How Design Enhances Startup Ecosystem: Design Education Centered Interventions

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Abstract
This paper explores the ways in which design and startup ecosystem affect each other by design education centered interventions. Study is based on some design related processes that have been implemented within the context of undergraduate and graduate level industrial design courses in collaboration with entrepreneurship ecosystem. While in graduate level courses, design thinking methods were used to intervene the startups' processes; in undergraduate level courses, three different design processes were actualized; first; an entrepreneurial design approach towards the graduation project; second, a design studio project about developing a working digital product from an existing maker project; and third one, developing visual identity for startups. Findings of this study show the need for designer's engagement in such processes and reveal the value of collaborative work. This study suggests a new ecosystem including design education and other design related stakeholders to enhance productivity and originality.
Keywords: design education; design thinking; technology startups; entrepreneurship

1. Introduction
This paper attempts to explore the ways in which university design education affects and collaborates with the startup ecosystems by a series of intervention processes in different courses and circumstances. The writers of this paper are the academic members of Istanbul Technical University where they act themselves as entrepreneurs of design education and design thinking to facilitate design into the ecosystem of entrepreneurship. Although the service of mentorship provided by the university members and academics is fairly common in the ecosystem, using the classes and curriculum itself in the design faculties as the laboratories of design service as presented in this paper is quite new.

One of the cases to be presented as a tool of intervention into the startup ecosystem in this context is design thinking which was literally used in one of the graduate courses given in the department of industrial design in ITU. So, we shall start with the basic definitions of design thinking and startup economy.

Design thinking is an interdisciplinary and human centered approach for innovation and is a way of solving challenging problems and a team based work more than being individual act (Curedale, 2013; Koh, 2012). Design thinking uses designers' sensibility and methods to meet users' needs by technologically possible solutions and by applying a business strategy which has the ability of turning them into customer value and market opportunity (Brown, 2008). When we look at the origin of design thinking, we come across with the study of Buchanan (1992) in which he defines four areas affected by design in modern life which are; graphic design as being design of symbolic and visual communication, industrial design as being design of material objects, management as design of activities and organizational services, engineering and architecture as design of complex systems and environment. However, design thinking deals with design of work, activity and service which go beyond graphic, product and environment design, in other words the physical aspect of design. Johansson-Sköldberg, Woodilla, and Çetinkaya (2013) related discourses in design literature into two group as: designerly thinking and design thinking. Designerly thinking belongs to design discourse and academic area of

design, reflects ideas and practices of professional designers. Design thinking expresses using design practice and design abilities beyond design problems by people from different backgrounds other than design based disciplines and using them for these people; it is the simplified version of designerly thinking or integration of design methods into academic and practical approach of the management (Johansson-Sköldberg, Woodilla, and Çetinkaya, 2013).

In design thinking process problem comes first rather than idea, and it is tried to be solved with suitable methods and approaches. Ideas are generated within the process, covered needs and opportunities are tried to be revealed in the process which begins with an intense research (Koh, 2012; Açar & Rother, 2011; Mueller & Thoring, 2012).

Based on this process focus in design thinking, it was found more suitable and sustainable for a term project in the graduate course called Design Thinking. So one of the major studies held with the help of design thinking methods in collaboration with startup firms based in the university startup incubation center were formulated.

According to Blank and Dorf (2012), startups, as being the first steps on the institutionalization path of people who want to solve a problem and to reveal innovative solutions, are organizations searching for scalable, repeatable, profitable business model and they aim at finding the right thing, which will be rapidly wanted and paid by customers (Blank & Dorf, 2012; Ries, 2011). In this study, it is focused on technology startups which manifest these basic characteristics more obviously. There are big differences between conventional businesses and startups in terms of their ways of working. After negative experiences, it is understood that startups are not the small version of big companies and MBA ideas which are used in managing big companies do not suit to startups (Blank & Dorf, 2012) deriving from the differences between the flexibility levels and contextual differences. Because of these differences between big companies and startups, every firm has different characteristics from other firms, too. Bhide (1996) indicates that people pass through more or less predetermined order of physiological and psychological processes, however firms don't have a common path of development. Every firm competing in the same sector has their own unique story of evolution including the role of founder, development of strategy and corporate structure. For this reason, it can be said that one thing which is suitable for one firm cannot be appropriate for another one (Bhide, 1996). According to Maurya (2012) for startup processes, which have constantly changing business plans and pivoting till finding the appropriate solution, success is not beginning with a good plan; it is reaching a valid business plan before extinction of the limited resