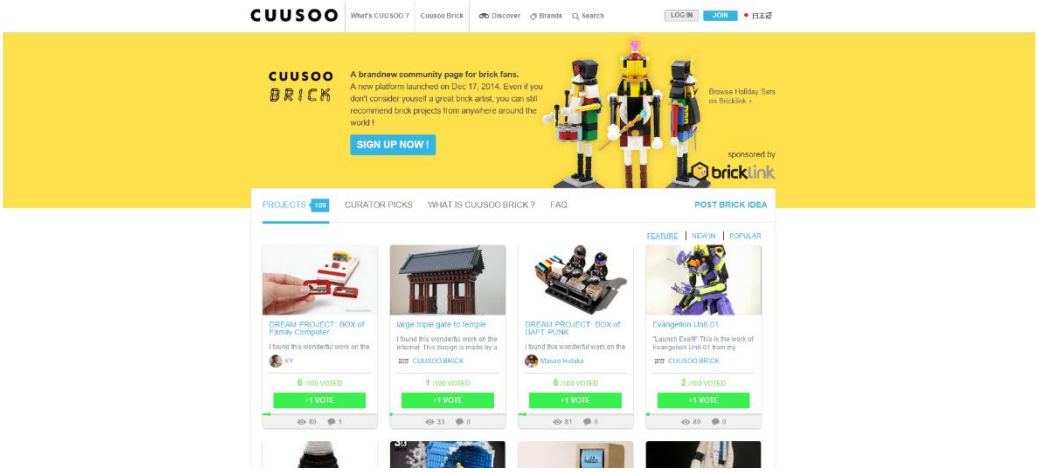


Figure 10. MOC web page of Cuusoo by LEGO (Brickfan, 2014)

CUUSOO brick is a crowdsourcing platform which offers instruction building service. The designer of model summits design, if it gets more than 100 votes, then CUUSOO publishes its instructions. The platform is the first consumer-generated brick community with crowdsourcing and funding features. After a design takes 100 votes, they are started selling on Bricklink MOCShop (Cuusoo, 2016).

Figure 11. Makerbot v1 3D printer (Makerbot, 2012).

Makerbot is the first company which offers affordable and accessible 3D printer for everyone because founders of the company believe that everyone is an innovator. The mission is democratizing manufacturing and offers an alternative to consumerism. The first working prototype was made in 2009, and next year, the company participated in Consumer Electronics Show as the first 3D printer company. In addition to 3D printer manufacturing, MakerBot also runs Thingiverse as the largest platform its area as mention before (Makerbot, 2016).

In 2009, the car manufacturer Fiat launched a co-design platform to crowdsource and develop concepts to imagine the car of the future. Between August 2009 and October 2010, over two million people in 160 countries visited the site and more than 17,000 ideas were submitted to the Fiat Mio website (Creative Commons Australia, 2010). A team of professional designers and marketers at the Fiat Style Centre in Brazil then utilized the site to interact with people via chat rooms, gaining an understanding of their insights, desires, needs and criticisms.

Figure 12. Fiat Mio first crowdsourced car of Fiat (Ennomotive, 2015).

The information released would not enable a person or company to make a facsimile of the Mio; there are no schematics or a bill of materials published to enable fabrication by others. However, the conversation surrounding the ideation and feedback process coupled with the specifications of the 3rd-generation concept car (FCC III) would allow others to draw rich conclusions and gain insights into what people want from a future car (Tooze et al., 2015).

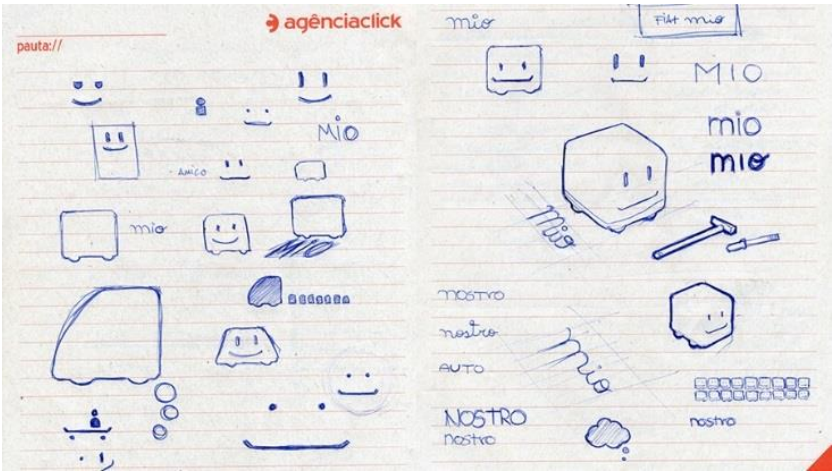


Figure 13. a Crowdsourced icon of Fiat Mio (Ennomotive, 2015).

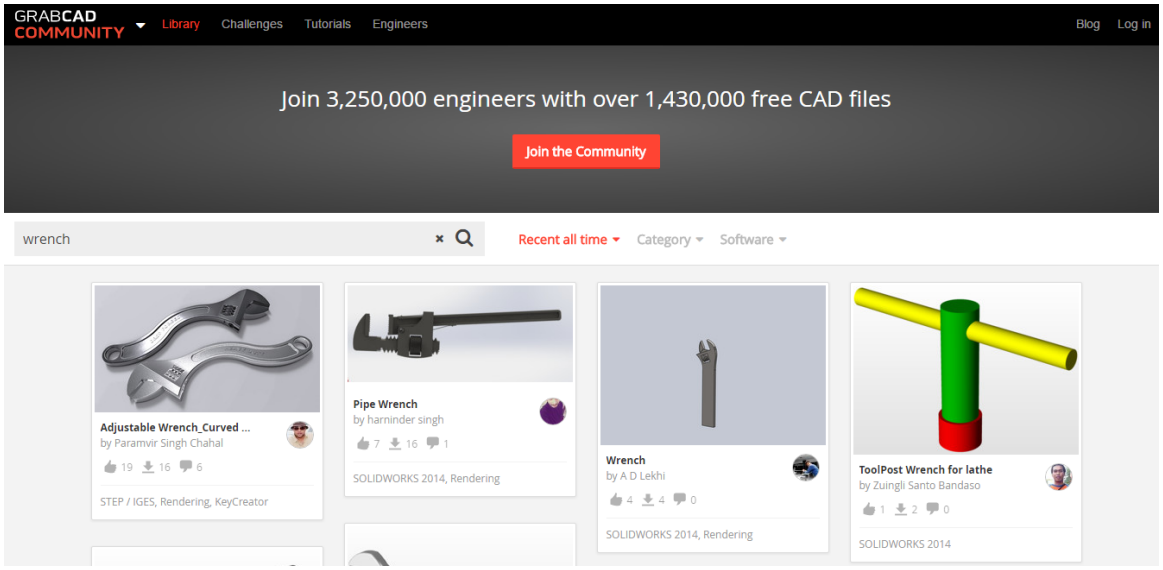


Figure 14. GRABCAD Library page view (GrabCad, 2016).

Another open source sharing platform is GRABCAD which is founded to connect engineers with CAD files sharing in 2009. In the platform, people can access, CAD files which are categorized software by software, 3D view, exploded view, render and measuring features online. Also, they can download files and make changes. In 2013, Grabcad launched workbench feature which makes engineers or designers can work together on the same file. Moreover, according to data shows that more than 3.500.000 users and 1.570.000 open source CAD files shared in the platform (GrabCad, 2016) .

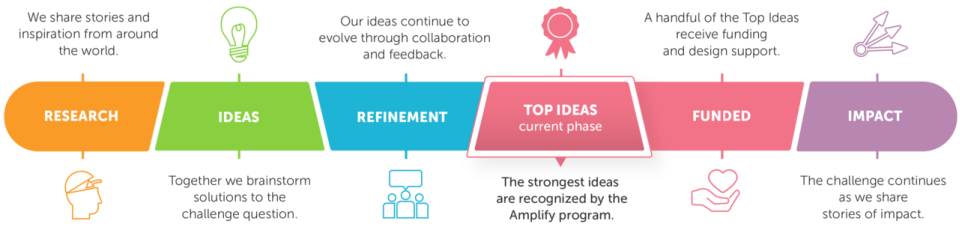


Figure 15. Phases of Open IDEO challenges. (Open IDEO, 2016)

"Open IDEO is a global community working together to design solutions for the world's biggest challenges." Open IDEO offers as a collaborative process with challenges, programs and

different processes such as events and meetings. The challenge takes 4 to 5 months to solve the specific issue by contributing, refining and prototyping solution. The program takes longer times and includes multiple challenges and other events to solve more general problems. According to Open IDEO, open innovation is the new frontier. As result of all these processes, increasing awareness, support project development, and supporting ecosystem about specific areas are seen in Figure 15.

Figure 16. Bitbots made with Little Bits (Little Bits, 2015) .

Little Bits aim to democratize hardware and offer tools which make everyone encourage to invent and create things. The hardware is easy to use and different size blocks. Regardless technical ability or discipline, Little Bits offers an innovative solution to help people in the design process. There are more than 60 parts, so millions of combinations to make things and reduce prototyping time. Little Bits also supports maker movements and open source hardware movement. The hardware offers multidisciplinary tools; it means that from hardware entrepreneurs to educators who want give inspirations for next generation can use it (Little Bits, 2016).

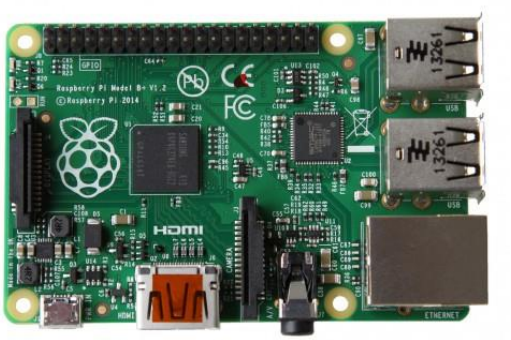


Figure 17. Raspberry Pi Model B+ (Raspberry Pi, 2014).

Another open hardware is Raspberry Pi which is credit card size computer slower than a normal computer but can function as basic LINUX computer. Board and source offer as open for users. It includes 256 or 512 MB RAM and USB ports, and also after the upgrade, there is a port for Ethernet connection. The hardware enables people to create interactive objects or IOT projects. Thanks to pins on the board, people can make connections easily (Open Source, 2016).

Figure 18. How FirstBuild works (First Build, 2016).

In contrast to previous open source tools, FirstBuild is neither a software nor a hardware. It is co-creation community which aims to connect people and create an environment to encourage them to make things. Mass production causes many risks and costs for people who want to release the own product in a small batch. However, FirstBuild

disappears these and offers conditions for them turn their idea into market easily and quickly. Its values can be listed as community, openness, sustainable, excellence and integrity. All these supports to the community for more sustainable projects (First Build, 2016).

Figure 19. How LEGO Ideas works (Lego IDEAS, 2016).

In similar with Lego Cuusoo, Lego Ideas works in crowdsourcing approach. However, instead of bricks, it focuses on all products with the concept. A user shares ideas, and if it gets more than 10,000 votes, then it is taken under review. After a successful review, the idea of the user may turn to product and release as a new Lego product (Lego IDEAS, 2016). Due to community structure, Lego Ideas is valued as open source.

2.3. Open Source Tools in Education

The Internet makes people more connected to the rapidly changing world. Issues and situations around people are more complex, ambiguous and altering quickly. Thus, education has to be adapt to all these, because working environments, required skills and also students are changing due to the impact of changes. Todays, learning "what" is turned to learning "how" due to the enormous amount of online information and easy to access. Moreover, students are more active and qualified to solve problems and use new media, so open source should be included in the education system to offer to learn in individual and collaborative level, and also with real context (Auer, Juntunen, & Ojala, 2011).

Open source tools can be used not only for software developing, but also in many areas mechanical, electrical engineering, business, forensic, space studies, etc., and they are

used in engineering education since they offer reliability, customization, innovation, collaboration and low cost (Scholz, Juang, 2015).

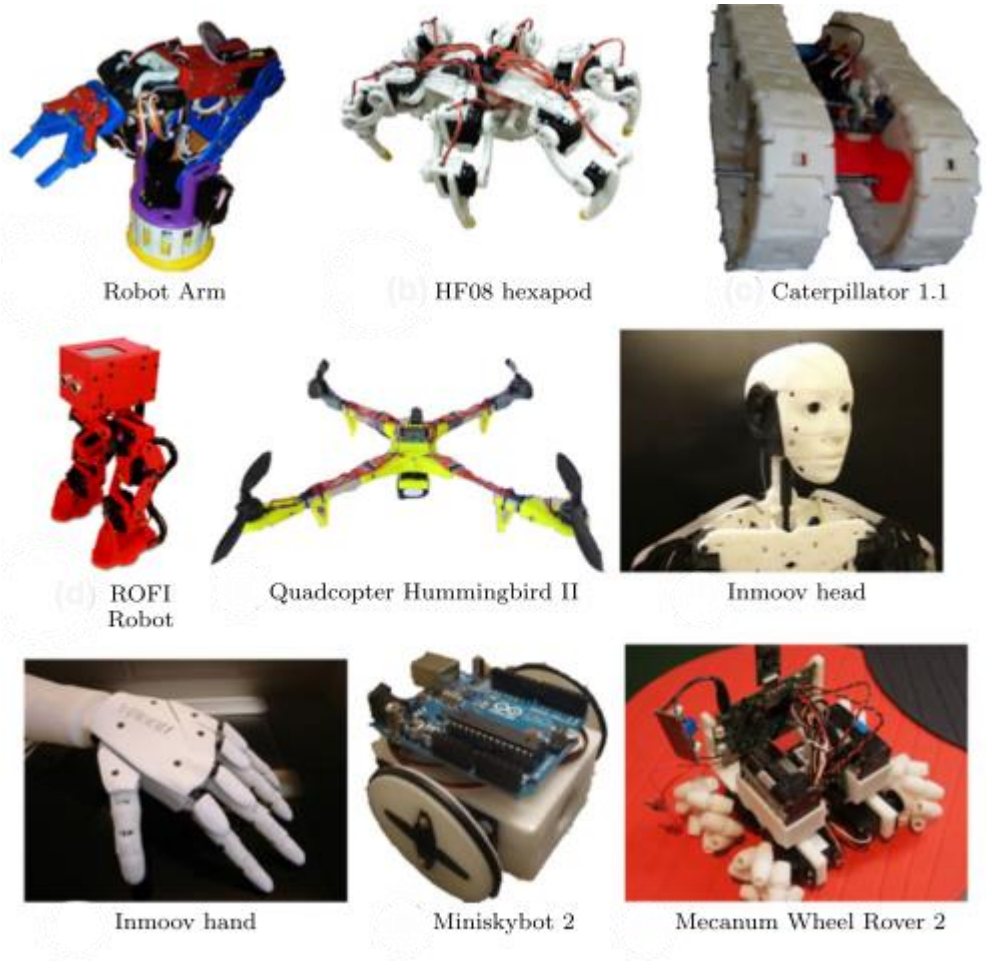


Figure 20. Examples of free printable robots (Armesto, Fuentes-Durá, & Perry, 2015).

Open source communities offer many designs which can be suitable to teach robotics like printbots. They can be used education and non-commercial purposes to research or teach. They are also more than simple toys. Printbots can contribute students' robotics skills like basics of robotics, improve design, capabilities, and stability of robots. As seen in, students can study on the different type of robots which are provided as open source; then they can develop and change their features. The aim of the study was building a multidisciplinary team, and to design and prototype robots to attend European Project Semester. Their working system is seen in Figure 21.

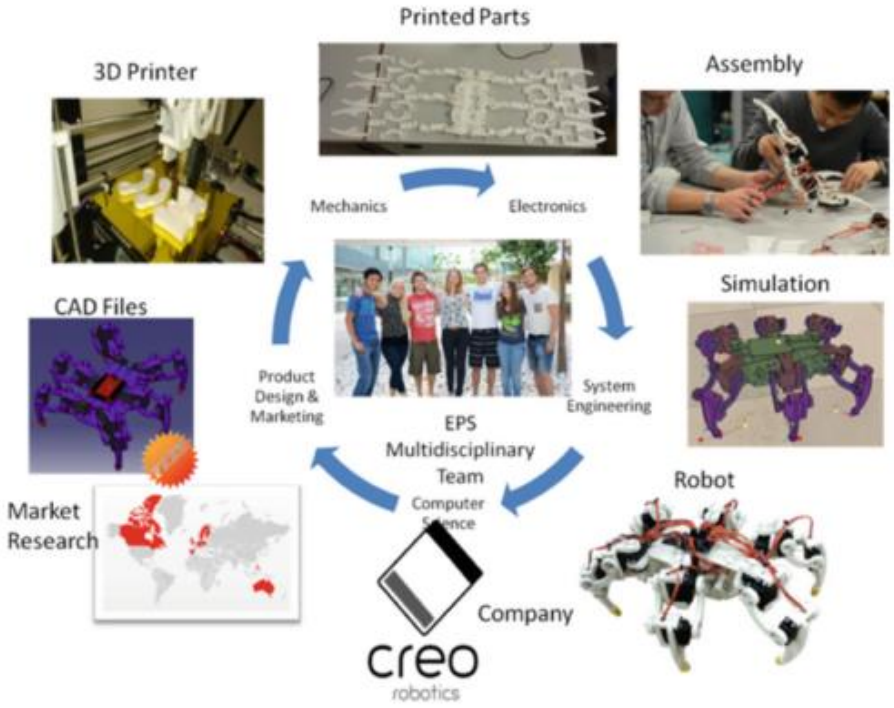


Figure 21. Project management of open source project for EPS(Armesto et al., 2015).

Students' feedback for open source tools use in their project can be summarized that they learned a lot from their mistakes thanks to the iterative working system, it was possible due to an economical solution which is offered by open source tools. With printbots, students had hands-on experience with real problems. Thanks to step by step approach and DIY method, students learned robotics in details. Moreover, they built a connection between theoretical written information and practice of that information, and also students were more motivated during projects and more satisfied at the end of the projects (Armesto et al., 2015).

Another example is about embedded systems design with open source software. At the University of San Buenaventura in Columbia, students had a project to design with using open source tools in the Electronic Engineering Department. License purchasing or upgrading costs were a limitation for them, but thanks to open source software, teachers offers a more capable environment for students. Moreover, developing countries could not support their institution as much as fitting to technology, so open source software can provide many advantages in this circumstances (Benavides, 2011).

Open source community and its culture can provide a new approach to educational institutions as much as open source tools themselves. Seneca College offers a course for its students with this approach. Their Open Source Development course encourages students to release their software version 1.0 with faculty support within Mozilla community. In the research, their learnings from outcomes of the course were summarized as:

- *"It is important to persevere.*
- *It is OK to share and to copy the code (within the con- text of the applicable Open Source licenses) instead of guarding against plagiarizing or having your code "stolen."*
- *You have done, and it will become a resource. (It is interesting to note that many of the Google searches which the students are performing now return our course wiki and blogs).*
- *Ask for help instead of figuring things out on your own.*
- *Key figures in this industry do not stand on pedestals – they are real people and are approachable. Relationships are important, and communication is critical.*
- *The code is alive."* (Tyler, 2008).

In undergraduate information security program, students must learn digital forensic. However, software and application which are used in the area are costly to create a barrier to providing a realistic experience for students. As the caution for these problems, Kennesaw University, Information Security department started to use open source tools to provides realistic cases for students(Austin, 2007).

There are some downsides of closed source educational products such as vendor lock-in, incompatibility and lack of technical insight. They cause limitations during education and research. CubeSat products are one of them, and LibreCube Initiative design open source product to prevent to these limitations. Department of Engineering Science started to use their design to develop their studies, teach CubeSat to students and make more research less costly more reliable and more capable at National Chang Kung University (Scholz & Juang, 2015).

Reasons for using open source tools in many areas of education prevent limitations caused by high cost of educational software and products and closed source which also prohibits to make a modification to follow technological and innovative changes in the area.

Industrial design departments also need to follow technology and trends. As similar as other departments, they may use open source tools for these purposes.

"Industrial Design is a strategic problem-solving process that drives innovation, builds business success, and leads to a better quality of life through innovative products, systems, services, and experiences. Industrial Design bridges the gap between what is and what's possible. It is a trans-disciplinary profession that harnesses creativity to resolve problems and co-create solutions with the intent of making a product, system, service, experience or business, better. At its heart, Industrial Design provides a more optimistic way of looking at the future by reframing problems as opportunities. It links innovation, technology, research, business, and customers to provide new value and competitive advantage across economic, social, and environmental spheres." ((ICSID, 2015).

Industrial design should be trans-disciplinary, and in interaction with many areas from social and life sciences, because industrial designers need to solve complex problems. All these problems are related to many other disciplines like behavioral science, technology, and business, etc., but there is no or basic education in these subjects in an industrial design education (Norman, 2010). In Turkey, the main purpose of industrial design education is to train designers to improve or design craft products, then increase their market potential (Er, Korkut, & Er, 2003). Moreover, intellectual properties, new product development and investment in the new field of business are the subjects which Turkey need to catch other countries. Industry' needs are not satisfied by ID or IDP Education programs. There are gaps between industry's expectation and outcomes of education programs for industrial design students (Erkarslan, 2013). Education of today is not suitable to create a multidisciplinary environment to solve current complex problems. New skills are needed instead of disciplinary skills (Design Collaborative, 2014).

For teaching interaction and more technology, there is a course which is called as Prototyping Interactive Media in the Department of Product design at the Norwegian University of Science and Technology. In the course, students learned to program with Arduino. They had two assignments which are a traffic lamp and a music instrument. At the end of the course, there are six different projects in 3 categories which are music: BeatBall, Rubberbeats, Discover; things with a personality: Argus, GhostWriter; and interactive art: PLAY. Thus, students turned everyday objects into interactive ones (Alsos, 2015).

In the example of Virginia Tech, they make students use Arduino to move their design from sketches through their real functions of wearable and pervasive computing products. In addition to industrial design exercises, hands-on exercises were added to syllables. In the content of this course, there are 12 students from 4 different departments which are electrical and computer engineering, industrial design, and marketing. As a result of the study,

industrial design students have the opportunity to design interactive products with the support of engineering students and also thought their consumers more deeply with the support of marketing students. Moreover, students did not work only their field, all of them worked together each disciplines week by week. As a result of this course, students learned working in the interdisciplinary team and boundaries of the teams for their future works (Martin et al., 2013).

As a new type of engineering discipline, the design of intelligent systems was tried to teach industrial design students at the Eindhoven University of Technology. The department had the challenge of teaching mathematical background of machine learning to students who are not a mathematician or computer scientist. They decided to teach it because even the most basic everyday object started to contain embedded electronics or computers. Due to the use of Lego Mindstorms, industrial design students learn more abstract theories for them through tangible units better. Also, Lego has positive effects on students since their childhood memories, so there is less bias (Yeh, Lo, Huang, & Fan, 2007).

Figure 22. Interactive design presentation with the interactive and functioning prototype (Aprile & van der Helm, 2011).

At the Delft University of Technology, there is a course which is named as Interactive Technology Design. It offers hands-on experience to students, while students learn technology with design. Iteration is the significant activity in the course. There are five steps which are a hack, autonomy, nut cracking, users, and integration. Students should make a prototype in each step with iteration. In the step of a hack, students make a prototype as

rough as possible, but in the user's step, they need to show the function of the products. At the end of the step of integration, students should exhibit their design with interactive and functioning prototype as seen in Figure 22. Moreover, students use Arduino and Max5 to make their prototype interactive.

At METU, there is Interactive Prototyping for Designers course in industrial product design department. The aim of the course is also offering hands-on experience while teaching basic electronics and building circuits, sensors, actuators, coding, etc. During the course, students make interactive prototypes and are encouraged to think outside the box. Arduino is used as a tool in this course as well.

As seen in the examples from many disciplines, open source can be used in education to set new skills to students for preparing them to solve today's and future's problems. They can support their lifelong learning with open source, so teaching and adopting open source tools into industrial design education may contribute students' development to not only prepare them as competent for the industry but also competent to solve any complex problems of future in a multidisciplinary environment.

CHAPTER 3

PHASES OF RESEARCH METHODOLOGY

Openness is a popular term in any professions today. It requires contribution as much as design. A designer or a developer contributes to any project; then it starts to develop in favor of her/him. Due to the interdisciplinary content of industrial design, if a designer follows the trend of open source and contributes it, then technologies around it may evolve in favor of industrial designers. Otherwise, all technology start develops for other professions, and the gap between designers and others may extend. Open source tools offer an easy, cheap, and practical way to express design ideas. In addition to the contribution to open source tools and making them evolve in favor of industrial designers, open source tools may help their design processes in terms of easiness, low cost, and practicality. Showing open source tools' benefits to design process may be the way to make industrial design students start using them. For this purpose, difficulties in their design process were identified with the guidance of Chen's study. Chen's study shows that industrial design students have difficulties in the several tasks which are categorized as design research, concept generation, design decision, design presentation and design documentation (2015). Thus, the study's validity for the research group was approved. The result of the questionnaire was used to find problems in the design process which may be overcome by open source tools' usage.

As a second step, a lecture and feedback session was prepared to learn their opinion about open source tools and their use in industrial design studio courses. A second questionnaire was prepared to use in the feedback session which includes pre-lecture and during lecture parts. They are willing to use open source tools in their industrial design studio projects, and their general opinion is that they will be useful.

3.1. Questionnaire for Evaluation of Industrial Design Students

The questionnaire aims to learn that whether open source tools can help industrial design students in any tasks of design studio course, and also measure industrial design students' knowledge and practice level about open source.

The questionnaire has four sections which are personal information, tasks in industrial design studio course and difficulty level, reasons for difficulty, and awareness of open source (see Appendix A).

In the first section, there are three questions which are name and surname, e-mail address, school, class. Tasks in industrial design studio course and the difficulty level is another section with a question which contains 5 degree Likert and 20 items. These items are named from T1 to T20, as seen Table 3. Students should accomplish several tasks to reach a design. They are design research, concept generation, design decision, design presentation, and design documentation. As seen in Figure 23, these five categories are separated into 34 sub-tasks (Chen, 2015). In the questionnaire, 20 of 34 sub-tasks are used, because some of the tasks are close regarding mean and content for students and this cause misunderstanding. Also, 34 option in a question looks long for students, and it may cause not to answer or random answering.

Next section also includes one question which aims to learn reasons for difficulties in these tasks. Reasons can be classified as experience, technical knowledge like ergonomics, material, etc., budget, time, technical support like help in the workshop, equipment, etc., relevant courses, lecturer, and classmates. There are 16 reasons to examine in Chen's study (Chen, 2015). However, in this research, 8 of them were asked, student. Reasons are also named as R1 to R8 in a queue, as seen in Table 4.

The following section measures to awareness of industrial designs students about open source. There are 3 questions which ask they have ever heard term of open source, knowledge about specific open source tools, which are Arduino, Raspberry Pi, Rasbian, OpenIoT, BugLabs, Makezine, RepRap, Lasersaur, GrabCAD, Thingiverse, Blender, Freecad, Inkspace, Gimp, Scribus, and as a last question if they use one of them or another open source tool in their design studio course project, or not, also they think it is useful or not.

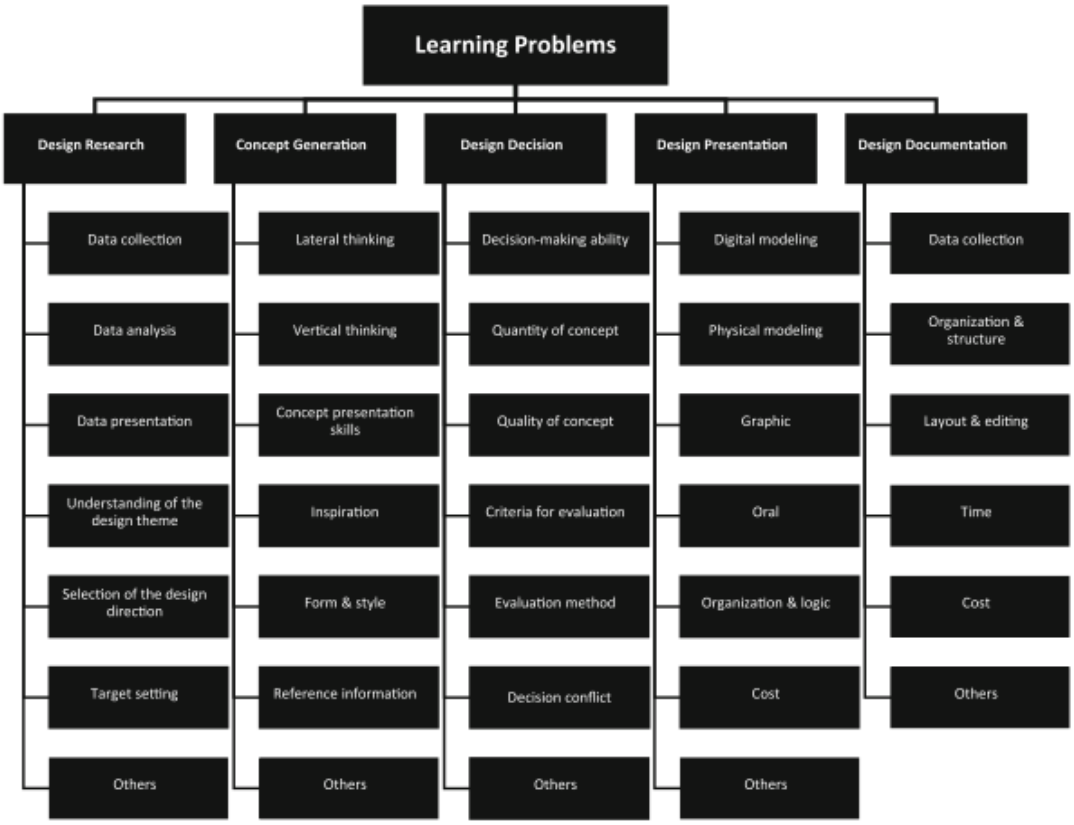


Figure 23. Problematic tasks in design studio courses (Chen, 2015).

Table 3: Tasks in Industrial Design Studio Course and Their Codes

Code	Task	Open source activity
T1	Data collection and analysis	Source
T2	Presentation of data (how they can be used in design)	Indirect
T3	Understanding theme of project	Indirect
T4	Understanding requirements of projects	Indirect
T5	Generating ideas in enough quantity	Source
T6	Changing and developing ideas	Sharing, Source
T7	Express the concept quickly and correctly	Contribution, Source
T8	Finding inspiration	Source
T9	Generating form and style according to user's need	Source
T10	Finding reference knowledge	Source
T11	Decision skills	Sharing
T12	Evaluation criteria	Indirect
T13	Meeting lecturer's expectations	Indirect
T14	Digital modelling	Source
T15	Physical Modelling	Source
T16	Preparing presentation poster	Indirect
T17	Organization of presentation	Indirect

T18	Affording presentation budget	Source
T19	Delivering project in due time	Source, Contribution
T20	Affording overall budget for project	Source

Table 4. Codes and reasons of difficulties

Code	Reasons for Difficulties
R1	Experience
R2	Technical Knowledge
R3	Budget
R4	Time
R5	Technical Support
R6	Relevant Courses
R7	Lecturer
R8	Classmates

The research focuses on industrial design students in Turkey. To study on industrial design department, a person should enter university entrance exam. In a sampling of three stage research process, three universities were selected according to their entrance point, accessibility and student number. As a result, at Middle East University (METU), Istanbul Technical University (ITU), and Izmir University of Economics (IEU), first and the second stage of research were done.

Questionnaires were sent ITU and METU via mail, also were conducted directly. There are 2nd, 3rd, and 4th grades at ITU and IEU, but only 3rd and 4th grades attend to research because 2nd grade students have not started to design project at METU.

At first stage, there are 8 students from 2nd grade, 15 from 3rd grade, and 9 from 4th grade at ITU; 37 from 3rd grade, and 7 from 4th grade at METU; 19 from 2nd grade, 34 from 3rd grade, and 18 from 4th grade at IEU, and as a total number of participant which is 147.

At the second stage, 173 students participated in feedback session of the lecture which aimed to give some advice about open source tools uses in industrial design studio course. 28 students were from 2nd grade, 26 from 3rd grade, and 11 from 4th grade at ITU. At METU, there are 27 students from 3rd grade and 20 students from 4th grade. There are 18 students from 2nd grade, 27 students from 3rd grade and 16 students from 4th grade at IEU.

3.2. Data Collection and Analysis of Questionnaire

At the first question, there are five different difficult rates which are "It is not difficult," "A little difficult," "Somehow difficult," "Difficult" and "Very difficult." Each rate was respectively assigned 1 to 5 to determine their total difficulty rate for each class. Then focused on tasks which have total rate larger than an average ratio to analyze reasons.

As seen in Figure 24, there are some tasks are above the average of difficulty rate which is 382 such as meeting lecturer's expectations (T13), affording budget (T18, T20), time management (T19), express concept correctly and quickly (T7), finding inspiration (T8), decision skills (T11), and generating ideas in enough quantity (T5). The only task of meeting lecturer's expectation is supported with open source tools' usage indirectly. As the element of open source tools, the source may support T5, T8 T18, and T20. With sharing their design, industrial design students can overcome difficulties in T11. T7 and T19 can be overcome by both contribution and source of open source tools.

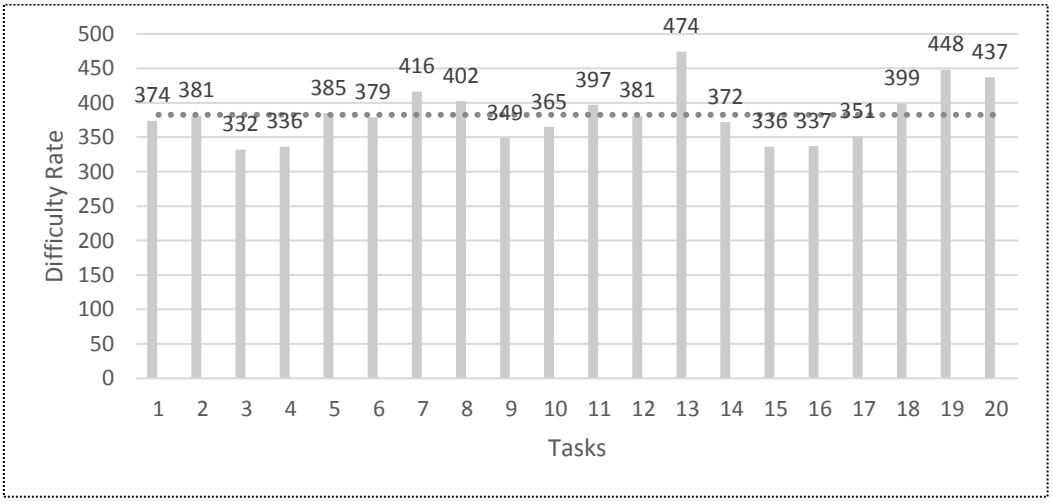


Figure 24. Difficulty rates and tasks analysis of Question1.

Students can examine open source projects, because of developer and contributors of the project share details, then give feedback and make updates. They can learn further

problems before starting their project. Contributors are also users of that product, so students can easily reach target users thanks to the related open source project. Finding more than one idea in around subject needs to look project from a different perspective, to know problems about that subject. Feedbacks in open source project may be a useful source for students at this point. When students start to contribute open source project, they will not only design the tool but also, they will need to express many ideas and discuss other contributors. This may help them to practice about expressing their ideas clearly and correctly. Moreover, students can use many sources to develop their design and use them express ideas clearly, because the lack of knowledge in some areas may cause limitation for students. When a student shares her/his design with other people, they start to give feedback, tell ideas and advice. These help students to give the decision about a path for their design.

Due to students' limited knowledge in many steps of the design process, they lose time. Using open source platforms and tools provide saving time like finding knowledge faster, making models in one try, spending no time for standard pieces, etc. Lack of knowledge causes not only wasting time but also wasting money. While student makes model, using material wrong cause make it again, so spend money again.

In the following part of the questionnaire, reasons of difficulties were analyzed. These are experience, technical knowledge, budget, time, technical support, relevant courses, lecturer, and classmates. According to collected data, lack of experience, technical knowledge, and technical support are the most common reasons behind the difficulties in design processes.

Experience can be gotten by working on more project in the industrial designer profession. However, during school term, which includes at least one design project, some compulsory and elective courses. In open source projects, developers and contributors share sources and details of the project. Thus, students can learn many thinks about projects like material, manufacturing method, equipment, and tools, etc. Also, taking place in open source project can make students gain experience and interact with other designers. Taking place does not mean only develop or design a project, it can be giving feedback after using 'source.' (See, Instructables, Arduino, Grabcad).

Developing technical knowledge needs much research and studying about materials, their alternative usage, menu. tech., ergonomics and many other topics. Nowadays, these

topics go from bits and atoms to digital like the internet of things, user experience (UX), user interface (UI), etc. learning all these at school is not possible for students even school provides all. As similar to experience, to overcome and put technical knowledge away, students should examine open source tools, but not only examine, they need to experience them. Thanks to open source culture, there are many sources to learn new things. For example; if industrial design students want to learn Arduino, starting from its website (www.arduino.cc), there are many forums, websites, and platforms which users share their projects' codes, handmade and how it's made steps, also users are willing to share their knowledge and help others.

Students spend much money for material in industrial design education especially for building mock-ups. Their lack of knowledge and practice cause most of the material and also extra cost. Students expense money for one time usable material and product. However, open source offers hardware which can be used again and again. It may help students to reduce cost.

In a semester, students have a busy schedule with not only studio courses, but also others. Their limited experience causes lack of time management. Wasting time on physical modeling is another issue for students. The reason may be a lack of knowledge about material and techniques.

During the design process, students need some facilities like computer, workshop, material, craftsmanship in some steps. However, some of them are limited in schools; students have to get through many of these steps by themselves. Open source culture is based on sharing; the source is not knowledge. It can be tool or facility. Fablab is the tangible example and space form of open: Students can learn and produce almost anything in Fablabs.

From data collection and analysis to making physical model, students said that relevant courses are needed in specific areas. However, limited time and inflexible curriculum do not allow to add any course. Also, today's technology and tools are changing so quickly, adopting to this speed may not be possible for each school. So, students should do more research and learn themselves. At this point, open source helps students to support many areas.

Lecturer and classmates may not be direct reasons of difficulties in the design process. An open source project is considered as a result of community's work. Lecturer and

classmates may be an element of open source community. If all of them have behaviors which are suitable for open source culture, then students can be more open to sharing, then get the habit of contribution, and interact with each other, so these may also support many tasks.

As seen Figure 25, 141 students answer Question 6 (Appendix A). 75% of students know the term of "Open Source, " and 25% of them do not. There is obvious difference between these two groups when data is examined in total. However, 4th grade students from METU, seco[nd] and 3rd grade students from ITU participated in researching as small group, so their data does not give information to interpret correctly. Nevertheless, there are approximately the same ratio which is 75% to 25 % in almost each data group except limited participated and 2nd grade students from IUE.

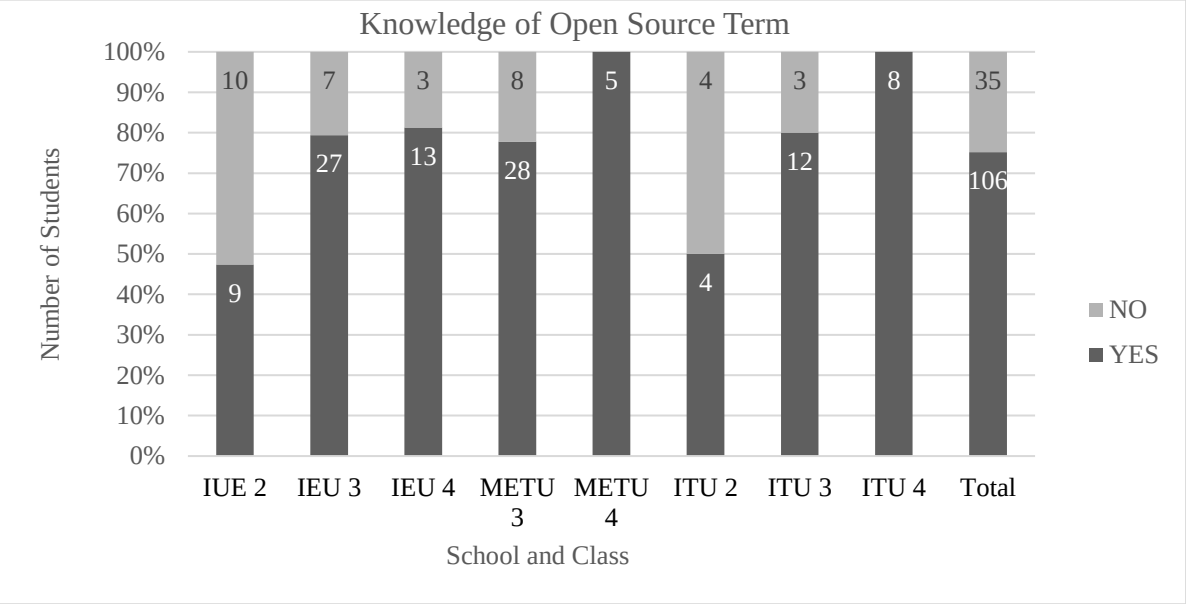


Figure 25. Students' knowledge level of "Open Source" term

As seen Figure 26, there are two more popular tools for industrial design students which are Grabcad and Arduino. Grabcad is easy to use and offers free CAD models which are compatible with many CAD software. Students may download standard pieces, or similar design as them and modify it. Popularity reason of Arduino is Interactive Prototyping for Designers course at METU, so some of the students from METU have already taken the course, so they have experience with Arduino, or at least they heard the course, and they knew the content. Thus, the result shows that Arduino is one of the popular open source tools.

Students also have experience and knowledge about Blender and Inkspace which are used for graphic design, because even they do not render or model in 3D, they can make these with them. Thus, students may use them for these purposes.

The issue of the data is 75% of students said that they know the definition of open source tools, but they I also answered: “I heard it for the first time” for tools. This indicates that students have some experience or knowledge about tools, or they heard the definition due to the popularity of software, but they do not know what its equivalent in design is.

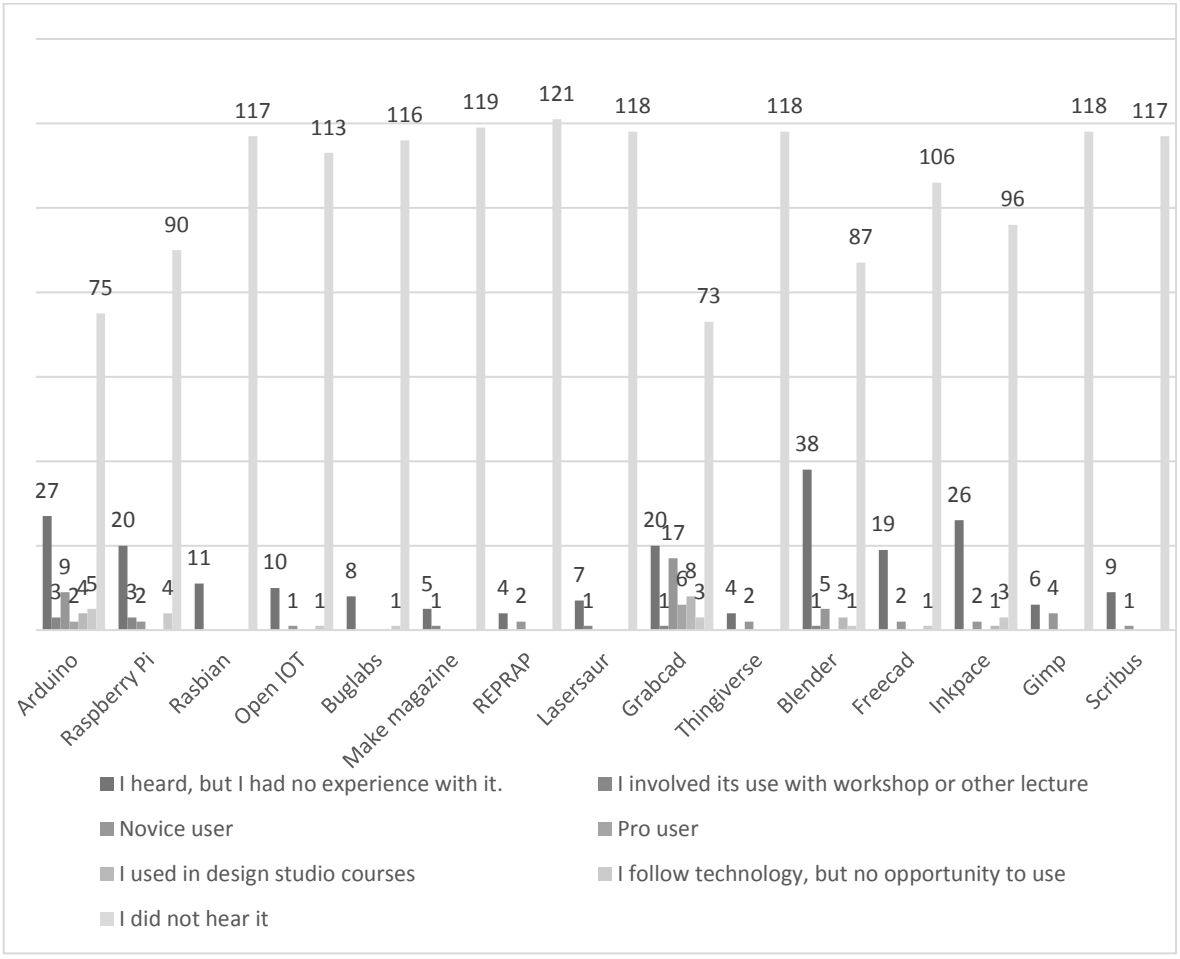


Figure 26. Industrial design students' knowledge and practice level about open source tools.

3.3. Introductory Presentation and Feedback Session about Open Source Tools for Industrial Design Students

According to the result of the first questionnaire, students do not match open source tools and open source terms. Except for 2nd grade students at IUE, in all classes, the majority of students know the term of open source. However, the same students answered as I did not hear it before for many tools in the questionnaire. This phase of the research aims to show industrial design students what is open source and its basic elements; some tools may help students in their difficulties during their design processes.

The presentation took between 10 to 15 minutes, according to students' interaction during the presentation (Appendix C). There were 13 slides in the presentation. It started with cover, then open source's basic elements, how open source community works, knowing things wrong about open source, difficult tasks for each class, reasons of difficulties, six different examples of open source tools, and notes in the order.

Difficult tasks and their reasons' slides were prepared for each class differently by taken data of question 1 and 2 in the first questionnaire in consideration. While telling about open source tools examples, these data were also considered. Open source tools in the lecture were Grabcad, Instructables, Thingiverse, Arduino, Raspberry Pi, and KAA. Each tool was told with their main use and side uses.

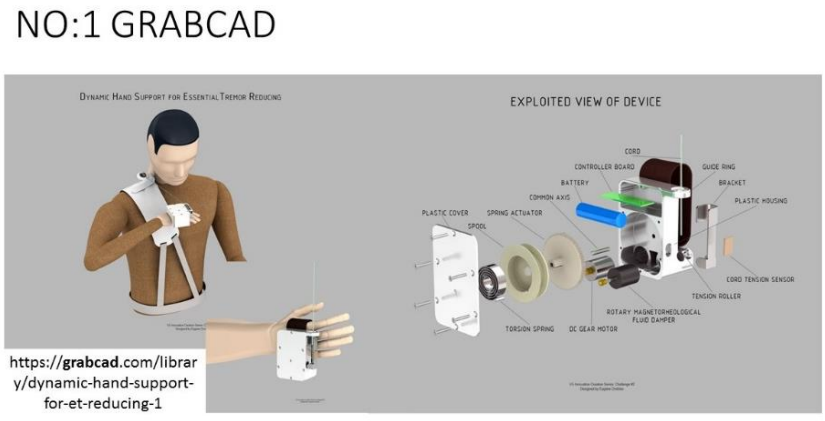


Figure 27. Example of project from Grabcad: Dynamic Hand Support (https://grabcad.com/library/dynamic-hand-support-for-et-reducing-1, reviewed in December 2015)

The first open source tool is Grabcad which offers CAD files sharing with parts, assembly, exploded view, 3D view specification, measurement tools, renders and information about the design. It is the most popular open source tools for industrial design students who use it to download many standard pieces and products for render environment. However, the downloading design is the first and the core offerings of the platform. As seen in Figure 27, the complex mechanism can be examined thanks to its exploded view specification online. Students can learn many technical pieces of knowledge which is one of the reasons behind difficulties in design tasks, also use or modify mechanism for another product design.

Instructables has limited use by industrial design students. In the presentation, some forms may look complex to model or to manufacture, and this situation affects students design negatively and creates a limitation for them. As seen in the example of Origami Furniture (Figure 28), connections between pieces or form may be hard to figure out regarding manufacturing or explaining the idea. However, when students need this kind of form or connection, they can do research on Instructables and find many solutions. It is helpful for that especially students need technical support and more relevant course with design tasks. Moreover, some students have some difficulties in physical modeling so that they can learn many methods from Instructables.

Figure 28. Example of project from Instructables: Origami Furniture Case Study a Table (http://www.instructables.com/id/Origami-Furniture-Case-Study-a-Table/, retrieved in December 2015)

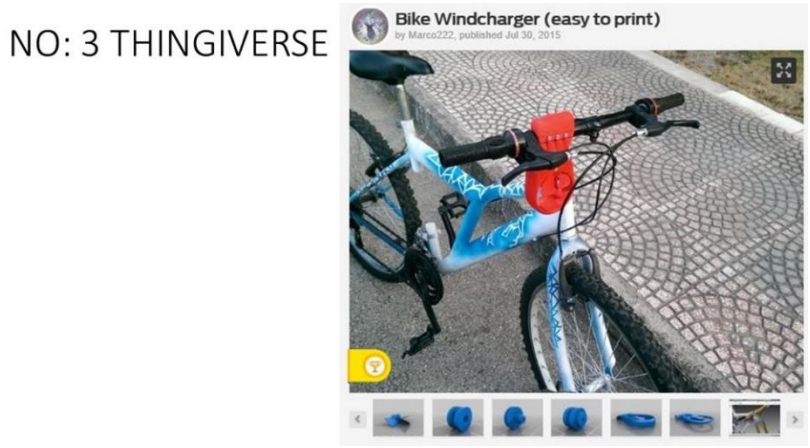


Figure 29. Example of project from Thingiverse: Bike Windcharger (http://www.thingiverse.com/thing:948231, retrieved in December, 2015)

As a third example of open source tools, Thingiverse was showed students. It is also web platform which offers STL format files to ready for printing. Products offer practical solutions for many problems. In the example, there is a wind charger which is designed for bikers charging problems with the simple product. It can be easily adapted for another use like camping or another outdoor sport or modified to charge computer in windy but no electrical power places. It may help students find inspiration, creating more ideas and also digital modeling.

In contrast to first three open source tools, Arduino and Raspberry Pi are open source hardware in the presentation. At METU, there is an elective course about Arduino, and according to their answers, they used it in their studio course projects. Arduino offers many sources to learns, and also users of Arduino share their codes and schemes about their board. Thus, students learn it easily and make their design more interactive or present more realistic mock-ups. The example is hacked IKEA lamp with Arduino. The aim of this example is how daily objects can turn an interactive object with just using open source without knowing coding or complex electronics (Figure 30).

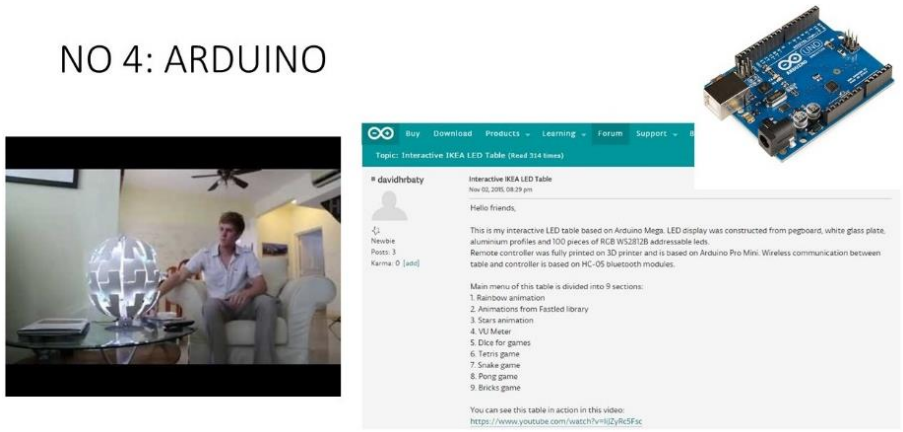


Figure 30. Example of project from Arduino: IKEA Death Star Lamp (https://www.youtube.com/watch?v=95-dtNbKG6Q, retrieved in December, 2015)

Figure 31. Example of project from Raspberry Pi: SMS Garage Door Butler (http://www .instructables.com/id/Raspberry-Pi-SMS-Garage-Door-Butler/, retrieved on December, 2015)

Raspberry Pi is also hardware which helps students to design interactive products, its use similar to Arduino and offers many sources either on its website or in Instructables and other web platforms. This example shows that students can design for IOT and daily needs with smart systems without advanced knowledge level of software or electronics (Figure 31).

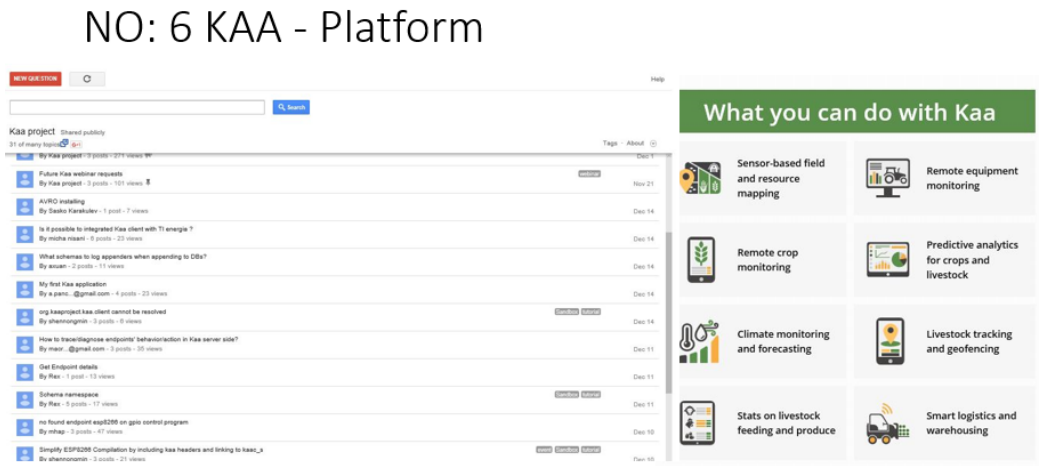


Figure 32. Example of project from KAA: Agriculture Application (http://www.kaaproject.org/agriculture/, retrieved in December, 2015)

KAA platform is another example of open source tools, but instead of product, its sources are about services and systems like Raspberry Pis. The aim of presenting KAA is showed that industrial design is not only designing product also, even in product design, but students also need much information about users. Moreover, KAA offers many themes and connection with target users around these themes (Figure 32). It may help to overcome difficulty about data collection and analysis.

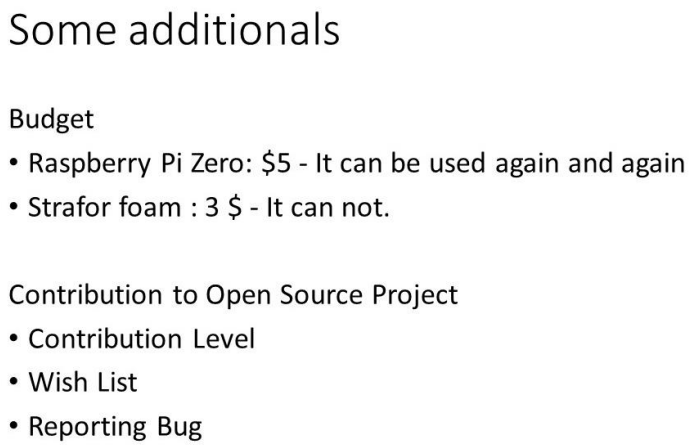


Figure 33. Additional information about the open source.

As the last slide, some additional information was given students regarding budget And contribution to open source projects. The affording budget for all project is the most difficult during design project for many students. Thus, buying hardware or another material to make open source projects may create a negative impression on students. However, most of the materials and hardware can be reusable in open source. Moreover, students may think that they have already busy schedule, and adding the new project as open source can cause extra workload for them. Whereas, contribution to open source has different levels like developing to reporting a bug or demanding a new feature.

In the feedback session, the 2nd questionnaire was answered by 173 students who are 28 2nd grade, 26 3rd grade, 11 4th grade students at ITU; 27 3rd grade, 20 4th grade students at METU; 18 2nd grade, 27 3rd grade, 16 4th grade student at IUE.

2nd questionnaire has two parts: pre-presentation and during the presentation (Appendix B). In the pre-presentation section, there are two questions which are class, and they know the open source or not. Questions were answered in parallel with a presentation by students. There are six questions in this section. 3rd question aims to learn the definition of the open source term, and working of the open source community was understood, not, or not clear enough. In the 4th and 5th questions, students' opinion about the analysis of their difficulties in design tasks and their reasons were asked. There are open source tools and students' relationship with each tool in the 6th question. As a 7th question, "Did you think about any tool which could be helpful, if you learned before the project?" was asked, students. In the last question, students' another idea or opinion were asked.

3.4. Data Analysis of Feedback Session

After presenting each tool, students answered the question with 7 options. They evaluated the tool according to its usability in design studio course project and their previous experience with the tool.

According to collected data, the participant chose "I heard it for the first time" for KAA, Thingiverse, and Raspberry Pi at most. The reasons may be that there is no or very limited number course related with service design, prototyping with a 3D printer and electronic boards. Due to the course of Interactive Prototyping for Designers at METU, data

showed less participant chose the option for Instructables and Arduino. Moreover, as data of the first questionnaire showed, Grabcad is the most known and used open source tools by industrial design students.

Some participants showed their opinion about the tools with only "It is an interesting tool." option. It is not related to their knowledge or practice about tools, but it can be assumed as a positive approach to students' possible further use. The option gave insufficient information. When data collected from this option, students chose it for Arduino, Instructables, and Grabcad at most.

The third option was " Advice were useful; they can be used in design studio project.", so this one was related to students' approach to the tools. According to collected data, students found advice about Arduino, Grabcad, and Thingiverse to use in their design process. Even students found some advice useful; they may not be usable in the design process for them. The fourth option aimed to measure this, so students chose "Advice were useful but not for design studio courses." for Raspberry Pi, KAA, and Arduino. This data had the similar reason as the first option.

The next option aimed to measure that students found advice enough or not to evaluate them. Improving studies for further steps was important. Very limited number of students chose the option as an answer. Students chose it for Raspberry Pi because due to its similarity with Arduino, there were fewer details about it. However, students' limited knowledge were not enough to connect these two tools.

Grabcad, Arduino and Raspberry Pi were chosen the most as "I have already used it." As mentioned before, in addition to Grabcad's popularity among industrial design students, the course at METU affected the results for this option.

The last option was "No opinion." which aim to prevent that student did not pass the question without answering. Students chose this for KAA and Raspberry Pi in very limited number of answer.

The following question asked that "Did you think that any tool could be helpful if you learned it before the project?" which aim to make students think about open source tools and their advantage for their design processes. Students gave many feedbacks for this question. Secon grade students had answers as only tools'name according to examples in the presentation and based on their limited experience in studio projects. However, third and

fourth-grade students answers included both tools and their previous experience. Moreover, their answers showed that they built a connection between their limited knowledge and skills in specific tasks which was related to difficulties in first questionnaire and open source tools. These feedbacks supported that the reasons of technical knowledge and technical support were analyzed as the result of the first questionnaire.

CHAPTER 4

RESEARCH: SIMULATION OF OPEN SOURCE COMMUNITY

After case study session in three different universities, workshop session is designed to understand the usability of open source tools in industrial design studio projects. According to feedback session, students have positive opinions to use open source tools in their design process.

At the first version of the workshop, re-designing one of their previous studio projects with open source tools is required. The first questionnaire was conducted by the student before the workshop, then lecture and feedback session were done at the beginning of the workshop.

The insufficient design process in the first version caused to design the second version. In the 2nd version, students did not design their previous project again. Instead of that, parallel session with semester was run, and students were followed through the all design process week by week in their first project in the Fall Semester of 2016-2017.

4.1. Pilot Study 1: Re-design Workshop

The workshop is designed to offer open source tools for industrial design students to design one of their previous design studio project again. The aim is seeing differences between with or without open source tools in the design process. The first questionnaire was sent students to conduct before the workshop, each of them evaluated to understand their situations in specific tasks in industrial design studio courses, and their awareness and practice levels of open source tools. At the beginning of the workshop, lecture and the feedback session were done to introduce tools. In the re-design with open source workshops, there were two sessions.

At the first session, two students are named as R1, 4th grade at Anadolu University, and R2, 3rd grade at Işık University. According to first questionnaire's results, İrem has some difficulty in T1, T12, T13, T19 and CT20. The reasons are a lack of experience, technical knowledge, budget and time. R2 has some problem with more than five tasks in design studio projects, and the reasons are similar to R1's. In the lecture and feedback session, offerings for both are the same, they can examine the open source projects, so they can have information about all the stages which were shared by developer or designer. Also, GRABCAD may be a useful tool for both of them to learn mechanical and electronic parts of any products. For example, R1 and her project group had to buy a vacuum cleaner to examine its pieces and mechanism. When GRABCAD was told in the lecture, she said that if she knew it, instead of buying a vacuum cleaner, they might examine parts and exploded assembly of the mechanism. However, she told that her lecturer might want that they buy it either case. Her another opinion was that not only necessary increasing student awareness about open source, but also lecturers' awareness should be increased, and they should courage students to use open source tools.

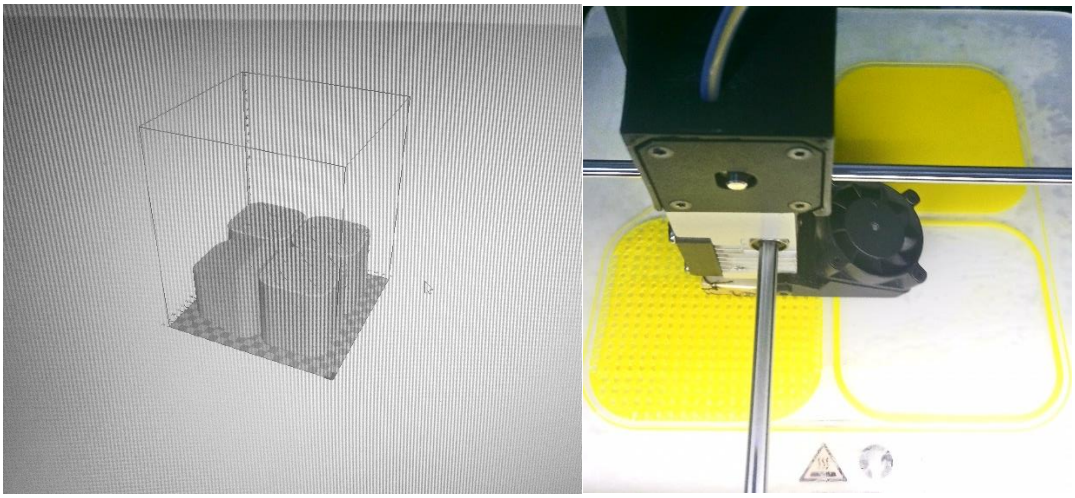


Figure 34: R2's design and prototyping process.

For re-design session, R1 selected bath towel apparatus for SME (Small-Medium Enterprises), and R2 selected modular speaker project. The problem of R1’s project was especially in the final model. They should be identical regarding angle and thickness. She modeled from plastic pipes with heat, but her craftsmanship was not enough to give the same

angle as her design. She thought that quick prototyping and research about modeling from Instructables might help her. In the R2's speaker project, he could not find enough source about the measurement of electronics in speakers. Also, his lack of modeling software skill affected his design negatively. After the lecture, he decided to use quick prototyping for the final model, Arduino for electronics of his speaker and looking for surface design he might use in his speaker model from GRABCAD and Thingiverse. Difficulties of the first session were long prototyping time, so providing space and taking students time that long.

In the second session, there were 3 participants (R3, R4, R5) from Işık University Industrial Design Department and Kadir Has University Industrial Design Department. As a first step of the session, they answered questionnaire 1, then listened to lecture and answered 2nd questionnaire. According to results of the 1st questionnaire, students have difficulties in digital modeling, budget, time and idea generation. The cause of these difficulties is lack of experience, technical knowledge, technical support and relevant courses. R3 (Kadir Has University, 3) wanted to redesign her lighting project with Arduino, and prototyping with a laser cutter. However, she should model it again within the consideration of electronics and manufacturing method. Due to time limitation and lack of obligation to redesign the project, she did not contribute to study further. R4 (Işık University, 3) told her experience about blender design project in design studio course, she had some trouble with digital modeling of blades with the right angle, and could not find enough information in limited times. However, she did not find any project to redesign with open source tools. R5 (Işık University, 3) also wanted to redesign his speaker project as similar as R2. In his project, there is modular system and wireless connection between modules, so he decided to use Arduino and also 3D printers for shell design. In prototyping process, he did not follow the process after some defected parts in 3D printing. Thus, he also did not finish the redesign.

As an outcome of the first session, design process at studio courses are stressful for industrial design students, so redesigning not the pleasure process for them. In limited times, they had to learn new tools and redesign their projects. This caused non-effective process. Even students had the opportunity to continue after the workshop, they did not follow the process or want to continue. As a result of this pilot study, students need longer time to learn new tools and apply their design.

4.2. Pilot Study 2: Using Open Source Tools in Design Studio Project

After negative outcomes of redesign workshop, case study session was designed to see how industrial design students use open source tools in their design studio projects. Case study session includes four steps which are profiling, online lecture and meet-ups, project term, and evaluation. In profiling step, the first questionnaire (Appendix A) and Form 1 (Appendix D) were filled by students, then according to their results online lecture was prepared and second questionnaire (Appendix C) was conducted by students. Also, meet-ups were organized to discuss open source tools which were used by students in their project, and their experiences with them. In the project term, participant students of the research attended their design studio courses as usual, but they used open source tools in their projects, and they gave feedback with Form 2 (Appendix F). Evaluation of participant feedback was the last step of the case study.

Participant profiles were viewed in two steps. One of them is Form 1 which asks personal information, education situation and participant willing to continue to the research. In the second step, the first questionnaire was sent students to know them better about their situation in design studio courses with difficulties and their reasons and their knowledge and practice level of open source tools. 2nd year students did not fill the form

13 students were volunteer to participate this research at the beginning. They are from 6 different universities which are 5 of them from Isik University, 2 of them from Anadolu University, 3 of them from Kadir Has University, 1 of them from ITU, 1 of them from METU and 1 of them from Ozyegin University. Students are three from 2nd class, seven from 3rd class and three from 4th class. Students' willingness about continue to end of research can be seen in Table 5. 3 students have 100% willingness and only one students have 40% willingness. However, after the online session about open source tools, one student with 100% willingness and three students with 80% willingness stopped to continue. Quitting's reasons of 3 students from Kadir Has University were preparing all design documentation by hand drawing, so learning new things and applying this busy term were difficult for them. Before student from METU could not start her project with tools; the pilot study was stopped. One student from ITU had to leave research, because their project was with a professional firm, so she cannot share her design data.

Table 5. Students' profile and their willing to continue to end of research

Student Number	Student Number	School	Class	Willing to continue to end of the research
Cansu Deniz Özben S1	S1	Isik University	4	5/5
Gürkan Özkan Student 2	S2	Isik University	3	4/5
Yağız Pala Students	S3	Isik University	3	4/5
Gizay Özden	S4	Isik University	2	3/5
Volkan Sönmez	S5	Isik University	2	2/5
İrem Berkant	S6	Anadolu University	4	3/5
Vefa Ayaz	S7	Anadolu Universiy	4	4/5
Pelin Doğan	S8	Kadir Has University	3	4/5
Ecem Kılınç	S9	Kadir Has University	3	5/5
Dilay Özçelik	S10	Kadir Has University	3	4/5
Ayça Akkın	S11	Istanbul Technical University	3	4/5
Elif Gökçen Bulut	S12	Ozyegin University	2	5/5
Ezgi Böcü	S13	Middle East Technical University	3	-

The video was prepared to teach open source terms and tools to students. As different from presentation, screen captured video tool was used while using open source tools.

In the process of industrial design studio courses, some students were always in interaction and did research through open source tools. However, the pilot study was stopped before most of them keep on track.

During the second pilot study, some participant tried to be included in research despite their busy schedule, because they were willing to learn new things, and online session and video were useful for them. S1's studio course project was an electrical scooter. She needed to learn about folding scooter mechanism and electrical systems. She inspired from open source bike projects which offer all information to enable everyone to produce their bike. S6 and S7 had the same project which was a remote controller for SME. In the beginning, they did research to make a remote controller with Arduino, but then circuit was provided by the company, their project was only designed buttons order and groups. Thus,

they could not use Arduino. S2 designed compact breakfast set which includes many utilities in one like a kettle, toaster, etc. He worked to transfer one of them output energy to others input like using kettle steam to heat toaster. He did research on Instructables to find how steam can be transferred as seen in Figure 35.

Figure 35: S2's research on Instructables to find energy transfer with steam (Source: http://www.instructables.com/id/DeskTop-Steam-Boiler/).

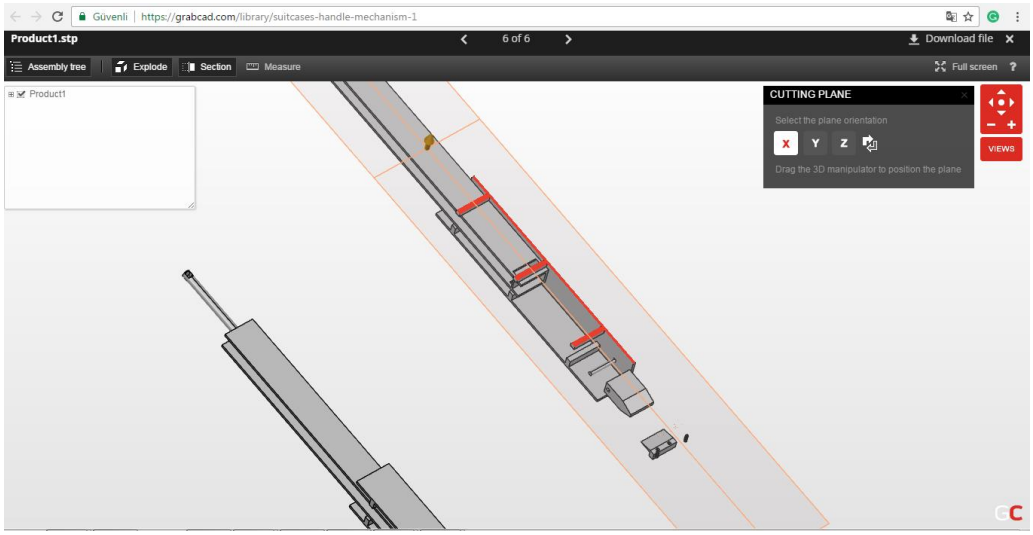


Figure 36: S12's screen view while she examines exploded and section view on Grabcad (Source: https://grabcad.com/library/suitcases-handle-mechanism-1).

S12 was second grade student, so she had limited experience with technical drawing, and she also thought that she need to learn it more deeply like section and assembly drawing.

However, she has already taken the course for that, but it was not enough for her. At this point, she agreed with Grabcad could be helpful for her project. Her project was luggage for kids, and she wanted to add wheels and scooter feature to make it more fun for kids. Before CAD modeling, she used Grabcad to learn drawing wheels and handgrip pulling mechanism. She examined section view and all parts with exploded view feature of Grabcad as seen in Figure 36.

Limitations and difficulties in this pilot study were caused by different schools and different classes mainly because some students had a fast process in design and others had slower with more focusing on research phases. In addition to this difference, some students did not continue due to studio process like hand drawing and agreement with the company. Moreover, different classes prevented to meet all students and running community process, also caused 1 to 1 process, so it took many times.

4.3. Primary Research: Simulation of Open Source Community

The result of pilot studies showed that students are not willing to learn new tools during industrial design studio course, also redesign their previous projects. At the beginning of the pilot studies, open source tools are explained students, and according to questionnaire results, they found each tool useful. However, methods in pilot studies did not offer motivating and helpful environment. Most of the open source tools were new for them. Thus, they need to practice before using them in design studio courses. Also, offering them only tools with specific ways of use did not effective and permanent solution to give the habit of open source use. Students should learn how open source community is working with all the elements which are a developer, source, sharing activity and contributors. For this purpose, simulation of open source community was designed to see what kind of behaviors and activities, industrial design students act and what are the impacts of simulation for students.

For simulation, Introduction to A Design Thinking Course in Industrial Design Department at ITU became a volunteer. The simulation was done in Introduction to Design Thinking Course in Industrial Design Department at ITU. Reasons of need open source simulation in this course were explained by the lecturer as design thinking includes empathy, prototyping, co-design and co-working in the scope itself. It is similar to open source

community regarding them. Design thinking is applied as design research step partially in the industrial design studio courses. However, when students started to design a product, they left all those steps and began working on a product without considering them. Design thinking is an interdisciplinary process, but in the courses, students or lecturer could not manage an interdisciplinary environment due to limitations like bureaucracy or unwillingness of other professions. With lecturer demand, it started in the 5th week of the semester, until those students learned basics of design thinking and made persona and brand studies. However, the design thinking process is the almost the same for students as in design studio courses. Lecturer and teaching assistant wanted to create a different atmosphere for design thinking. Their term project was cup which is designed for persona and considering the brand. Persona is accepted the common point of design thinking and open source. In an open source community, persona would be turned to the contributor. After the 5th week, they started to create their open source community.

4.3.1 Phases of Open Source Community Session

The simulation took five weeks in total as seen in Figure 37. During the first week, the content of the simulation was introduced to students, then as a first-week assignment, creating Instructables profile, uploading their design, persona and brand studies to their page, then examining each other and commenting were wanted.

In the second week class, each student presented their works and Instructables experience, then the short lecture about open source tools and contribution session was held. As an assignment, students will have continued developing their projects according to the outcomes of contribution session. SWOT analysis was made as structure co-working session. Each student mention concern and additional idea on current product design, then every student wrote an idea for strength, weakness, opportunities and threats of the product. The reason of using SWOT is offering a certain tool to contribute each other's projects instead of saying only that now, everyone will contribute each other's projects. In SWOT analysis session, students use A3 paper and post-its. They divided the paper into four as ideas for strength, weaknesses, opportunities and threats, then classmates wrote their ideas on post-its and stuck them to the related part of the paper. Thus, students could evaluate ideas more

easily and clearly. As 2nd assignment, the student would continue to develop their ideas, update their Instructables, and contribute each other's project. Also, they had to consider SWOT analysis, while developing their design.

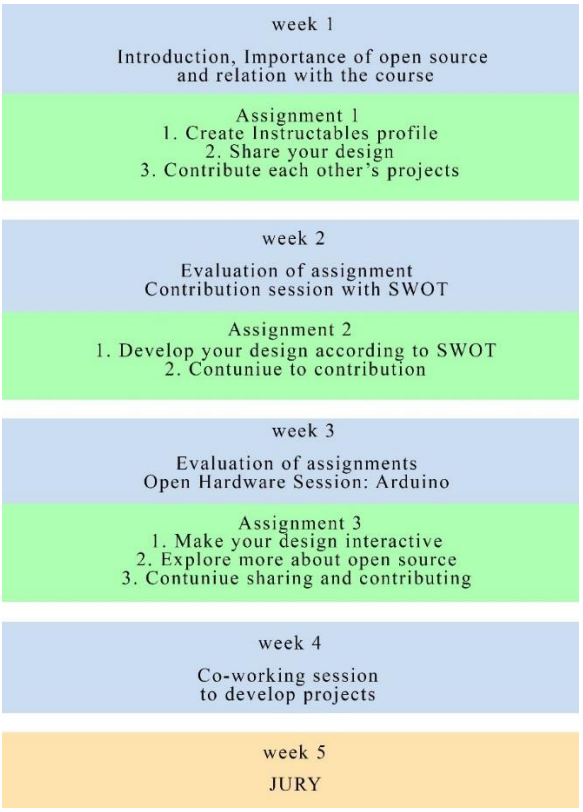


Figure 37: Flow chart of 5 weeks Open Source Session.

The third week, started with presentations of students about their works and persona's contributions. Until this point of the simulation, students mainly experienced open source platform. Thus, in the third week, Arduino was introduced to students as open source hardware, and they made simple Arduino circuits and learned its basics. The session aims to teach capability and basics of Arduino to students. For this purpose, Arduino, breadboard, jump wires and LED were supplied for students by Inno FabLab. The open source hardware session included three parts which were an introduction to Arduino, practice, and discussion. In the introduction part, basics elements and capability of Arduino were mentioned. Moreover, how they can build a basic connection with wires and LED showed with the only principle which is they have to be careful about parallel and serial connections on a

breadboard and LED's positive and negative sides, how they can download the open source code and run in Arduino IDE. After all these, without showing a specific example with basic elements, building their blinking LED circuits and finding codes and schemes were wanted from them. The purpose of not giving a specific example is showing them was showing that Arduino is easy to use without knowing complex electronics and coding. They have to do some online research and try more. After few trying of connection wires and LEDs and running codes, each student succeeded to blink their LED (Figure 38). This example may be the easiest one to build with Arduino, but the aim is making and exploring own by own or with friends, not with and expert about the subject.

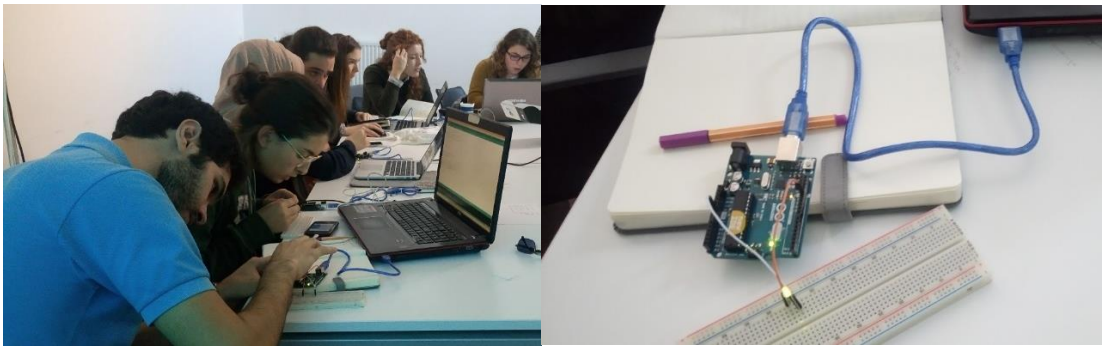


Figure 38: Students built their circuits to blink LED. & Blinking LED circuit with Arduino.

In the last part, students asked about what they can do more with Arduino. Then, sensors and their capabilities were mentioned such as that proximity sensor, or heat sensor which are related to their projects. According to lecturer and teaching assistant opinion for this session, Arduino is the most tangible expression of open source practice for industrial design students, because they are used to deal with products, but taking sharing as a movement, and reflect it into their design process are not enough to understand open source. However, they can use open source as hardware and software with Arduino. Moreover, these affected their design process, and some of them may want to continue with this side. Also, their lack of knowledge about coding makes them use open source. As a third week assignment, students have to work on an interactive version of their cup design with Arduino. Even they do not have required hardware such as sensors or modules, which some basics

modules like temperature or pressure were supplied for them, they present their ideas, finding from open source research, circuit design in some online tools like Fritzing or circuits.io, and their concept of interaction. After that, making their cup interactive was wanted during the rest of the class.

During the fourth week, students continued working on their design and using open source tools in co-working session, they asked about Arduino and sensors based on their needs. In the final week of the open source session, students presented all their experience with the open source community and tools in the jury (Appendix G).

4.3.2. Introduction to Open Source Community Session in Introduction to Design Thinking Course

In the first week, students introduced themselves and mentioned their projects shortly. Each student has to design a cup according to their persona and brand design which were made in previous weeks of the class. After starting open source session of the course, students have to add ready mate feature on their product, because when they share their design on Instructables, it must be enabled to do by anyone else.

After a short introduction by students, the content of research, the aim of the session and relationship between open source and design thinking course are mentioned. Lecturer and teaching assistant also contributed to discussion and mentioned why they need open source session in the course. They mentioned that initial steps of design thinking are used in any design project by industrial design students. However, most of the research and studies about persona stays as research. When students start to design a form, they do not take them into consideration. Design thinking course does not offer new students actually, but there is no evidence to use it in studio projects. We need to include the different practice of design into this course to show students what else and how they can do. For this purpose, we added sessions of open source and service design into design thinking course. Many steps in open source and design thinking are similar. Empathy step is supported with contribution step of open source. This creates situations which are opposites to their reflex which make students to show their last idea with the non-iterative method. Students focus on form more

than function. They do not tend to try showing alternatives. However, both design thinking and open source have iterative prototyping process. They want to teach quick and dirty prototyping to students. Design thinking aims to offer multidisciplinary teamwork in the co-working environment. In this environment, industrial designers have a duty of facilitator, so learning conditions of this environment are important for them. Open source communities also need co-working and co-creation, so it may help students to figure out all the concepts together.

In addition to common points of design thinking and open source, effects of contribution to open source projects were mentioned in the first week class. An open source project needs developer and contributors. After developer put the main product on the site, or share it, users of it and experts from related areas start to contribute by coding, making, fixing bugs, designing, reporting bugs, offering wish lists and similar activities. As results of all these, the product starts to evolve according to contributors needs and acts. For example, if more engineers contribute a project, then product turn more suitable to use by engineers easily. Thus, industrial designers start to contribute open source projects; then they are evolved for industrial designers.

Another thing mentioned in the class; before becoming professional industrial designers, industrial design students have several things to learn from open source platforms and tools. As mentioned problems and analysis in section 3.2., industrial design students have some difficulties in technical subjects like material and manufacturing techniques, finding inspirations, data collection, and analysis, delivering the project in due time, affording budget, digital and physical modeling.

After the presentation and discussion session in the class, first week assignment was given students as sharing their cup design, persona and brand studies on Instructables, then commenting each other project, so they will be started sharing and contribution process for their open source community.

4.3.3. Students Cases in the Open Source Community Session

In this section, the aim is exploring students' projects before and during the open source community session in the course, then evaluating implications of open source tools usage in their design process. The evaluation of the implications was based on basics of open source such as source, sharing, and contribution.

4.3.3.1. Students' Project Before Open Source Community Session

Figure 39: Students' presentation of their design in the second week: (a) S1Grab, (b) S2Geo, (c) S3Cont, (d) S4Fshp, (e) S5Cpfy, (f) S6Mlt, (g) S7Meas, (h) S8Cmp (i) S9Heat.

As first week assignment, students shared their design until the week on Instructables. In the second week class, each student started with 5 minutes presentation about their design

and Instructables experience in the last week. Nine students shared their design on Instructables, as seen in Figure 38, students were named with a number and abbreviation of a keyword which was related to their project.

S1Grab chose “Rebul” as a brand for inspiration. Her persona likes natural and warm feeling, so it is also related to the image of the brand. For this purpose, she decided to use wood and ceramic to embrace these feeling in her product. S2Geo did not pick a brand; she only worked on creating a persona who likes geometric patterns and forms, also pays attention environmental issues. Thus, she used the recycled material on her design and added geometric details on it. S3Cont did not include and brand in her design either. Her persona gives importance to the safety of drinks in case of spilling. The persona also likes contrast colors and materials as visual. Thus, she designed the cup with two materials which were paper and metal. The metal part can also create extra weight to prevent spilling. S4Fshp focused on friendship theme, so she created a product family via the form. She inspired from friendship bracelet which is taken each friend. Thus, she aimed to design cups which can be taken by each friend. S5Cpfy chose “Spotify” as a brand; she inspired from the favorite object of a person to create a persona. The favorite object was small ceramic pot which is used for storage. According to these, she designed espresso shot cup, when the user drinks espresso, then she/he finds lyrics of a song. S6Mlt chose “Faber-Castell” as a brand, and her persona adopts a healthy lifestyle, also is fun, ambitious, tidy and calm. Based on these, she designed cup with the compartment, so her persona can carry any healthy snack or herbal tea in it. S7Meas created a persona based on a favorite object which is Kindle. Her persona also enjoys measuring things like how much book, how many steps, etc. She chose “LEGO” as a brand, and she tried to reflect its assembly look into her design, so this form was designed. S8Cmp designed a compact cup for her persona based on the favorite object which is a compact watercolor set with colors, brush, and water bottle. She added compartment in the cup’s cap. S9Heat’s persona finds important features of safety, personalization, aesthetic, comfort, customization and cautions, so she designed safer cup with stronger isolation.

4.3.2.2. Open Source Community Session Through Selected Students' Cases

During this section, four different cases were evaluated to understand adoption level of open source tools in student' design process, and which element of open source is more effective for students. The cases are S1Grab, S4Fshp, S8Cmp, and S9Heat. All figures and explanation about students projects were published on Instructables.

4.3.2.2.1. Student Case: S1Grab

Student S1Grab's brand analysis and persona study were mentioned in the Chapter 4.3.3.1., and her presentation can be seen in Figure 40. She used the form and some patterns in her first concept before brand analysis, then she decided to different materials together and created warm feeling via material to engage with her material choice. Moreover, she aimed to create a sense of belonging through the compact design of cup and spoon Figure 41.

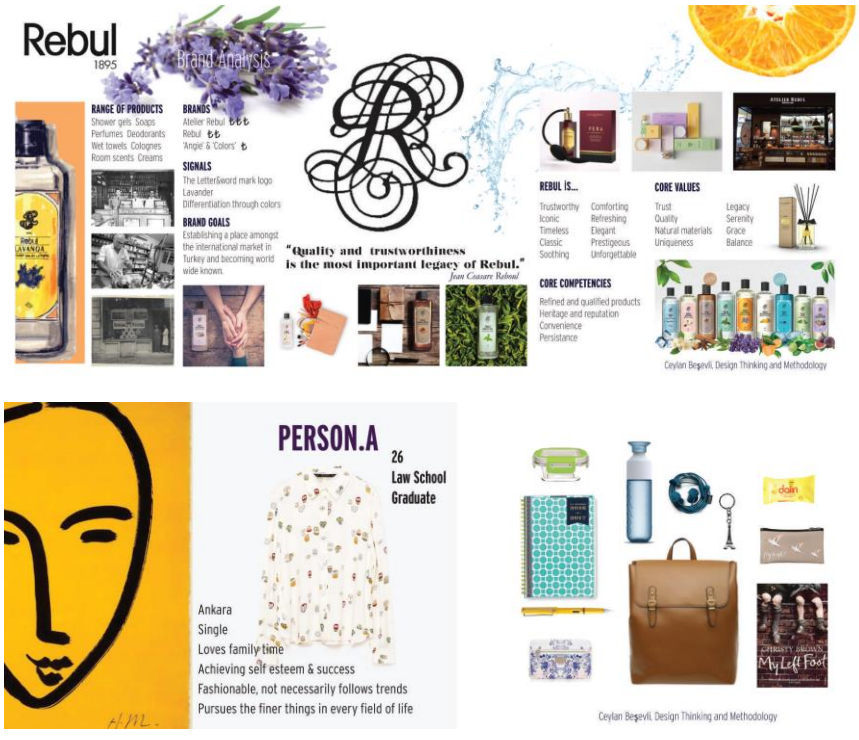


Figure 40: Student S1Grab's brand analysis (a) and persona study (b).

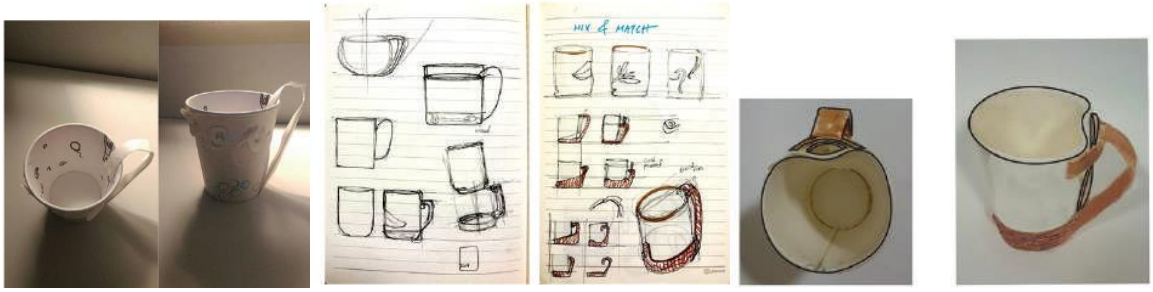


Figure 41: S1Grab's design before the open source session.

After she had shared her concepts on Instructables as first week assignment, she took feedback from her classmates. Until this point, she creates a source, then shared it. These are the first two step of the creating open source. Furthermore, her classmates can be defined as contributors here, and with their feedbacks, open source community was built around the S1Grab's product design. In feedbacks, there are some points which helped to shape her design in further such as,

- *Instead of using the wood only handle, you can use it all grabbing surface to create the more homey effect.*
- *In the first concept, form looks fun, but the handle does not look functional.*
- *Using different material together can add some movement to it while it is still simple, and also you can add some feature to show it only belongs one person.*

Figure 42: S1Grab's update after feedback on Instructables.

After she took feedback on Instructables, she updated her design. She added more wood surface in consideration of the feedback. As seen in Figure 42, she made her product larger and used two different material. From outside, it has a regular form, but it has a convex form inside.

In the second week, there was a structured co-working session with SWOT (Strenght-Weakness- Opportunities- Threats) method. According to feedbacks for S1Grab on SWOT analysis, she can focus on experience like tea ceremony as an opportunity; she needs to pay attention manufacturing method, joining details and hygiene (Figure 43).

With SWOT, she focused on threats and weaknesses of her product. Due to hygiene problem and hard process of manufacturing previous version fo her product, she decided to use cork instead of wood, because it is more flexible material. As a caution for hygiene problem, she made cork part as detachable (Figure 44).

Figure 43: Feedbacks for S1Grab's product in SWOT analysis.

Figure 44: S1Grab's design after feedback session with SWOT.

In the third week, she explained why she changed outer material as cork. However, feedbacks showed that it is not easy to give this form. She noted that to develop until the next week. In the open source hardware session, only basics of Arduino and how they can find the source and run it was taught, so during rest of the session they did research to work Arduino circuit. During research for Arduino, she told that she did not see prototypes with Arduino as design because all the cables look chaotic, and the only function could not be design a product, so these were disturbing for me. At this point, why industrial designers may need to involve open source was mentioned if it is disturbing for her, then she can add her industrial designer view into open source tools, so they can be tidier product and offer open source tools which make people design more than function.

S1Grab designed DIY product instead of mass production, as the final design, she prepared a guide to how people can produce her design. As seen in Figure 45, she defined her design as;

> *The resulting product is cohesive and follows the principles of the brand identity, comforting, trustworthy, serene, carries a natural feeling. It also satisfies the persona's mindset and lifestyle; it ties the persona to the moment by urging to grab it with both hands and demands focusing and relishing the drink.*

Figure 45: S1Grab's final submission "Relish" as cup design (a) defining function of the product.

S1Grab used felt instead of wood or cork, so she handled the problem of manufacturing and hygiene. It can be produced with sewing, and it is also washable material. Her guide which was shared on Instructables was easy to understand, she aimed to engage users easily to take feedback more clearly. Moreover, her presentation of her design on Instructables even showed her designer touch; she considered users and not only their production process but also their experience with this product (Figure 47, Figure 48).

Figure 46: Material list for "Relish."

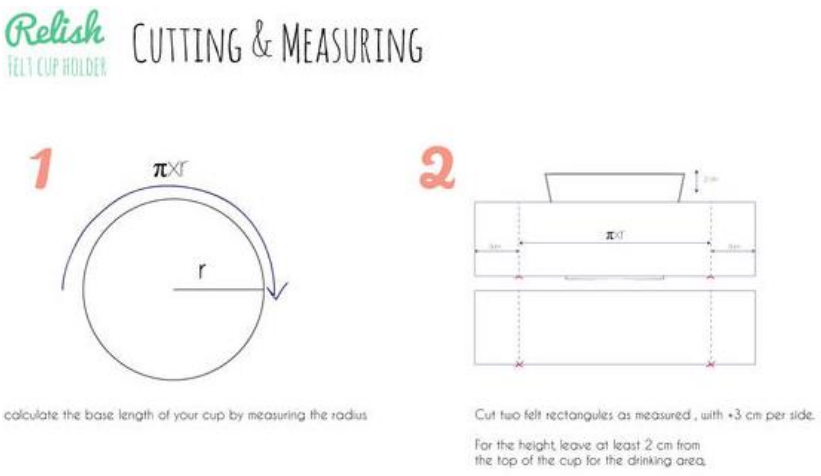


Figure 47: Cutting and measuring steps for "Relish".

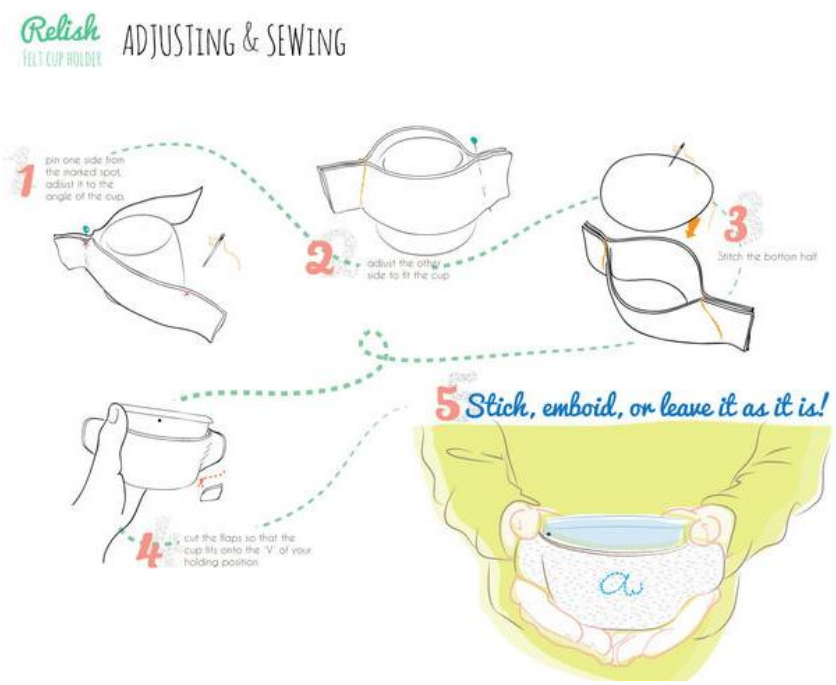
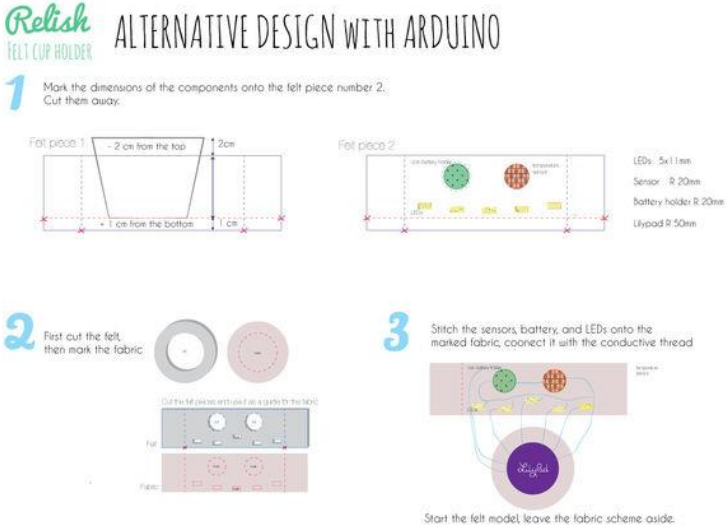


Figure 48: Adjusting and sewing steps for "Relish."

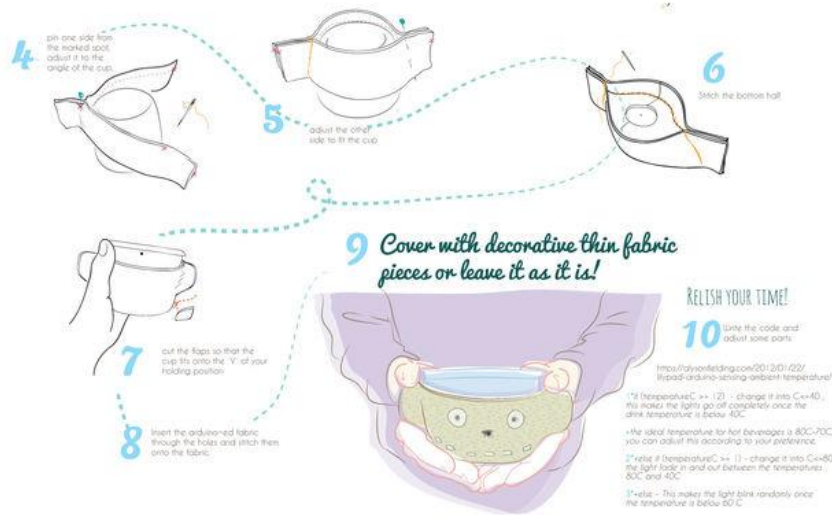
In the final step of her product, she offered customization, and this brought feedback session on Instructables after the first week into mind (Figure 49). One of the feedback said that adding a feature which shows it belongs to only one person. This shows how her product developed step by step with consideration each feedback; even the product was changed.

Figure 49: Customization step of "Relish."

(a)



(b)



(c)

Figure 50: Interactive version of "Relish" with Lilypad.

She also designed interactive version of “Relish” in the scope of open source hardware session in the class. She aimed to design reminder for people who let their hot drink to cool, but then they totally forget to drink. She decided to use Lilypad which is sewable Arduino for wearable technologies, temperature sensor, coin battery holder, LEDs, conductive thread and thin fabric which enable to light transfer. As a similar previous version, her presentation included designer touch and aimed to engage with user more. Moreover, she added customizability feature into an interactive version of “Relish” too (Figure 50).

During five weeks, S1Grab reflected sharing activity and interaction with feedbacks as open source’s elements. She integrated each feedback into her concept step by steps such as changing material of product and her presentation of instructions on Instructables.

4.3.2.2.2. Student Case: S4Fshp

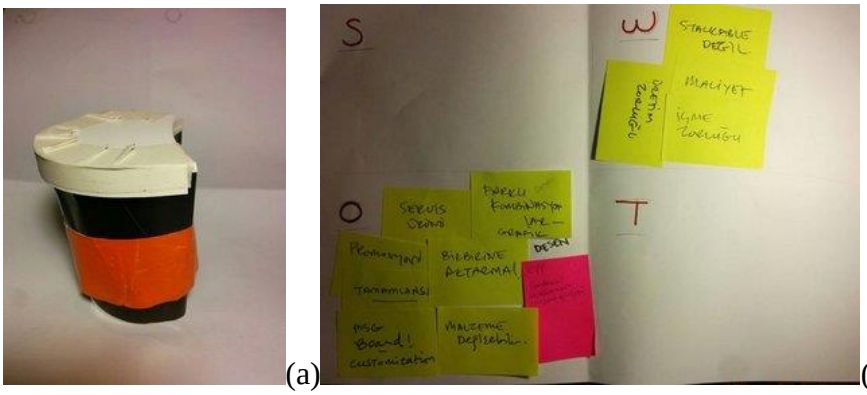
S4Fshp is another selected case; she focused on friendship theme with inspiration from friendship bracelet. In the beginning, she only shared her paper cup mock-up and wanted feedback on her Instructables profile (Figure 39 (d)). Then, she decided to share the story behind her design with persona analysis. She added an alternative combination of her product family (Figure 51).

Figure 51: S4Fshp's persona analysis and her cup design.

She defined her persona and the cup design as

> *"The persona likes simplicity and comfort, care about memories and friendships, want to remember always. Regarding product, the persona prefers light, coherence, endurance, and eco-friendly. The cardboard cup is designed as friendship cups. Every unit should be part of one thing. It is aimed that while they are using the product, it will remind "the part of one(friendship)." For that reason, units are designed like puzzle parts. They make a holistic image. There are some alternatives for both units and the total image. This effect will be made with applying of colors and form."*

After she had shared her design on Instructables, she took feedbacks such as trying different form to create modularity, storage together, trying a different material combination to embrace product family. S4Fshp did not change the form after feedbacks, but she decided to use different materials together (Figure 52). Before SWOT analysis in co-working session, she presented this model and told relationship with her persona. During SWOT analysis, she took similar feedback. However, thanks to opportunities step of the analysis, S4Fshp and also contributors who were classmates at this point thought over the potential of the product, so it provides to keep strong sides of the product and reach to better one. As seen in, there are many potential and some weaknesses for her product, but this showed that after she worked on these weaknesses, the product may catch many opportunities. As a result of SWOT analysis, she focused on form to make manufacturing easier, looked for a different way of giving friendship message.



(a) (b)

Figure 52: s4Fshp's design after feedacks on Instructables (a), SWOT analysis result (b).

At the beginning of the third week, she presented her new design. She created a new way to embrace friendship theme. She decided to design cup sleeves instead of a form or

pattern of cup. These sleeves were set with three combinations, so when a group of friends wants to buy a cup of coffee or another drink with these sleeves, then they can keep them and use as a bracelet.

Figure 53: The sleeve design according to SWOT analysis.

The previous week, there was an announcement about Arduino session, so she made research about a possible project with it. She looked for basics of Arduino, interactive bracelet projects and some alternatives. Her research indicated that she understood the potential of open source tools and possible implications into her project. While she did her research, she focused on wearable technologies mostly.

After open source hardware session with Arduino, she designed interactive and communicative friendship sleeve bracelet. The interactive version aimed when one of the friends use bracelet or sleeve again, then it sends a message to others mobile phone or others sleeve which blinks LED. She also used Lilypad, because it is flexible and easy to sew.

Figure 54: Interactive sleeve-bracelet design of S4Fshp.

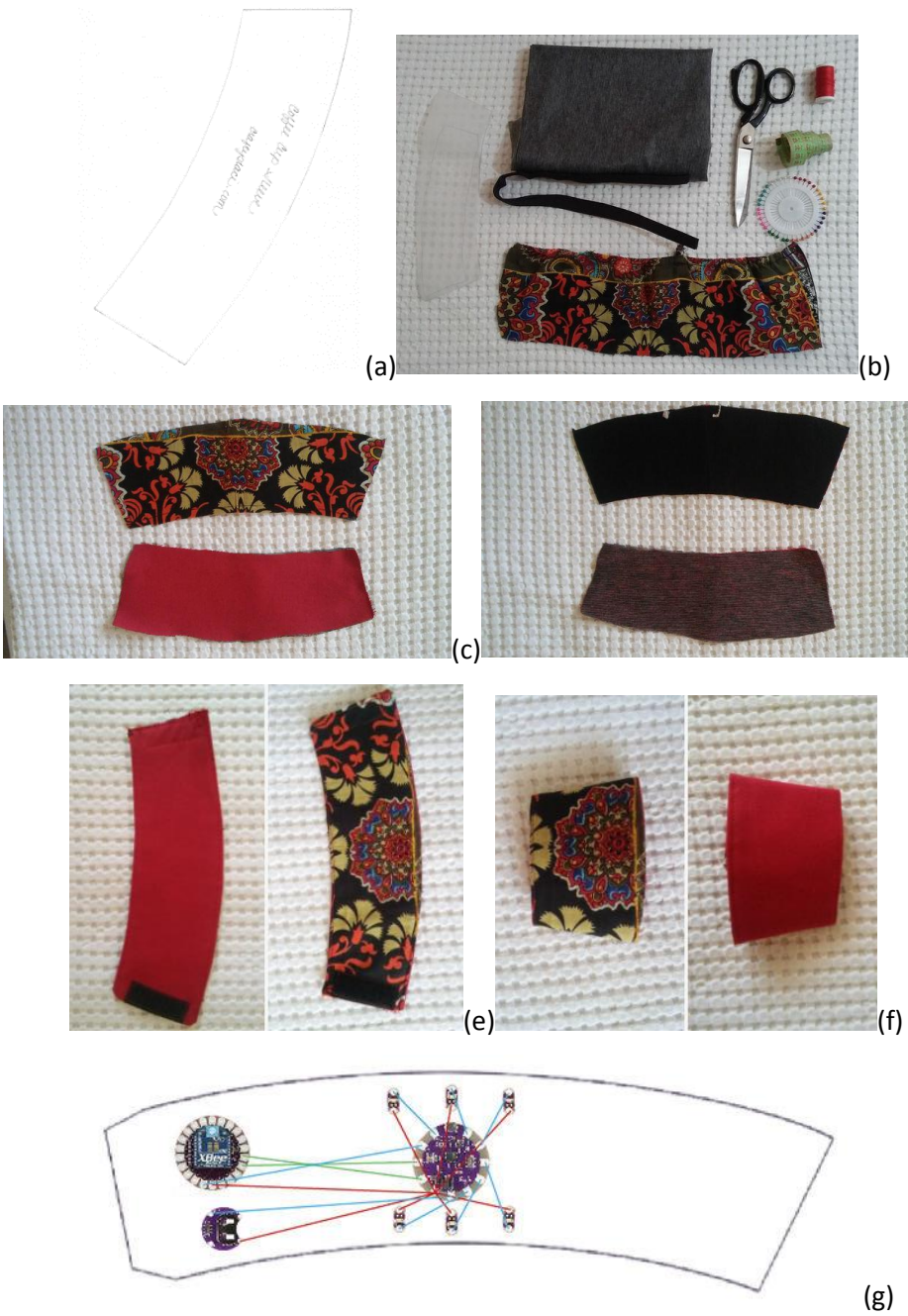


Figure 55: Instructions of Sleeve-Bracelet by S4Fshp.

In the final jury, she presented her interactive sleeve design. Moreover, she shared instructions of the first version of the sleeve on Instructables. She explained instructionsFigure 55:

1) Cut the patterned fabric and interlining according to template with the seam allowance.(a)

2) Iron the fabric and interlining for joining.(c)

3) Appy these steps for another face.(d)

4) Lay out velcro parts to two edges.(e)

5) Sew velcro on fabric.(f)

At the end, S4Fshp's design's last phase showed that advantages of co-working and taking feedbacks, because at the beginning using form to reflect her friendship concept can be seen as good idea for her, after that she saw the threats and weaknesses. She used feedbacks to reach final ideas. At the stage of open source hardware, she made extensive research to compensate lack of experience in this area. She used source effectively as open source's element.

Figure 56:Result of S4Fshp's design instructions.

4.3.2.2.3. Student Case: S8Cmp

S8Cmp focused on compact cup design, she aimed to offer experience with drinks and side together, so she wanted to add compartment into her cup design. The feature of the compact was inspired by her persona and favorite object analysis as mentioned before (Figure 57).

Her first mock-up offered compartment to save tea in it. According to feedbacks on Instructables, she needed to work on;

- Leaking problem,
- Need to spoon or any detail which can work as spoon,
- Compartment for bulk tea instead of ready product,
- Only cup or thermos as function.

Figure 57: S8Cmp's first concept.

In consideration of all these feedback, S8Cmp divided her cup into two part to save any required thing for drink experience, but there were still leaking problem and complex manufacturing process.

Figure 58: S8Cmp's cup design with compartment after SWOT analysis.

In the SWOT analysis, feedbacks showed that there are some opportunities for the product if it offers an experience like traditional drink boza and roasted chickpea. At this point, connecting between traditional experience with open source may provide more engagement. Before SWOT analysis, she thought smaller compartment for sugar, but some people prefer their drinks without sugar. She found the idea of offering traditional experience with her design interesting and catchy, so she continued with it.

Figure 59: S8Cmp's cup design for the traditional experience of Boza and roasted chickpea.

After the open source hardware session, she also turned her learning into service product. She decided to design colorful and interactive coaster to offer customizable service for each customer. In this phase, she had the most detailed work with Arduino with the help

of another user which reflects contribution as open source' elements. Another user was an engineer, and he had more knowledge and experience than S8Cmp. Their work showed the result of interdisciplinary co-working, she designed the part of the transformation of traditional experience and how it can be customizable with Arduino, then she took help and interact with another user.

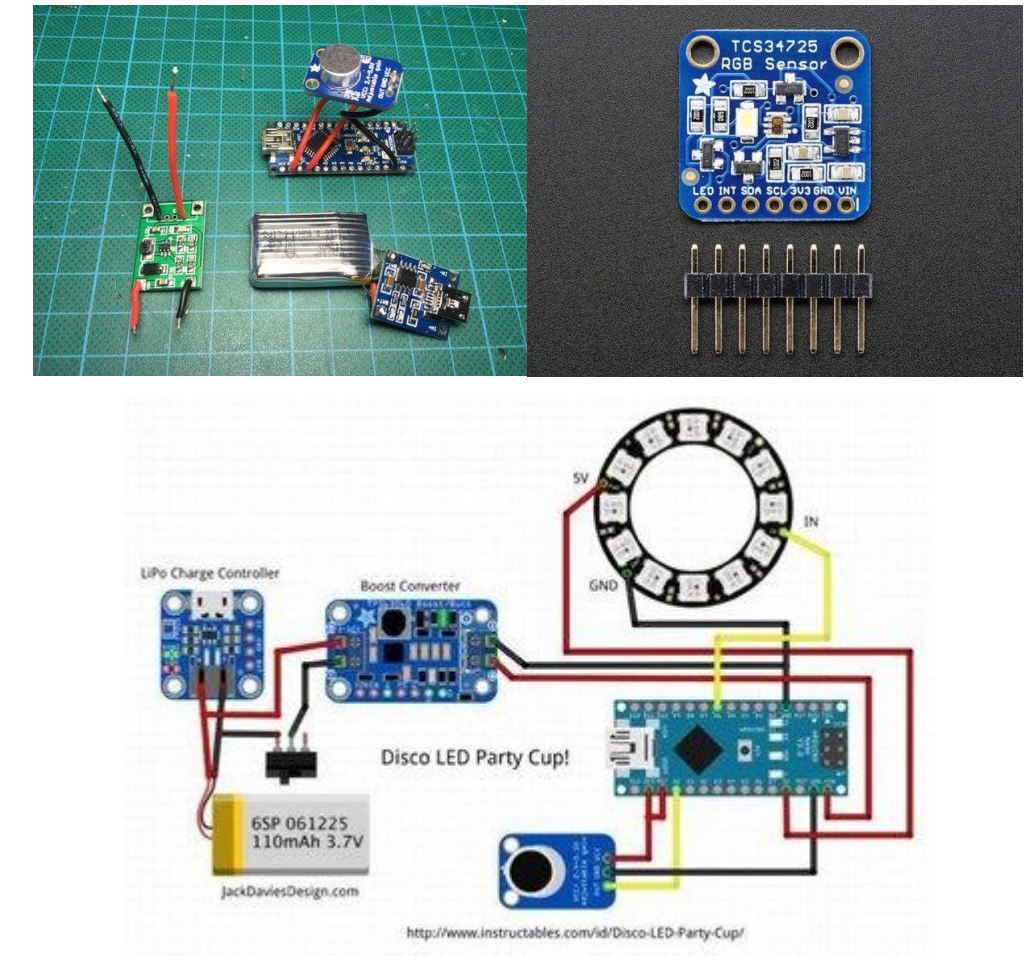


Figure 60: S8Cmp interactive coaster design.

Her coaster includes battery, charge controller, microphone amplifier, converter, neopixel ring, and 3D printed parts. Her circuits and assembly of Arduino and 3D parts can be seen in Figure 60.

In the end, her product worked as similar as her previous design, but with a 3D printer, she did not have to deal with leaking problem (Figure 61). Using open source tools leveled her project and provided connecting different disciplines. She used to source and contributions in her design as open source's element. Her interactive design was not directly related to her cup design, but she found the way of engaging regarding service design.

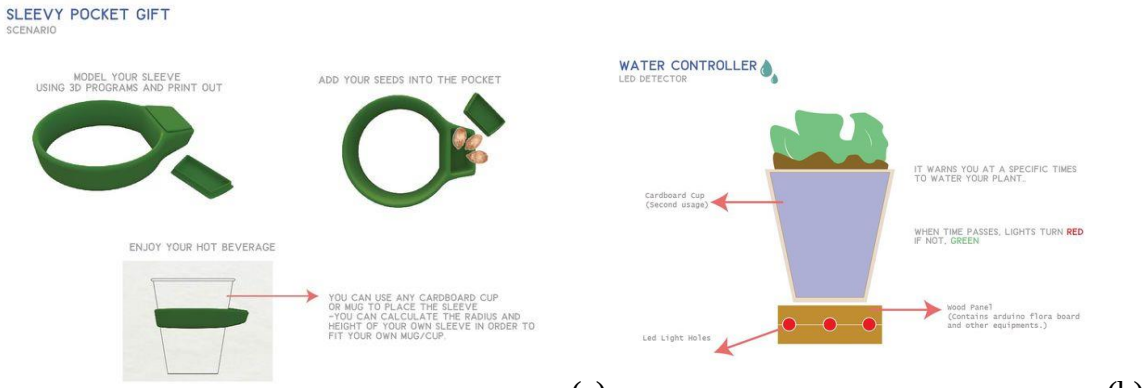
Figure 61: S8Cmp's final cup design with the compartment.

4.3.3.3. Other Implications with Open Source Tools

In addition to selected cases, other students' design process had some stages of needing analyzing. These stages show alternatives views about open source tools use in their design process.

In the 3rd week, S5Cpfy shared her new findings and developed parts on her design. She wants to design espresso cup which offers interaction with the customer through Spotify music list. She found dynamic QR code as a different from previous weeks, but she has thoughts about why she need to share her project, and what it may offer other people on Instructables. With that, S1Grab and S6Mlt claimed that they learned dynamic QR code and offering interaction with it thanks to her Cupify project, so it may give inspiration to other people, too. This indicates that students accept sharing activity of open source for only complex production or very interesting idea, but the point is sharing and taking feedback, then level the project one step further.

Another remarkable thought was expressed by S12No. He has not presented any projects idea yet. He said that the aim of industrial design department is teaching how we design a product with economic value, so why I share my idea free instead of that earn money with it; I am not clear about sharing, and also I think if my design is good enough, then I share Kickstarter, not Instructables. According to his opinion, many posts on Instructables does not have a design or product value. He thinks that there is no value for the market.



(a) (b)

Figure 62: S2Geo's gift design (a), interactive water controller design with Arduino (b).

S2Geo started with recyclable material cup with geometric pattern, and she wanted to add some seeds on it for the secondary use of the cup. However, she did not find the direct way of it, instead of that, she designed the gift idea with seeds (Figure 62(a)). Then, she designed water level controller for plants (Figure 62 (b)). All steps of her design were not connected each other through a cup design, but she still continued with the eco-friendly concept, and use sharing and source as open source elements.

S9Heat designed cup with high-level isolation as mentioned before. Then, she did not design isolation for the all surfaces instead of that she built a relationship with heat via color changing paint with heat (Appendix G.10). In her interactive design, she also designed a coaster which has a piezo speaker as output and temperature sensor as input. When drink reaches to users desired temperature, the speaker starts working (Figure 63). Her interactive design also did not directly her product design. However, she had the focus point as heat during the process.

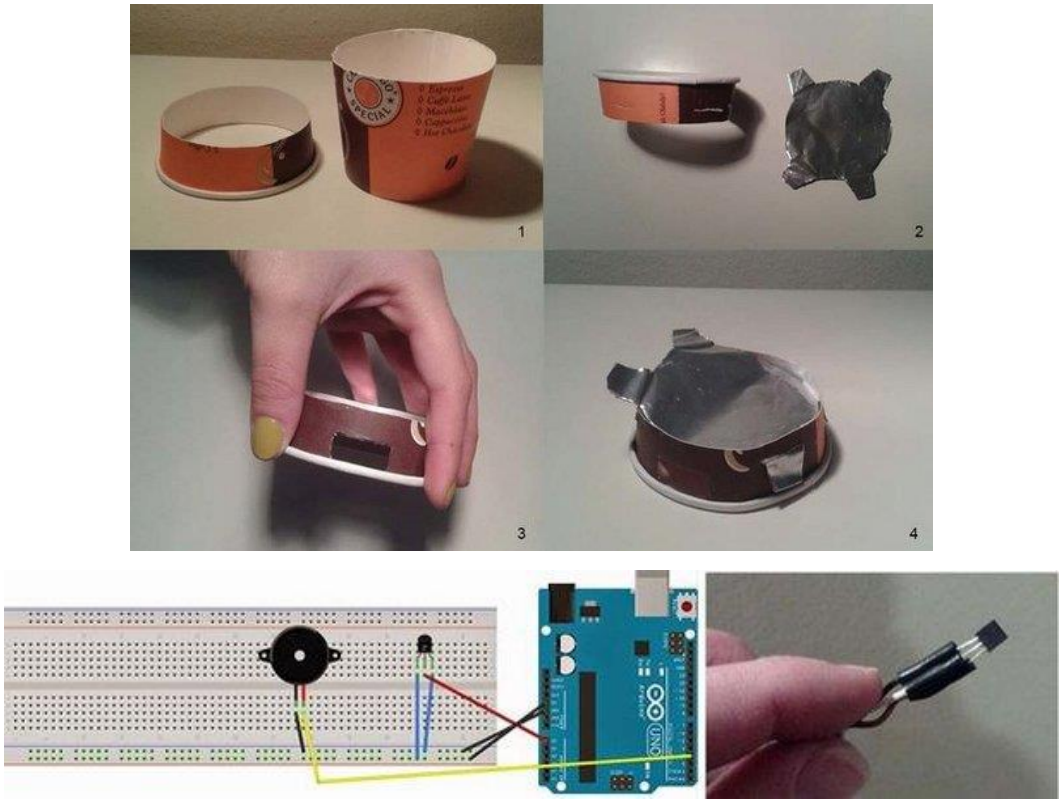


Figure 63: S9Heat's interactive coaster design steps with Arduino.

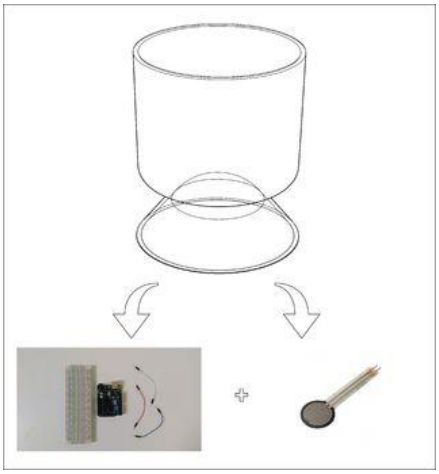


Figure 64: S6Mlt's implication of open source tools in her previous design.

In addition to the design process and open source session in the class, students used open source tools in their previous design. For example, S6Mlt had designed cocktail glass in her previous design studio courses, and she decided to add interaction her glasses for parties and cocktails (Figure 64). The aim of interaction was building communication with the waitress, when customers' drink are finished. For this purpose, she decided to use load cell in the cocktail desks which sense to weight of the drink; then it sends signals to waitress. Moreover, she shared on Instructables and wanted help from other Arduino users. Using open source outside the class and without any obligation shows that she may adopt it as a design element and usable in the design process.

Figure 65: S4Fshp's previous design project "Bookside."

As similar to S6Mlt, S4Fshp also shared her previous design on Instructables. She published instructions of her previous "Bookside" project. She did not need any support about her design. Furthermore, she said that I just want to share and see other people produce my design. This indicates that students adopt open source to interact communities and being part of the communities.

4.4. Results of Open Source Community Session

In this section, results of open source community session were analyzed in terms of early experience, and adoption of open source tools to see differences and changes of students during the session.

4.4.1. Evaluation of the Early Experience of Students' Open Source Tools Usage

Students answered five questions before SWOT analysis of their design to evaluate their thoughts about open source. Ten students answered questions, and two of them did not upload their designs on Instructables, but he mentioned his project in the class. After that, he was added to the last line of the table. According to answers, 8 of students knew the term of open source before starting the open source session, and 2 of them did not. In the second question, students defined the open source with keywords to use at the end of the research for analyzing their progress and changes.

In addition to 5 minutes' presentation and sharing their design on Instructables, students defined their product design with keywords as an answer of the 3rd question. In addition to keywords, students wrote simple or minimalist and practical the most.

In the 4th question, students answered that "Did uploading your design on Instructables and taking comments affect your design process? Why?". Answers can be listed:

- I understood which part of my design needs to work on.

- Comments supported my form design and directed me to design a product which may fit my persona more.
- Comments showed me missing parts of my design, then gave my ideas about how I can express more clear and effective.
- Before sharing my idea, I am not sure how I can reflect my idea to product, after comments, it became clear and easy to me.
- They did not affect my design process much. Comments focused on the favorite object of my persona, so I did not follow this way.
- Reaching comments anytime was good for me, it affected my process.
- Uploading my design step by step made me think about it more deeply. In the comments, I found many ideas about part of my Project which make my mind busy. Also, I saw missing points of my design.

In the last question, students answered that how they feel and think about sharing their design open. Some students have concerns about sharing their design due to the possibility of using commercially, or stealing their ideas, and also negative and deconstructive critics. 6 of 10 answers were positive about sharing their design. Because it helps developing ideas, shows missing points, an effective tool as online critics session, and can be an opportunity to make people try my product. In addition to these, one student mentioned that less motivation to share openly because of no financial benefits.

4.4.2. Adoption of Open Source Tools Use into Design Process of Students

As mentioned in the previous section, students also defined the open source based on their early experiences about it. Students defined the open source with keywords which are sharing, free, ready, source, contribution, co-design, benefit, accessibility, and community. Students wrote 16 keywords in total. Moreover, 5 of them were sharing and 4 of them source as a keyword. Accessibility, ready, benefit and free were written twice.

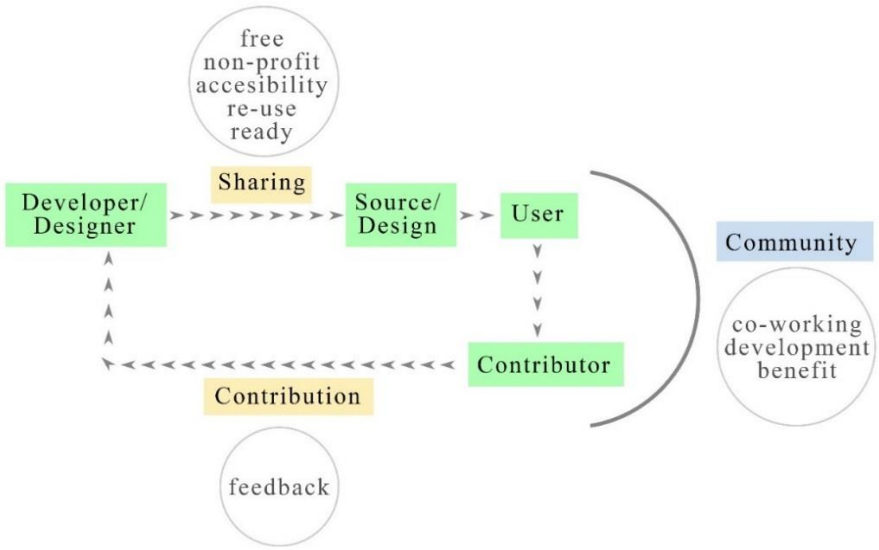


Figure 66: Analysis of students' open source tools and community definition (The author's compilation.)

As a result of students' answer in the questionnaire in Appendix I, a flow chart of open source community was drawn with only students' keywords. Keywords in the rectangular are the main elements of open source. Moreover, students added new keywords to the definition and density of keywords use also was changed. Students used "development" and "feedback" as keywords in the evaluation session in addition to evaluation of the beginning. Furthermore, more students used contribution and co-working keywords in their definitions. These indicate that students did not only learn open source as a definition, but also they learned how the system works.

Students found using open source tools and communities useful. 8 of students agreed about positive contribution of the session on their design process, but 3 of students claimed that this made their design process slower. 2 of them did not find effective or useful for their design process.

The question of students' anxiety about sharing their design was asked in 0 to 10 Likert scale. 0 was no anxiety to share, five was I have some, but it did not prohibit to share, and ten have I felt anxiety, and I did not want to share. As a result, only 2 of students felt anxiety about sharing and somehow limited willing to share. 3 of them chose scale 5, and rest of students had less anxiety about sharing.

According to students' feedback about effects of sharing their design on Instructables, almost each student agreed about comments had a positive effect on their design process. Some comments helped students at the point where they were stuck; some were stimulating for them to make their process much easier. One of the students said that he found critics objective and helped his design. Another student's opinion was about comment helped the transformation of her design from raw to more developed product.

A great majority of students agreed with positive effects of contribution to each other's project. Only 1 of students found a contribution to another project time-consuming. Two students said that contribution provide personal satisfaction to help other design. Rest of students claimed that this activity supports their project and also their personal development. Moreover, two students gave the answer which contributing other projects provide contributing both my projects and myself.

Other opinions about making a comment and contributing another project can be listed;

- I became more objective thanks to the web platform because in the classroom making a comment for people who know is not easy. It was a valuable experience for me.
- Because other people made comments for my design, it makes me need to make comments others' project. It was a cycle.
- Even it is online, not face to face, so commenting someone whom I know can be hard.
- I hope my comments help others; it makes me more motivated.
- Focusing other projects were eye-opening for me. It gives me a different perspective.
- Normally, after critic session everyone is focusing their session, then leave the classroom. However, this time each of us contributed to another's project. Moreover, contributing another project was not useful for that project also contributed mine.
- I found very useful this co-working experience.

In the 3rd week class and assignment, students had to do research and find open source to build their Arduino prototype. There is a question about how hard or easy process of finding knowledge from an open source. It was asked to evaluate their research process on open source. Only one student found it hard, 5 of them thought that it is a normal process and 4 of them agreed with its easiness.

As an answer to following question, students evaluated their experience with Arduino as open source hardware during open source session of the course. Students had some difficulties due to their lack of practice yet, but the majority had a positive thought about learning Arduino and gaining this experience for their further projects. For example, S6Mlt could not run any code with Arduino at the beginning, but she was pleased to know that she has this kind of opportunity to design interactive products. Another student also evaluated her experience as doing many things with little coding knowledge. One of them also expressed a different opinion which is also related directly to design profession. This was using open source and seeing transformation through physical thing is excited. Arduino phase of the session gave a different approach to a student like S8Cmp. When she was an Erasmus student in Italy, she was not interested in Raspberry Pi in a course while engineers were. However, after Arduino experience, she feels more comfortable with dealing with coding and electronics. S2Geo found useful taking feedback and answers to question very quickly in open source community. In contrast to other seven students, 3 of them claimed that they did not feel engaged enough with Arduino, and no think about continuing to use it.

Due to course structure, all students used Instructables Even there is a part which includes Arduino in the course, each student did not use Arduino. To find a 3D model for their design, students used GrabCad and Thingiverse. One of the students chose the option of other, but he did not note specific one.

The following question aim to learn how much open source tools and its culture engaged with students, so the question was “will you use open source tools in your further projects?”. Majority’s opinion was learning these tools will be helpful for the further project, if they need to design any interactive project. Also, one of the answers said that if this class was only design course we only design the thing, and all activities could be related to it, but now I can use anywhere what I learned this course. Moreover, student understood Arduino, coding or electronics are not difficult that much, they need clear and open sources to learn from them.

As the last question, if there is any additional feedback to give, they wrote here. One of the students said that she knew the open source as a term but using it gave a different approach.

CHAPTER 5

CONCLUSION

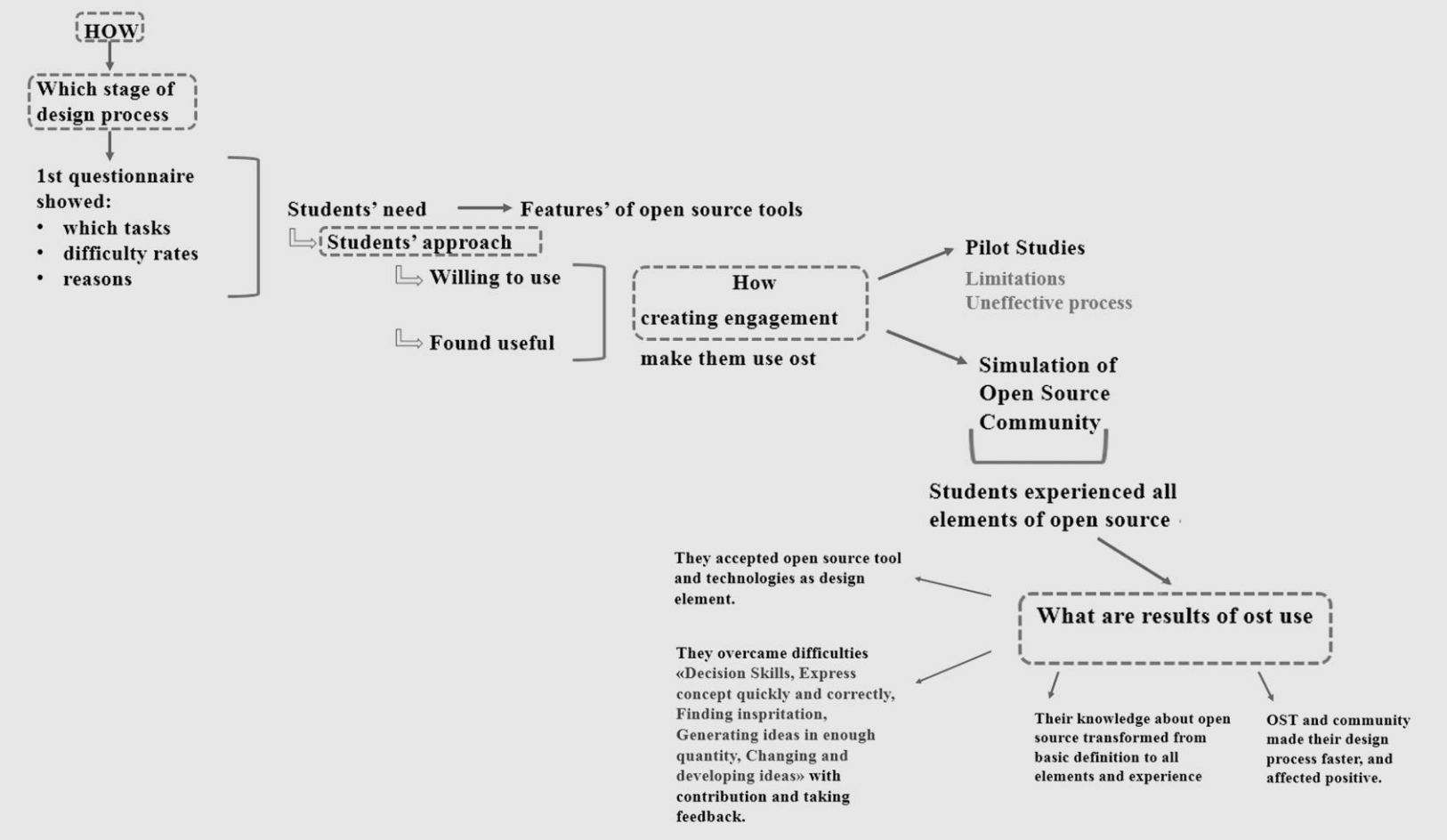


Figure 67. Summary of the process with conclusions.

Industrial design students accomplish several tasks during industrial design studio course projects. Results of the first questionnaire showed that students have difficulties in many tasks which can be supported by open source tools use directly. These are data collection and analysis, generating ideas in enough quantity, finding inspiration, finding reference knowledge, digital modeling, physical modeling, delivering the project in due time and affording budget. The first questionnaire did not only give information about tasks and difficulty rates of students, but also showed reasons of difficulties. Knowing reasons provided deciding approach and emphasizing which side of each open source tool. The second questionnaire showed that students have limited knowledge about open source tools such as Grabcad, Arduino, Instructables, Thingiverse, Raspberry Pi, Kaa. However, they have also positive approach about using open source tools in their design studio course projects according to their answers. Pilot studies were designed to find an effective way to make industrial design students use open source tools in their projects. The last step of the research showed that the effective way of creating engagement between students and tools is offering all elements of open source such as hardware, software, community, and platforms.

Open source community session was designed with open source community, software, hardware, and platforms. After each assignment, students got experience with each part of the session. Without using in their design, students did not see open source tools as a design element. With co-working and contribution elements of open source culture, students overcame difficulties which were evaluated as a result of the first questionnaire. They are decision skills, express concept correctly and quickly, finding inspiration, generating ideas in enough quantity, changing and developing ideas.

Industrial design students defined open source different before and after open source session in the class. With experiencing open source community and culture on some level, it became process than term. Before the session, students focused on source and sharing. However, after the session, they mentioned co-working, contribution, and feedback. All these are related to culture, and also indicates students engaged with open source culture.

In contrast to offerings of open source tools for industrial design students, they have a view about their occupation. They interpreted their job definition as that industrial designer's design a product with economic value, so the product has a place in the market,

then it makes its company earn money. In this circumstances, students did not understand why they share their design clearly. In consideration of the definition, they should not use open source tools, because they cannot be used as commercially. However, as the opposite of this definition, some of the students mentioned about personal satisfaction due to contributing another project. The process is the matter for open source users and people sharing projects. Open source culture should be mentioned and discussed more, and taken industrial designers views about the process, then students start to meet open source tools.

Limitations of the research can be listed phase by phase like;

- Pilot studies 1 showed that students need more time and practice to engage with open source tools. In the 2nd pilot study, students' feedbacks indicated that they need more time, more practice and knowledge before using in studio course projects. Moreover, students did not want to use anything without notice of lecturer.
- Students get used to designing for economic value, so sharing their design in free of charge is not a usual demand for them. Thus, students need to understand why people share their design and other works in free. For this purpose, students can meet those people and interview to understand them.
- The first limitation on primary research included open source session into the on-going course, so students have some confusion about how they continue on their projects. Even in the 4th week, students were not clear enough, they have to include their previous work such as persona or brand, or they need to design DIY product.
- Students' feedback in evaluation session showed that they could not engage with the reason of sharing their projects. It shows that there is a need for one more class before starting open source session to talk about open source culture and its effects.

As further studies, after open source tools are taught in the class, students pick a project to develop themselves instead of giving a specific theme and obligation. Moreover, contacting any project owner from any open source platform and contributing it can be demanded from students so that they can be part of a real community.

The way of creating engagement between industrial design students and open source tools is building an environment will all open source elements. With this environment, students experience the whole process starting from source, sharing, contribution to the community. Then, they start to accept them as a design element. Moreover, they contribute

open source like sharing their design, developing them with community and give feedback others, so they add their design perspective into open source as much as they learn from them.

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APPENDIX A

EVALUATION OF INDUSTRIAL DESIGN STUDENTS' DESIGN PROCESS TASK BY TASK AND THEIR AWARENESS ABOUT OPEN SOURCE

This questionnaire was applied for Zeynep Aykul's MSc Thesis in Industrial Design Department at IZTECH. In the first chapter, there are two parts which are difficulty rates design tasks and reasons design tasks. In the second chapter, knowledge of students about open source term and open source tools are asked.

1. Name and Surname

2.E-mail

3. School/Class

Tasks and Their Difficulty Rates

4.Please, mark your difficulty rate for each task in the design studio projects. *

	It is not difficult	A little difficult	Somehow difficult	Difficult	Very Difficult
Data collection and Analysis					
Data presentation					
Understanding project theme					
Understanding project needs					
Producing enough amount of ideas					
Developing and changing ideas					
Express the concept quickly and correctly					
Finding inspiration					
Generating form and style according to user's need					
Finding reference knowledge					
Decission ability					
Evaluation criteria					
Meeting expectation of lecturer					
Digital modelling					
Physical modelling					
Preparing presentation poster					
Preparing presentation organization					
Affording budget for presentation					
Delivering project on due date					
Affording budget for overall project					

Reasons of difficulty for design tasks

In this section, you will answer reasons of difficulties of tasks as the same as the previous question.

5. Please, mark your difficulty reason for each task in the design studio projects.

	Experience	Technical Knowledge	Budget	Time	Technical Support	Relevant Courses	Lecturer	Classmates
Data collection and Analysis								
Data presentation								
Understanding project theme								
Understanding project needs								
Producing enough amount of ideas								
Developing and changing ideas								
Express the concept quickly and correctly								
Finding inspiration								
Generating form and style according to user's need								
Finding reference knowledge								
Decission ability								
Evaluation criteria								
Meeting expectation of lecturer								
Digital modelling								
Physical modelling								
Preparing presentation poster								
Preparing presentation organization								
Affording budget for presentation								
Delivering project on due date								
Affording budget for overall project								

Measurement of Awareness about Open Source Term and Tools

In this section, your knowledge about open source will be measured.

6. Did you hear term of "open source" or "açık kaynak"?

- ◯ yes
- ◯ no

7. Mark your relationship about each open source tools

	I heard it, but did not use before	I participated its use in workshop etc.	novice user	pro user	I used it in design studio course project	I am following the tool, but no opportunity to use	I did not hear it
Arduino	◯	◯	◯	◯	◯	◯	◯
Raspberry Pi	◯	◯	◯	◯	◯	◯	◯
Rasbian	◯	◯	◯	◯	◯	◯	◯
Open IoT	◯	◯	◯	◯	◯	◯	◯
Buglabs	◯	◯	◯	◯	◯	◯	◯
Makezine	◯	◯	◯	◯	◯	◯	◯
Reprap	◯	◯	◯	◯	◯	◯	◯
Lasersaur	◯	◯	◯	◯	◯	◯	◯
Grabcad	◯	◯	◯	◯	◯	◯	◯
Thingiverse	◯	◯	◯	◯	◯	◯	◯
Blender	◯	◯	◯	◯	◯	◯	◯
Freecad	◯	◯	◯	◯	◯	◯	◯
Inkspace	◯	◯	◯	◯	◯	◯	◯
Gimp	◯	◯	◯	◯	◯	◯	◯
Scribus	◯	◯	◯	◯	◯	◯	◯

Additional

If you used any tools in your class, then please answer the question.

8. Did you use open source tools which you marked in previous question or another one in

design courses? Please note your aim and experience. *

APPENDIX B

FEEDBACK SESSION OF INTRODUCTORY PRESENTATION

Pre presentation Section

This survey aims to take feedback about my presentation. For further information on your questions, you

can send me email to zeynep.aykul@gmail.com

1.Your School/Class (If you want to take information e-mail about open source and further studies, you can write your email)

_____

2. Do you know term of "open source"?

- ◯ Yes
- ◯ No

During Presentation Section

You should answer these questions during the presentation.

3. Did you understand Open source terms and system?

- ◯ yes
- ◯ no
- ◯ not clear enough
- ◯ Diğer: _____

4. Do you think that I analyzed challenging tasks of industrial product design students and

reasons of them in studio courses?

absolutely true	true	there are some missing points	there are wrong analysis
◯	◯	◯	◯

5. If you think there is mistake or missing point in previous question, you can add here.

6. In this question, can you pick the best option for you in each project sample?

	I heard it for the first time	It was interesting tool	Advises are useful, I may use it in future project	Advises are not enough	Advises are useful, but they are not effective for studio project	I am already a user
No:1 GRABCAD	◯	◯	◯	◯	◯	◯
NO: 2 INSTRUCTABLES	◯	◯	◯	◯	◯	◯
NO 3: THINGIVERSE	◯	◯	◯	◯	◯	◯
NO 4: ARDUINO	◯	◯	◯	◯	◯	◯
NO 5: RASPBERRY PI	◯	◯	◯	◯	◯	◯
NO 6: KAA-PLATFORM	◯	◯	◯	◯	◯	◯

7. Did you think about any tool which could be helpful, if you learnt before the project?

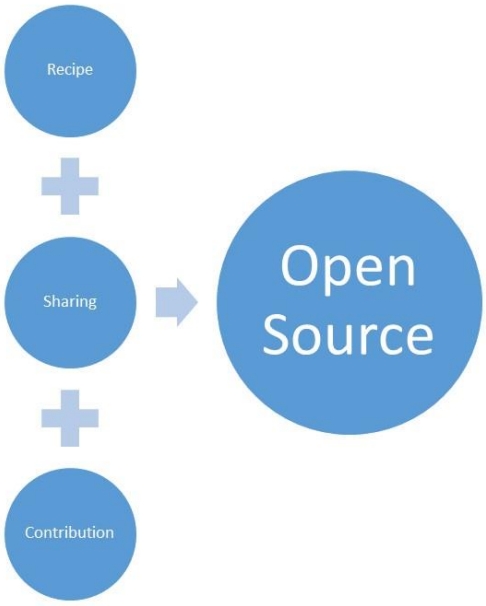
8. If you have any additional opinion or idea, you can add this part. Thank you.

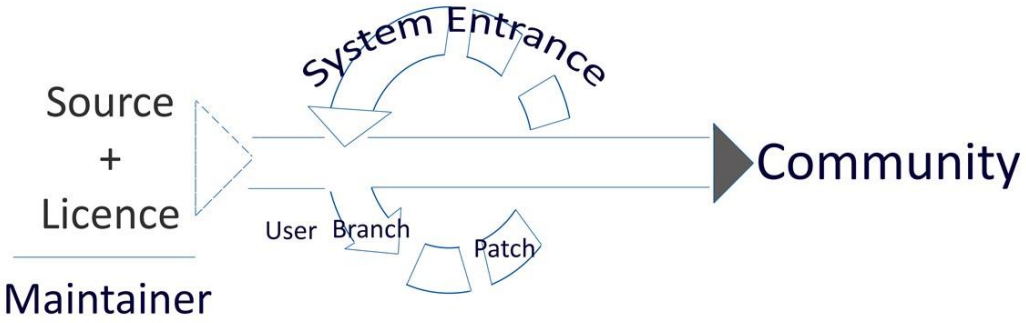
APPENDIX C

INTRODUCTORY PRESENTATION ABOUT OPEN SOURCE TOOLS FOR INDUSTRIAL DESIGN STUDENTS

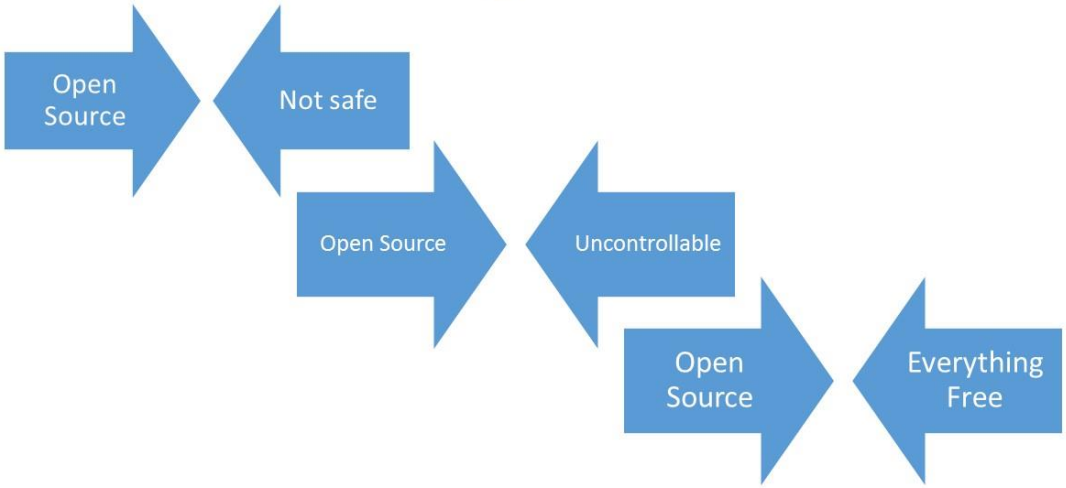
Open Source Use for Industrial Product Design Students

Zeynep Aykul
Izmir Institute of Technology
Master of Science in Industrial Design

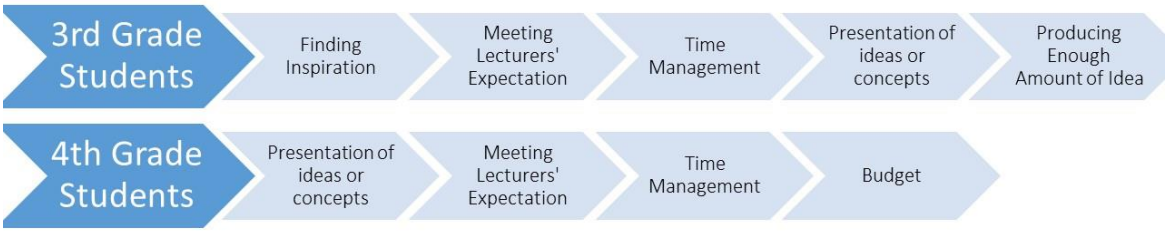




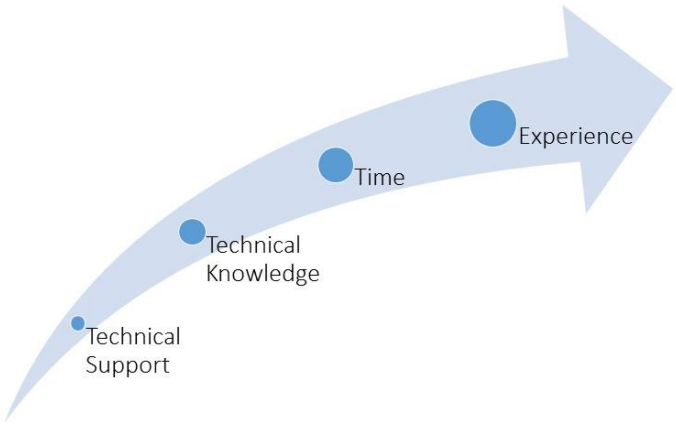
Wrong things about Open Source known as right



Students of Industrial Product Design

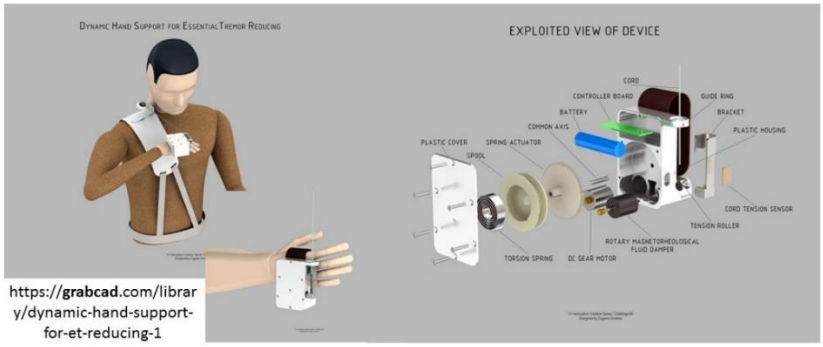


Reasons of challenge on those tasks...



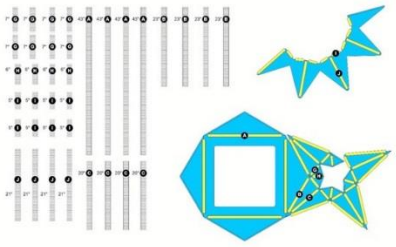
What about Open Source Tools and Platforms? Can They Help Students?

NO:1 GRABCAD



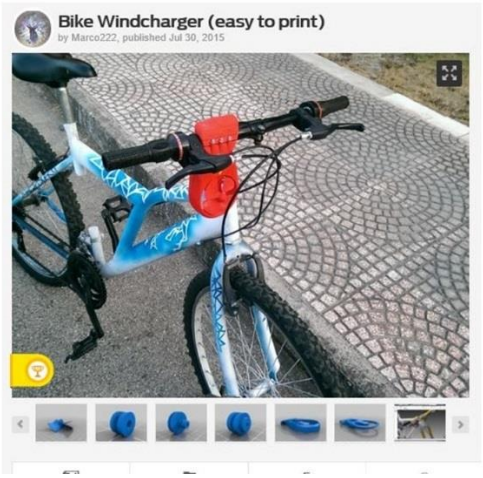
https://**grabcad**.com/library/dynamic-hand-support-for-et-reducing-1

NO: 2 INSTRUCTABLES

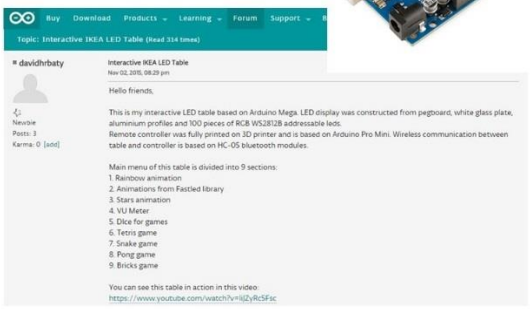


http://www.**instructables**.com/id/Origami-Furniture-Case-Study-a-Table/

NO: 3 THINGIVERSE



NO 4: ARDUINO



NO: 5 RASPBERRY PI

NO: 6 KAA - Platform

Some additionals

Budget

- Raspberry Pi Zero: $5 - It can be used again and again
- Strafor foam : 3 $ - It can not.

Contribution to Open Source Project

- Contribution Level
- Wish List
- Reporting Bug

APPENDIX D

FORM 1: TO IDENTIFY STUDENT PROFILE WHO CONTRIBUTE PILOT STUDY 2

Çalışmanın Amacı:

Bu çalışma, İzmir Yüksek Teknoloji Endüstriyel Tasarım Yüksek Lisans tezi kapsamında Zeynep Aykul tarafından yürütülmektedir. Endüstriyel tasarım ve endüstri ürünleri tasarımı öğrencileriyle yapılacak çalışmaların amacı, onlara açık kaynak araçları tanıtarak ve öğreterek tasarım stüdyosu projelerinde kullanımını sağlayarak, bir tasarımcı olarak bu araçları kullanımlarının nasıl olduğunu gözlemlemektir.

Bu kapsamda, 2016-2017 Güz döneminde ilk stüdyo projesinde kullanmak üzere dönem başında açık kaynak araçları tanıtıcı bir ders yapılıp, bu derste, her bir açık kaynak aracının kapsamı, kullanım alanları ve yöntemleri öğrencilere öğretilecektir. Sonrasında, öğrencilerden haftalık olarak yaptıkları tasarımlarda bu araçları ne şekilde kullandıklarına yönelik raporlar istenerek süreç izlenecek ve bu raporlarda, öğrenciden kullandığı aracın tasarım sürecini nasıl etkilediğine yönelik bilgilere ve aynı zamanda stüdyoda aldığı kritiklere bu raporda yer verilmesi beklenmektedir. Bu adımlar doğrultusunda açık kaynak araçların kullanımın stüdyo dersindeki sürece uygunluğu araştırılacaktır.

FORM 1:

Amacı : Öğrencinin profilinin belirlenmesi.

Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.

İsim, Soyisim:

Telefon Numarası - E-mail adresi:

Okul:

Sınıf:

Stüdyo Numarası:

(Öğrencinin katıldığı kaçıncı stüdyo dersi?)

Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım

Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?

E.1. Form 1: Vefa Ayaz

Amacı : Öğrencinin profilinin belirlenmesi.
Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.
İsim, Soyisim: VEFA AYAZ
Telefon Numarası - E-mail adresi: 5434843321 -vefaayaz@gmail.com
Okul: ANADOLU UNIVERSITESI
Sınıf: 4
Stüdyo Numarası: 7
(Öğrencinin katıldığı kaçıncı stüdyo dersi?)
Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım
3
Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?
Evet açık kaynak kullanımını arttırarak ,projelerimi daha kısa sürede bitirmeme yardımcı olabilir.

E.2. Form 1: İrem Berkant

Amacı : Öğrencinin profilinin belirlenmesi.
Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.
İsim, Soyisim: İrem Berkant
Telefon Numarası - E-mail adresi: 538 681 5040 – iremberkant@gmail.com
Okul: Anadolu üniversitesi
Sınıf: 4
Stüdyo Numarası: 5
(Öğrencinin katıldığı kaçıncı stüdyo dersi?)

Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım
3
Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?
Tasarım ve araştırma sürecinde farklı bakış açıları ve yöntemler kazandırabileceğini düşünüyorum

E.4.Form 1: Elif Gökçen Bulut

Amacı : Öğrencinin profilinin belirlenmesi.
Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.
İsim, Soyisim: Elif Gökçen BULUT
Telefon Numarası - E-mail adresi: 05383768336 – elif.bulut@ozu.edu.tr
Okul: Özyeğin Üniversitesi
Sınıf: 2.sınıf (2.sınıf fakat irregular olduğum için 2.sınıfın 2.stüdyo dersini bu dönem alıyorum.)
Stüdyo Numarası: 202
(Öğrencinin katıldığı kaçıncı stüdyo dersi?)
Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım
Evet, bu çalışmaya sonuna kadar katılabilirim. -5
Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?
Evet, düşünüyorum. Tasarımda sadece öğretim görevlilerimizden değil, diğer tasarımcılardan da fikir almak isterim. Başka yöntemleri nasıl kullanacağımı ve uygulayacağımı öğrenmenin bana deneyim ve yeni fikirler katacağını düşünüyorum.

E.5. Form 1: Cansu Deniz Özden

Amacı : Öğrencinin profilinin belirlenmesi.
Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.
İsim, Soyisim: Cansu Deniz Özben

Telefon Numarası - E-mail adresi: cansu_ozben@outlook.com
Okul: FMV Işık Üni.
Sınıf: son sınıf
Stüdyo Numarası: proje 5
(Öğrencinin katıldığı kaçıncı stüdyo dersi?) 5.
Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım
5
Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?
Projem için bilgi toplamam konusunda katkı sağlayacağını , değişik fikirler ile daha yaratıcı ve farklı tasarımlar yapmama yardımcı olacağını düşünüyorum.

Şu an üzerinde çalıştığımız konu Elektrikli scooter (şarj üniteli)
Bu hafta scooter ı hangi alanda çalışacağımızı belirledik. Neresi için , kim için, hangi yaş grubuna ,nasıl sokaklarda kullanacağımıza kısacası konsepte karar verdik.
Ben bir senaryo belirledim onun üzerinden sorunları belirleyip ilerleyeceğim.
Kadıköy'de Boğa heykelinin civarlarında bir evim var. Her sabah işe giderken önce Beşiktaş iskelesine yürüyorum .10 dakika sürüyor, sonra vapura binip Beşiktaş'a varıyorum. Oradan da işyerime Ortaköy'e gidiyorum. Bir şirkette yöneticiyim.Yolum yürüyerek 20 dk sürüyor. Bu kadar yolu daha kısa sürede gitmek istiyorum,20 dk lık mesafe için toplu taşıma kullanmak bana göre gereksiz masraf .Scooter 'ım olsa bu sorunu kolay yolla çözebilirim.

Hedeflerim;
1- Zamandan tasarruf sağlamak.
2- Otobana çıkmadan kaldırım üzerinde scooter'ımı sürmek bunu yaparken diğer insanları rahatsız etmemek.

3- Saklama alanı gibi bir hedefim yok ; amacım beni istediğim uzaklığa götürebilecek bir scooter sahibi olmak.

4- Sadece kısa mesafeler için kullanacağımdan ötürü konfor 2. Planda.

5- Kolay taşınabilir,mümkünse küçülebilir,katlanabilir,sırt çantası olan bir tasarım hedefliyorum

Haftaya görevim bu bahsettiğim yolları kendim kullanarak deneyimlemek ve sorunları belirleyip fotoğraflarla proje hocama fikirlerimi savunmak.

E.6. Form 1: Gürkan Özkan

Amacı : Öğrencinin profilinin belirlenmesi.
Bu form çalışmaya katılan öğrencilerin profillerinin belirlenmesi amacıyla sunulmuştur.
İsim, Soyisim: Gürkan ÖZKAN
Telefon Numarası - E-mail adresi: 05375004426 – gurkanozkann@gmail.com
Okul: FMV IŞIK ÜNİVERSİTESİ
Sınıf: 3
Stüdyo Numarası: Proje 3
(Öğrencinin katıldığı kaçıncı stüdyo dersi?) 3
Çalışmanın sonuna kadar katılabileceğinizi düşünüyor musunuz? En az katılım 1 2 3 4 5 En çok katılım
4
Bu çalışmanın size katkı sağlayacağınızı düşünüyor musunuz? Evetse nasıl?
Yeni kaynaklar ve düşünce kanalları oluşturucağını kısacası tasarım sürecini kısaltacağını düşünüyorum.

APPENDIX F

FORM 2 TO TRACK STUDENTS' WEEKLY STUDIES IN STUDIO COURSE

Amacı: **Öğrencinin haftalık çalışmalarının takibi**
İsim, Soyisim:
Proje Adı:
Tarih / Hafta:
Proje Adımı:

Kullanılan Açık Kaynak ve Amacı:

Öğrencinin yorumu:

Kritikte öğretim görevlisi ya da araştırma görevlisinden kullandığı açık kaynakla ilgili aldığı geri dönüş varsa:

Görseller:

APPENDIX G

STUDENTS' PROJECTS IN OPEN SOURCE COMMUNITY SESSION

G.1. S1Grab: Ceylan Beşevli

Concept 1 ; Minimalist yet fun and comforting
A comfortable handle form that makes one feel in control
Texture and a hint of color

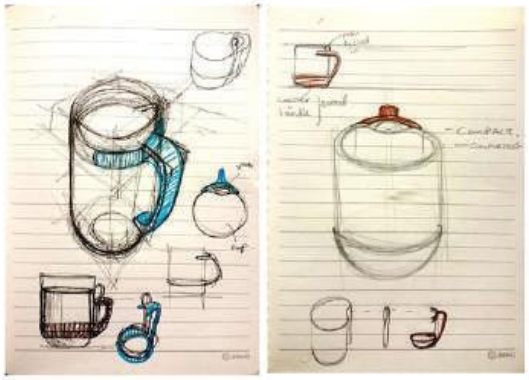
Ceylan Besevli, Design Thinking and Methodology

Concept 2 (with the Rebul Brand in mind)

2.a

Soothing and subtle
Wooden handle for a homey , natural, warm feeling
Mix and match the cups and handles,
DIY cup family
Texture differentiation

Ceylan Besevli, Design Thinking and Methodology



2.b Intimate Spoon and cup relationship
Cozy
Deformed cup
Simple wooden handle

Ceylan Besevli, Design Thinking and Methodology

Model 1 explains the structure principle, the red ears would be wooden added pieces

Model 2 shows the scale of the cup

3 Further development according to the feedbacks

An alternative way of experiencing coffee
Intimate, tactile
Feeling of warmth
No handles, wooden grabbing surface

Ceylan Besevli, Design Thinking and Methodology

4 SWOT Analysis with the workshop participants

STRENGHTS	WEAKNESSES
Cultural reference to the delicate Japanese tea ceremonies	Hygiene
The warm feeling of holding the wooden surface	The shape of the cup might not keep the liquid warm effectively
OPPORTUNITIES	**THREATS**
A different coffee drinking experience	The manufacturing details of corresponding porcelain and wood pieces
Using it with one hand as well	Joining details
Emphasizing the grabbing surface	Tactile feeling as the only function
Toss the porcelain keep the wood; afterlife, alternative usage	

Concept detailing

Semi dented porcelain cup with cork add-ons that work as an insulator and a coaster

Easier to manufacture than wood
Removable, more hygienic

Multi purposed

cikciks a month ago Reply

Kulptan ziyade ahşabi bardagi elle kavramayi saglayacak bir şekilde kullansan sanki o "homey" havayı daha çok yakalarmissin gibi geldi, hem tutuş olarak hem de ahşabın hafifçe elleri ısıtmasıyla :)

Flag

ipder (author) ▸ cikciks a month ago Reply

evet bunu dikkate alacağım teşekkür ederim :)

Flag

Nuriye SultanK a month ago Reply

Concept 1 için, eğer malzemesi karton ise kulbu çok kullanıma uygun görünmüyor. Texture eğlenceli bence :)

Flag

ipder (author) ▸ Nuriye SultanK a month ago Reply

Porselen ve ahşap olacaklardı, teşekkür ederim :)

Flag

ayin77 a month ago Reply

Farklı malzeme denemeleri başarılı olabilir. Hem hareketlilik katarken hem de sade bir yaklaşım. Kaşığın bardakla bir olması güzel. Bu bardağın sadece bir insana ait olduğunu belirtecek bazı öğeler ekleyebilirsin.

Flag

ipder (author) ▸ ayin77 a month ago Reply

Teşekkür ederim dikkate alacağım :)

Flag

ipder (author) ▸ ayin77 a month ago Reply

Teşekkür ederim :)

Flag

DIY Hacks and How Tos a month ago Reply

Nice design A+

Flag

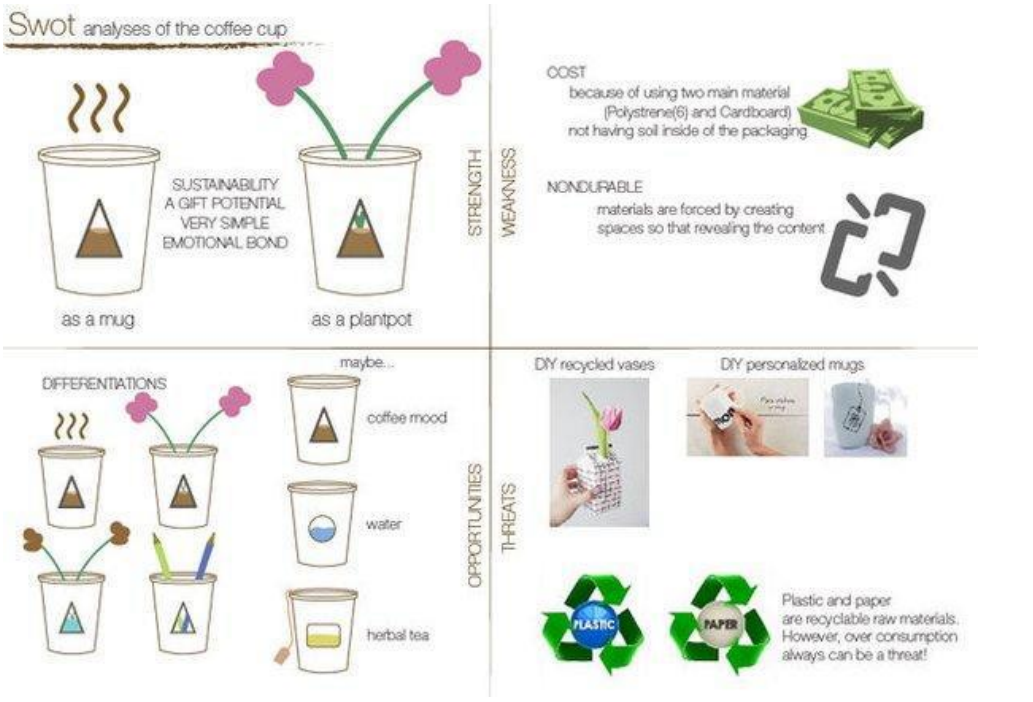
ipder (author) ▸ DIY Hacks and How Tos a month ago Reply

Thanks a lot :)

Flag

G.2. S2Geo: Nihan Sığırcı


CONSEPT design
Çalışmama basit bir karton bardağı temel alarak başladım. Oluşturduğum personadan yola çıkarak oldukça basit ve ürünün asıl amacına hitap eden bir tasarım yolu izledim.
Sıradan bardaklarında malzemenin opaklığı dolayısıyla tüketttiğimiz sıvıyı görmüyoruz.
Tasarımda 3 ana çözüm üzerinde durdum. Bunlar; daha sıcak dokuda malzeme kullanımı, personanın karakterine ilişkin detaylar barındıran ve de asıl amaca uygunluğu pekiştiren içme eylemine vurgu.
Step 1 Herhangi bir karton bardak buldum.
Step 2 Maket bıçağı makas vb. aletlerle boşlukları ortaya çıkardım.
Malzemeler: Craft kağıdı, cardboard bardak, plastik(pp 05 transparent), makas, maket bıçağı, cetvel.
3 temel geometrik şekil(üçgen, çember, kare) ile bir ürün seti oluşturdum. Sık kullanılan bir ürün olduğu için farklı yaklaşımlar ürünü monotonluktan uzaklaştırır diye düşündüm.
Şuanda konsept olarak hazırladığım ürünün temel çalışma prensibi pp 05 bir malzeme üzerine craft veya cardboard kaplamayla sağlanacak. Kontrast alanlarda dengeyi plastik ve cardboard oluşturacak.
Step 3 Craft Kaplama
Final
Nihan Sigirci


Swot analyses of the coffee cup
SUSTAINABILITY
A GIFT POTENTIAL
VERY SIMPLE
EMOTIONAL BOND
as a mug
as a plantpot
STRENGTH
WEAKNESS
COST
because of using two main material (Polystrene(6) and Cardboard) not having soil inside of the packaging
NONDURABLE
materials are forced by creating spaces so that revealing the content
DIFFERENTIATIONS
maybe...
coffee mood
water
herbal tea
OPPORTUNITIES
THREATS
DIY recycled vases
DIY personalized mugs
PLASTIC
PAPER
Plastic and paper are recyclable raw materials. However, over consumption always can be a threat!

G.3. S3Cont: Seçil Cıkcık

human-ur 5 days ago Reply

en aşağıdaki yorum çok doğru. :) nasıl yapıldığı ve herkesin yapabilmesi ile öne çıkan tasarımlar olmalı burda.

Flag

Nuriye SultanK a month ago Reply

ben de başka renk denemeleri yapılabileceğini düşünüyorum. metal ve karton kontrastı ilginç bir fikir.

Flag

ayin77 a month ago Reply

Güvenliğe önem veren bir persona için rüzgarda bardağın uçmaması önemli bir özellik. Renkler konusunda ise belki de bir ürün ailesi olarak düşünebilirsin. Başlangıç olarak mor güzel, buna uyumlu farklı renkler güzel bir seçenek olabilir:)

Flag

ipder a month ago Reply

Renkler ve metalin kullanımı personan ile oldukça örtüşüyor :) Form için de onu yansıtacak birşeyler deneyebilirsin belki?

Flag

DIY Hacks and How Tos a month ago Reply

Hi and welcome!

We're glad you want to share something with the community, but unfortunately this doesn't qualify as an Instructable . . . but you can fix it so it does! :)

An Instructable shows others how to do or make something, and outlines the steps to show readers how to duplicate what you have done. Would you like to make some changes or additions to this? Leave me a message here if you do, and I will take a look and publish this if it is ready!

Thanks,

Your friendly neighborhood instructables staff.

Flag

G.4 S4Fshp: Nuriye Sultan Kostak

Hello,
The cardboard cup which is designed according to design thinking methods, here. Take a look at this and make a comment please. I will improve my project with your comments :)
Thanks a lot

Step 1: Persona

Zülal,22

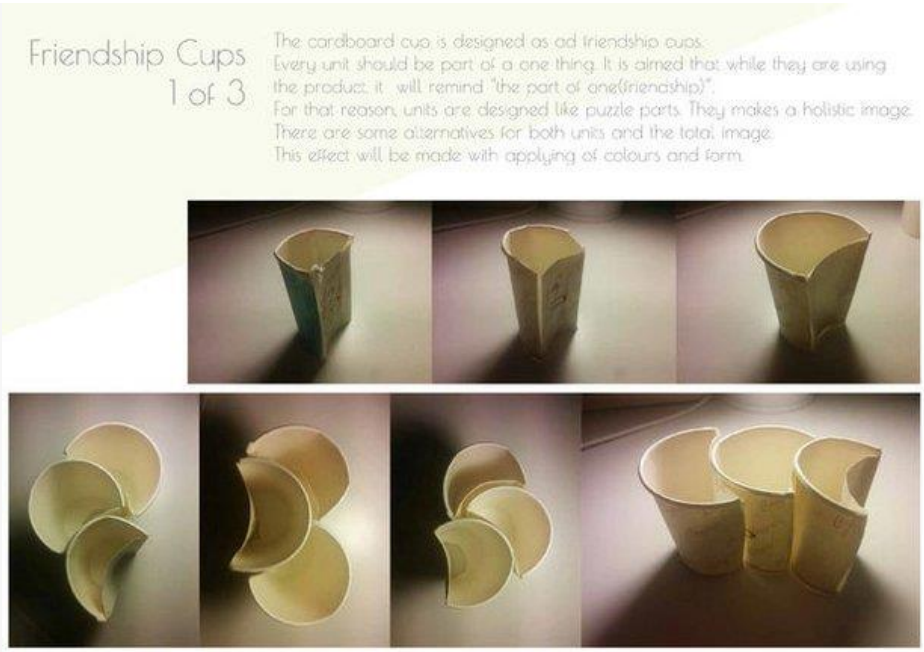
Sadelik ve rahatlıktan hoşlanıyor.

Hatıralarına ve arkadaşlıklarına değer veriyor, onları sürekli hatırlamak istiyor.

Uzun süreli kullanacağı ürünlerde hafiflik, uyum, dayanıklılık arıyor.

Doğal malzemeleri kullanmayı seviyor.

Step 2: Concept 1 - part of one



The cardboard cup is designed as friendship cups.

Every unit should be part of a one thing. It is aimed that while they are using

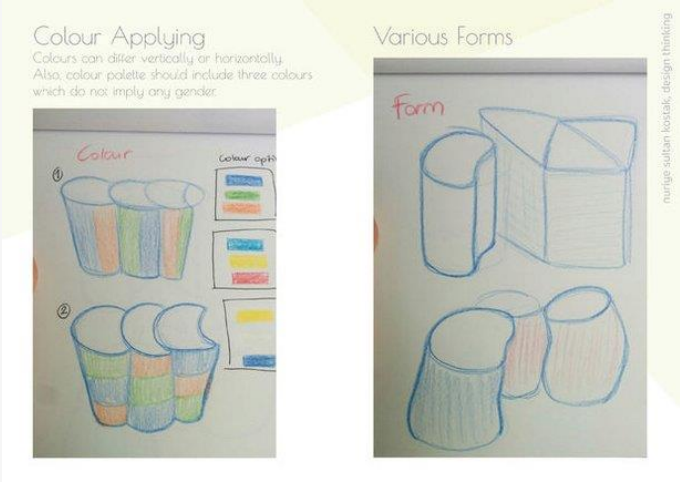
the product, it will remind “the part of one(friendship)”.

For that reason, units are designed like puzzle parts. They makes a holistic image.

There are some alternatives for both units and the total image.

This effect will be made with applying of colours and form.

Step 3: Concept 1 - color&form



I can use different colours and forms to create a total image.

Step 4: Redesigned cup with the comments

Different parts-different materials and colors

Swot analysis in the photos

We will continue to develop the cup according to Swot Analysis and new comments.

Step 5: New concept after research and swot analysis

These are links for arduino based project development.

http://maker.robotistan.com/arduino-dersleri-11-si...

http://www.instructables.com/id/supplies-and-tools...

http://www.jewelbots.com

http://www.instructables.com/id/3D-printed-LED-bra...

Step 6: Concept and usage

Step 7: Sleeve-Bracelet development with Lilypad Arduino

Here are the links which make profits

http://www.instructables.com/id/LED-Cuff-Bracelet/
http://www.instructables.com/id/Fabric-amp-Bead-Ti...

http://www.instructables.com/id/LED-Seahawks-brace...

http://www.instructables.com/id/Fabric-amp-Bead-Ti...

http://sewelectric.org/diy-projects/sparkling-bra...

http://www.instructables.com/id/Fabric-amp-Bead-Ti...

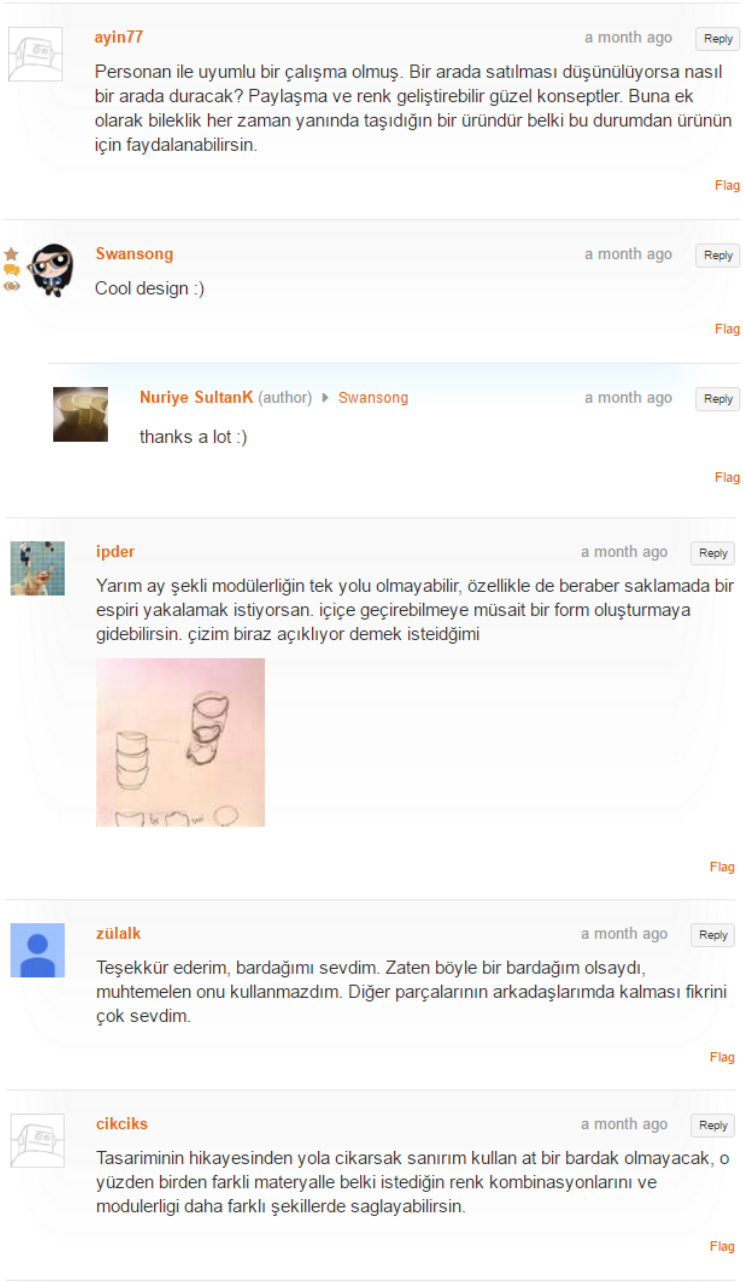
http://sewelectric.org/diy-projects/sparkling-bra...

http://www.instructables.com/id/Fabric-amp-Bead-Ti...

https://makezine.com/projects/make-29/beating-hea...

http://www.instructables.com/id/Fabric-amp-Bead-Ti...

That is already at concept stage, so please help me to develop my concept. I do not have enough info about arduino and lilypad things. Thanks :)



ayin77 a month ago Reply

Personan ile uyumlu bir çalışma olmuş. Bir arada satılması düşünülüyorsa nasıl bir arada duracak? Paylaşma ve renk geliştirebilir güzel konseptler. Buna ek olarak bileklik her zaman yanında taşıdığın bir üründür belki bu durumdan ürünün için faydalanabilirsin.

Flag

Swansong a month ago Reply

Cool design :)

Flag

Nuriye SultanK (author) ▸ Swansong a month ago Reply

thanks a lot :)

Flag

ipder a month ago Reply

Yarım ay şekli modülerliğin tek yolu olmayabilir, özellikle de beraber saklamada bir espiri yakalamak istiyorsan. içiçe geçirebilmeye müsait bir form oluşturmaya gidebilirsin. çizim biraz açıklıyor demek isteidğimi

Flag

zülalk a month ago Reply

Teşekkür ederim, bardağımı sevdim. Zaten böyle bir bardağım olsaydı, muhtemelen onu kullanmazdım. Diğer parçalarının arkadaşlarımda kalması fikrini çok sevdim.

Flag

cikciks a month ago Reply

Tasariminin hikayesinden yola cikarsak sanırım kullan at bir bardak olmayacak, o yüzden birden farkli materyalle belki istediğin renk kombinasyonlarını ve modulerligi daha farklı şekillerde saglayabilirsin.

Flag

G.5. S5Cpfy: Dinem Kurşun

My friend's favorite item was this little thing. I don't know what it's called. She said she likes it so much because it looks so small but it can keep so many stuff inside, and it looks tidy and clean

Step 1: Persona

The persona I created here is a girl that has an introversion personality. She likes minimal products. She wants the products she have to do it's job. It's enough for her to do one thing for a product if it's doing it well. She is shy with people at first, but when she gets closer she is more open to them.

Step 2: Brand Analysis

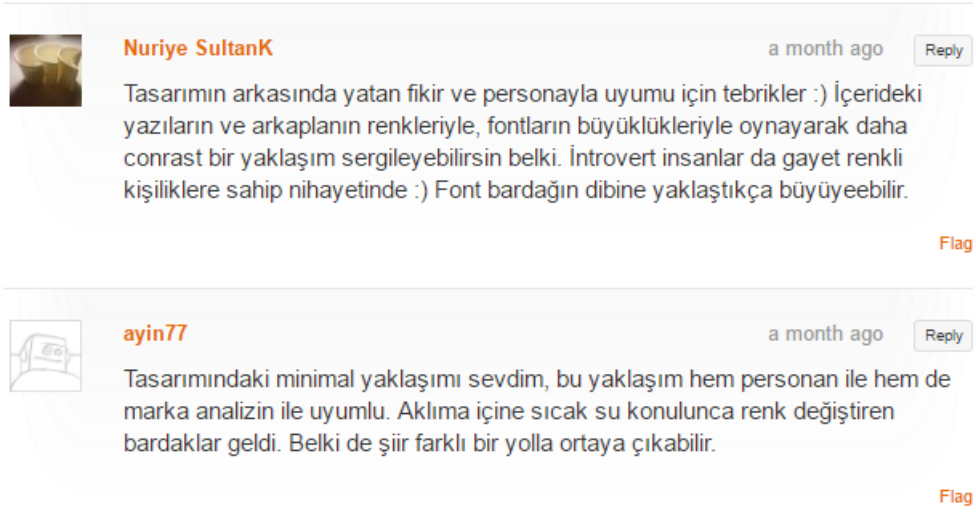
Here is the brand analysis of Spotify. Spotify is a music streaming application for pc and mobile. Their motto is "Providing music for everyone". They have customised playlists for users' taste of music. You can follow your friends and see what they listen to, but they also have "Private Mode" for when users don't want other users to see what they are listening up to 6 hours. Another privacy option is the private playlists. So you can keep some of what you're listening secret, and some of them public. It's up to you.

Step 3: Paper Cup

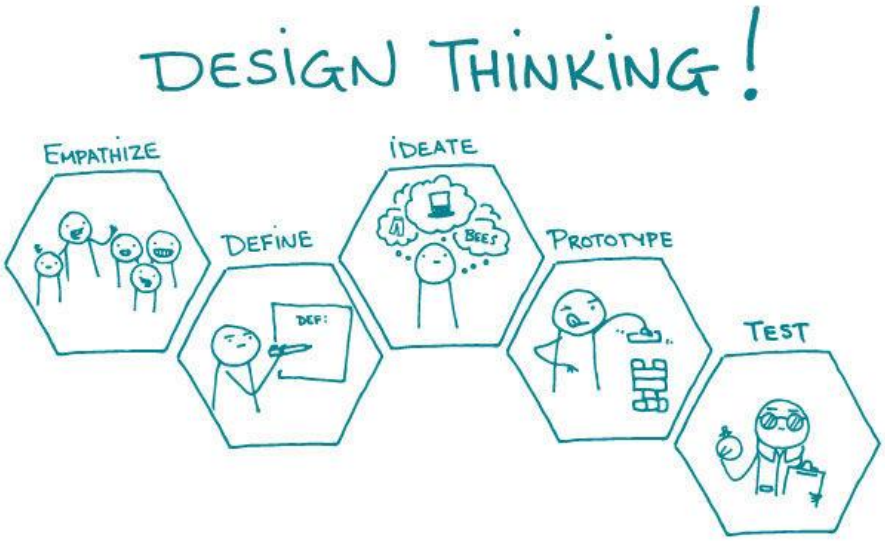
Here is my first idea. It's a basic paper cup from outside. I just wanted it to look minimal, and wanted the text to look like in relief. From outside all you can see is a white simple cup.

Step 4: Paper Cup (Inside)

Here is the inside of the paper cup. I wanted to write the lyrics of the song that I wrote it's title under the cup. You will be able to read the more of the lyrics as you drink your tea/coffee etc.



G.6. S6Mlt: Aylin Karadeniz




hande
25
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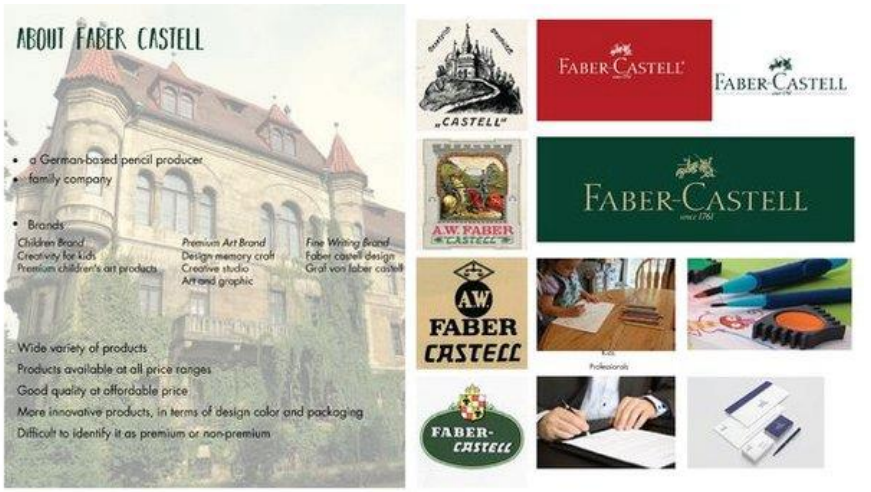
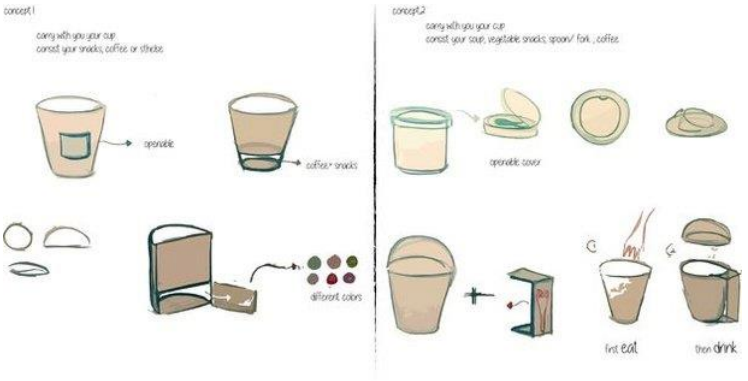
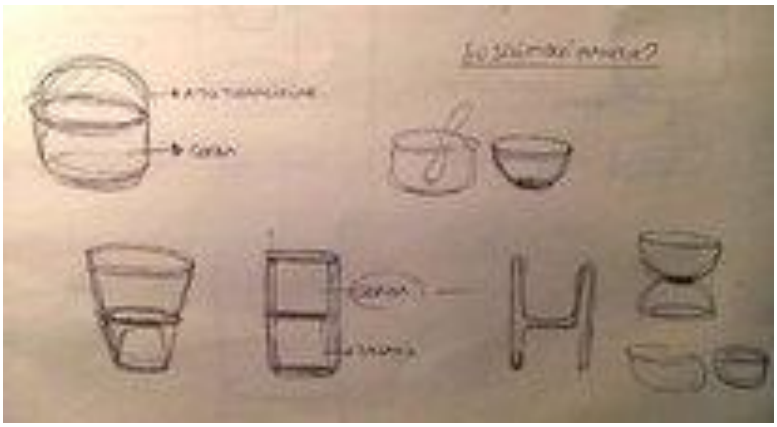
academician
healthy lifestyle
fun
ambitious
tidy
calm

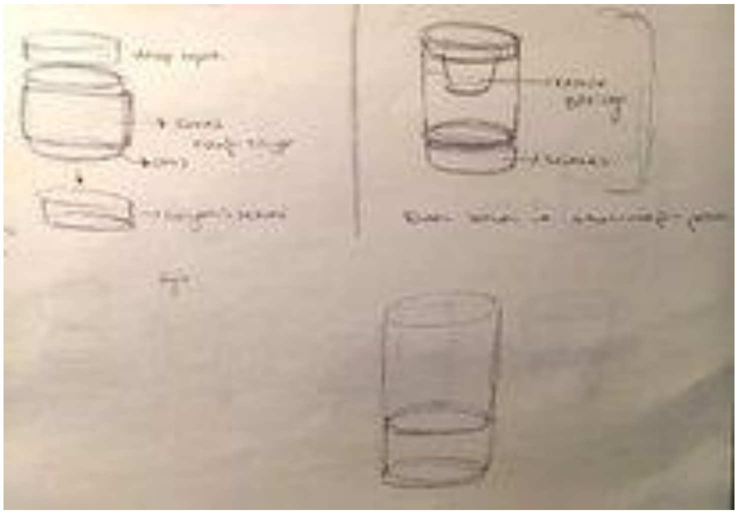

Tagline : TRUE COLORS

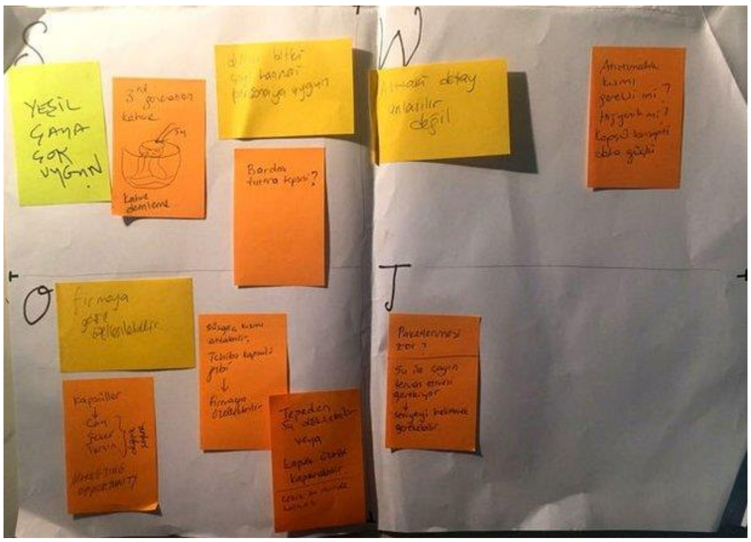

ABOUT FABER CASTELL
a German-based pencil producer
family company
Brands
Children Brand
Creativity for kids
Premium children's art products
Premium Art Brand
Design memory craft
Creative studio
Art and graphic
Fine Writing Brand
Faber castell design
Graf von faber castell
Wide variety of products
Products available at all price ranges
Good quality at affordable price
More innovative products, in terms of design color and packaging
Difficult to identify it as premium or non-premium
„CASTELL"
FABER-CASTELL
FABER-CASTELL
A.W. FABER CASTELL
FABER-CASTELL
since 1761
A.W.
FABER
CASTELL
FABER-
CASTELL
Professionals


concept 1
carry with you your cup
consist your snacks, coffee or drinks
operable
coffee+ snacks
different colors
concept 2
carry with you your cup
consist your soup, vegetable snacks, spoon/ fork , coffee
operable cover
first eat
then drink


ÖZEL YALOVA
HASTANESİ







STRENGTHS

very convenient for green tea
drip coffee
3rd generation coffee
appropriate for persona

WEAKNESSES

bottom component is unclear
bottom component for snacks is necessary
hygiene
the concept of capsule is more essential

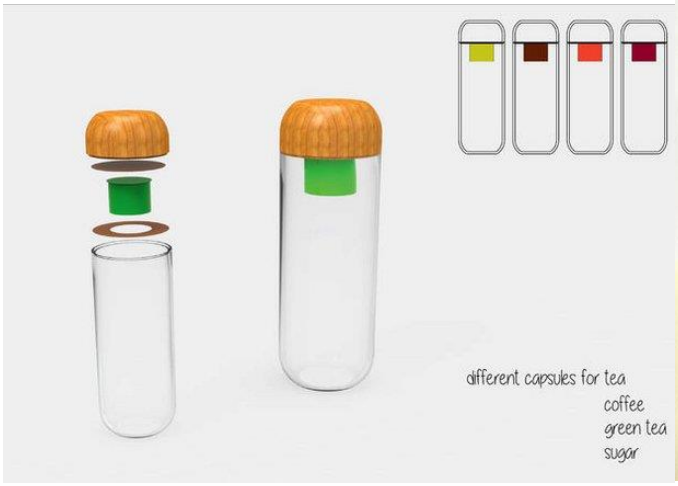
OPPORTUNITIES

specialize for brands
capsules : tea, coffee, snacks, sugar,
marketing
tchibo capsule
pour water from top
seperate water from tea, etc.

THREATS

hard to package
contact between water and capsules
joining details

SWOT



sirinsen 15 days ago Reply

Kapsüllü konseptinde kapsül sürekli kullanılacak mı yoksa kullan-at mı olacak ? Hacim olarak ne düşünüyorsun bir de ? Renderda sanki 500ml gibi geldi bana ? Cam olmasının ne gibi avantajını kullanılıyorsun ?

Flag

ayin77 (author) ▸ sirinsen 14 days ago Reply

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Sürekli kullanım günlük kullanıcı ve kendisi bu projeyi uygulamak isteyenler için uygun. Tek seferlik kapsülleri ise doğadan gibi markalar için uygulayabilirim.

Cam olmasını temizliğini düşünerek tasarladım, öte yandan daha çevreci bu da personama uyuyor.

Flag

Nuriye SultanK a month ago Reply

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Flag

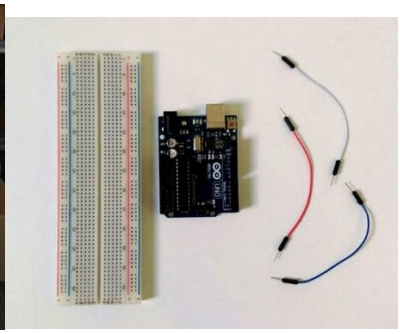
ipder a month ago Reply

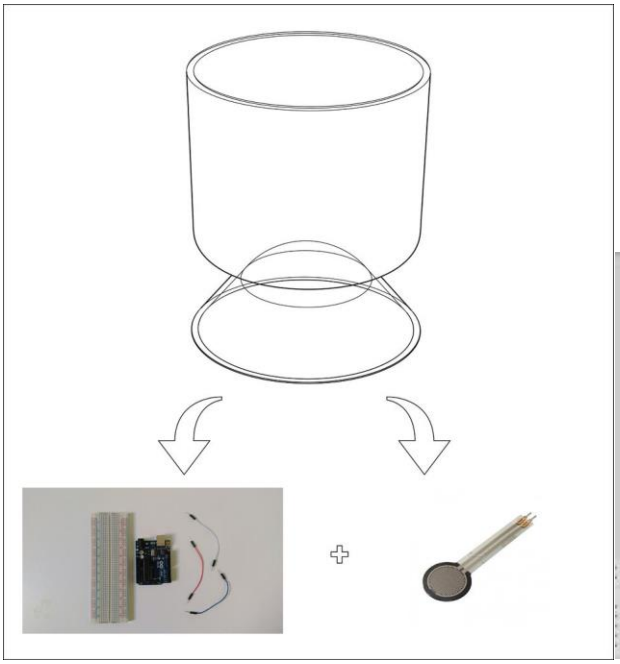
Konsept 1'deki kupanın altına snack kompartmanı oldukça kullanışlı, hem alta hem üste monte olablir?

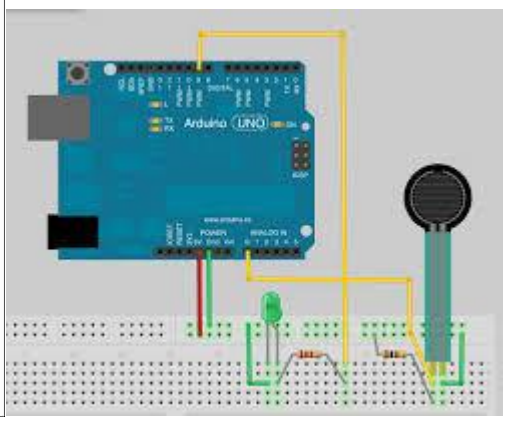
Konsept 2'de formun yüksek değil basık olması iki ürün (çorba ve kahve) için de daha uygun olabilir.

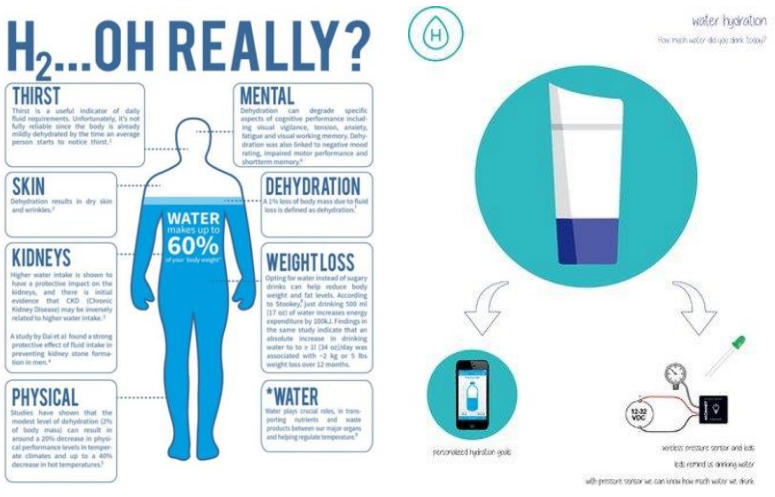
Flag

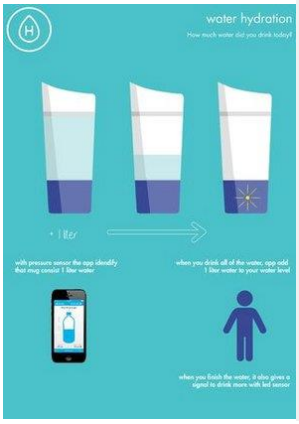
G.7. Interactive project of S6Mlt






Arduino UNO


H2...OH REALLY?
THIRST
Thirst is a useful indicator of daily fluid requirements. Unfortunately, it's not fully reliable since the body is already mildly dehydrated by the time an average person starts to notice thirst.[1]
MENTAL
Dehydration can degrade specific aspects of cognitive performance including visual vigilance, tension, anxiety, fatigue and visual working memory. Dehydration was also linked to negative mood rating, impaired motor performance and shortterm memory.[2]
SKIN
Dehydration results in dry skin and wrinkles.[3]
DEHYDRATION
A 1% loss of body mass due to fluid loss is defined as dehydration.[1]
WATER
makes up to
60%
of your body weight*
KIDNEYS
Higher water intake is shown to have a protective impact on the kidneys, and there is initial evidence that CKD (Chronic Kidney Disease) may be inversely related to higher water intake.[3]
A study by Dai et al found a strong protective effect of fluid intake in preventing kidney stone formation in men.[4]
WEIGHTLOSS
Opting for water instead of sugary drinks can help reduce body weight and fat levels. According to Stookey,[5] just drinking 500 ml (17 oz) of water increases energy expenditure by 100kJ. Findings in the same study indicate that an absolute increase in drinking water to to ≥ 1l (34 oz)/day was associated with ~2 kg or 5 lbs weight loss over 12 months.
PHYSICAL
Studies have shown that the modest level of dehydration (2% of body mass) can result in around a 20% decrease in physical performance levels in temperate climates and up to a 40% decrease in hot temperatures.[3]
*WATER
Water plays crucial roles, in transporting nutrients and waste products between our major organs and helping regulate temperature.[3]
water hydration
How much water did you drink today?
personalized hydration goals
wireless pressure sensor and leds
leds remind us drinking water
with pressure sensor we can know how much water we drank



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Flag

G.8. S7Meas: Leyla Melis Aslan

The cup was designed according to Deniz's favorite object which was his Kindle.

Step 1: Persona

Step 2: Cup according to persona

He mentioned that he liked that he could see how many pages he read in percentage. And also that he had a habit of charging the kindle even if the battery wasn't low. So I kind of

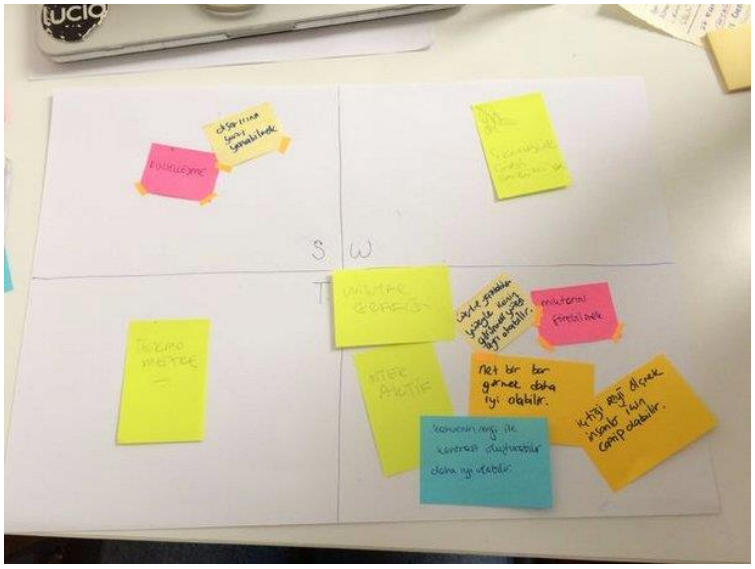
realized that Deniz has a habit of controlling everything around him and is a bit of a control freak.

According to this data I tried to personalize a cup so that it would satisfy Deniz's needs, such as the need to control how much he drank.

Step 3: Brand Analysis

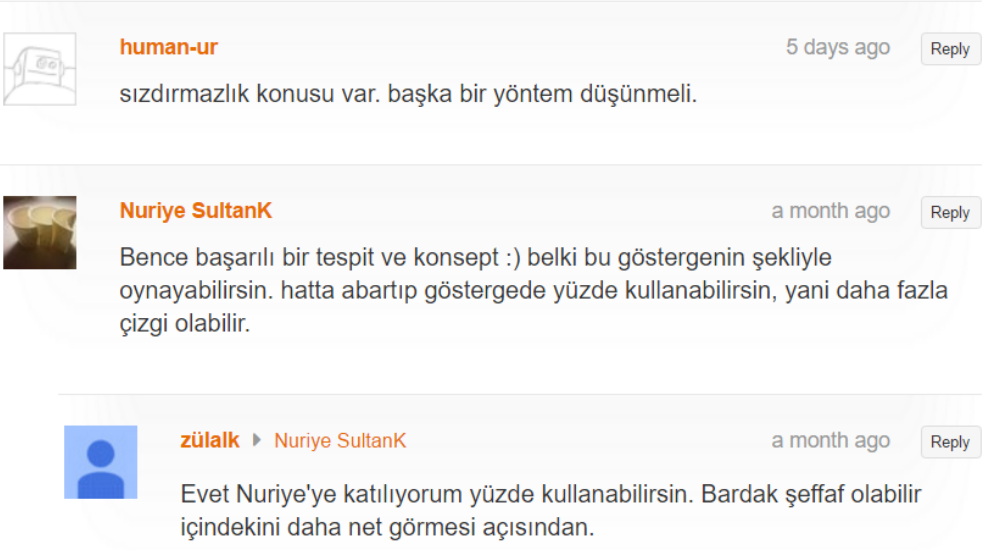
Step 4: Improvement of design according to brand analysis

Step 5: SWOT Analysis



Step 6: Improvement of design according to comments and swot analysis

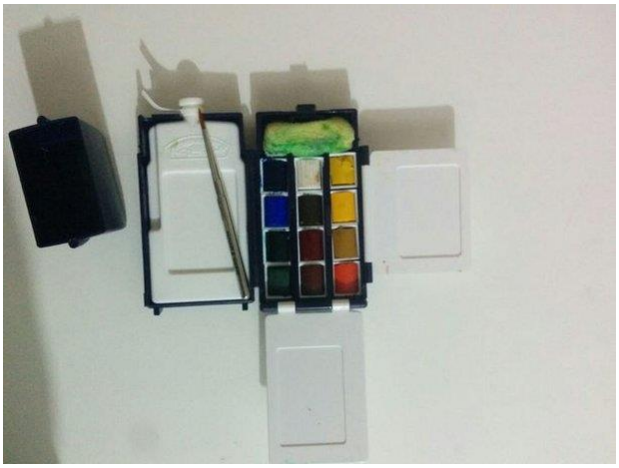
Step 7: 3D Print Data



G.9. S8Cmp: Zülal Keskin

Bardak tasarım

Step 1: Persona



Nuriye 22 yaşında öğrenci. En sevdiği kendini anlatan ürün suluboyası. Bu ürünü kompakt olduğu için çok seviyor çünkü çok pratik bir ürün. Su, palet, fırça var boyalar hepsi iç içe. Aynı zamanda kapağı sayesinde çok korunaklı. Dışarda rahatça korkmadan bu ürünü kullanabiliyor. Dışardan bakıldığında suluboya gibi durmamasını seviyor. Sade renklerden oluşmasını seviyor ; lacivert ve beyaz. Boyaları da istediği gibi seçip kendi renklerini koyabiliyor.

Step 2: Bardak tasarımı

Nuriye'nin en sevdiği üründen yola çıkarak onun için bu bardağı tasarladım. Kompakt bir bardak. Çay için özelleşmiş. Bardağın içinde çay koyabileceği özel bir bölmesi var. Bu bölmeye istediği çayı koyabilir. Bu sayede okulda kendi çayını içebilir. Sadece sıcak su alması yeterli. Aynı zamanda bardağa şekerini ve kaşığını da koyabilir. Güvenli kapağı sayesinde yanında rahatça taşıyabilir.

G.10. S12Heat: Selin Yağsan

Personam doğrultusunda geliştirmeye başladığım bardağın ilk basamağında personamın güvenlik ve tedbir özelliklerini ele aldım. Bu doğrultuda elinin yanmasını ve dökülmeyi en aza indirgeyecek şekilde kapalı bir form tasarladım.

Step 1: Persona

Step 2: SWOT analysis

Step 3: Concept

Swot analiz doğrultusunda maliyet, geri dönüşüm, üretim, gibi problemleri göz önüne alarak tasarımı geliştirdim. Üst kısımdaki parça 270° dönerek hem taşıma esnasında dökülmeyi ve

sıçramayı engelleme hem de tüketim esnasında elimizin yanmasını engelleyecek yalıtım işlevi görmektedir

Step 4: Concept 3

Bardak içindeki sıvının sıcaklığından emin olmak adına sıcaklıkla renk değiştiren thermochromic boya kullandım. Bu verinin daha sağlıklı işlemesi için daha iletken olan seramik bardak tercih ettim. Böylece personamın tercihi doğrultusunda seçtiğim derecede (80°C gibi) renk değiştiren boya sayesinde sıcaklıktan zarar görmeden sıvıyı tüketmesine olanak vermeye çalıştım. Ayrıca personamdaki 'personalization' anahtar kelimesini düşünerek desen olarak kendi elinin izini kullanmasını sağladım. Üzerine ise hem boyayı korumak hem de yalıtım sağlamak adına tüp silikon uyguladım

Step 5: Materials 

1) Seramik bardak

2) Karıştırma kabı

3) Akrilik boya

4) Tüp silikon

5) Karıştırma aparatı

6) Thermochromic pigment

Step 6:

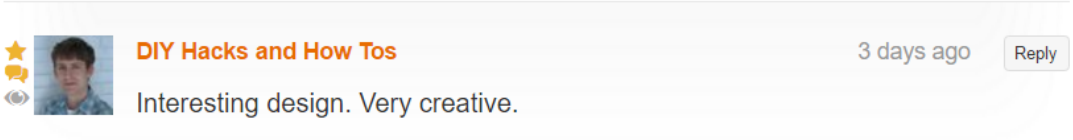
1) Akrilik boya ve pigment karıştırılır.

2) Elin bardağa temas eden yerleri elde edilen karışımla boyanır.

3) Elin izi çıkartılır.

4) Tüp silikon boyanan yerlerin üzerine uygulanır.

Step 7:



APPENDIX H

WEBSITE LINK OF STUDENTS' SHARING ON INSTRUCTABLES

Ceylan Beşevli - http://www.instructables.com/id/Fundamentals-of-Design-Thinking-the-Development-of

http://www.instructables.com/id/Design-Thinking-the-Coffee-Cup-Part-I/

http://www.instructables.com/id/Design-Thinking-the-Coffee-Cup-Part-II/

Nihan Sığırcı - http://www.instructables.com/id/Cardboard-Cup/

Seçil Cıkcık- http://www.instructables.com/id/Contrast-Cup/

Nuriye Sultan Kostak - http://www.instructables.com/id/Design-a-Cardboard-Cup-With-Design-Thinking-Method

Dinem Kurşun http://www.instructables.com/id/Cupify

Aylin Karadeniz http://www.instructables.com/id/ArduinoCupDesign/

http://www.instructables.com/id/Fundamentals-of-Design-ThinkingCup-Design/

Leyla Melis Aslan http://www.instructables.com/id/Design-ThinkingCup/

http://www.instructables.com/id/Design-Thinking-Cup/

Zülal keskin http://www.instructables.com/preview/E5WL9U6IUKF06CN/

http://www.instructables.com/id/Fundamentals-of-Design-Thinking/

Gizem Erim http://www.instructables.com/id/Design-Thinking-Cup-Proj

Selin Yağsan http://www.instructables.com/id/Design-Thinking-Cup-Design/

Kutay can http://www.instructables.com/id/Collapsible-Cup

ARDUINO LED IŞIK LINK

http://arduinothings.blogspot.com.tr/2015/06/blink-led-with-arduino.html

APPENDIX I

Evaluation form for Simulation of Open Source Community

The aim of this form is evaluating 5 weeks process in the "Introduction to Design Thinking" course. the study is run by Zeynep Aykul as master thesis study.

1. **Name-class**

_____

2. **What is mean of open source for you?**

_____

3. **What is open source community? Please answer based on your experience in the class.**

_____

_____

_____

4. **Do you think open source tool contribute your design process?**

Uygun olanların tümünü işaretleyin.

- [ ] No contribution
- [ ] Limited contribution
- [ ] positive contribution, fast process
- [ ] positive contribution, but slower process
- [ ] negative effect, it was hard to focus on my project
- [ ] negative effect
- [ ] Diğer: _____

5. **Did you anxious about sharing your design? 6= I feel few anxiety, but it was not obstacle to share.**

Yalnızca bir şıkkı işaretleyin.

	0	1	2	3	4	5	6	7	8	9	10	
no anxiety	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	very anxious, I did not want to share my design

6. **How did comments on Instructables affect your design process?**

7. **What did you think about contributing others' projects?**

8. **Affects of contributing others' projects:**
Uygun olanların tümünü işaretleyin.

- [ ] It was time consuming
- [ ] It made me hardly focus my own project.
- [ ] It also contributed my design process
- [ ] It provided personal satisfaction.
- [ ] It provide me to develop myself in different topics.
- [ ] Diğer: _____

9. **Reaching knowledge for open source tools was..... for me.**
Yalnızca bir şıkkı işaretleyin.

	1	2	3	4	5	
very hard	◯	◯	◯	◯	◯	very easy

10. **How do you evaluate your experience with Arduino?**

11. **Which open source tools did you use in your project?**
Uygun olanların tümünü işaretleyin.

- [ ] Arduino
- [ ] Instructables
- [ ] Grabcad
- [ ] Thingiverse
- [ ] Diğer: _____

12. **Will you use your learning from this class in your future projects?**

_____

_____

_____

_____

13. **other...**

_____

_____

_____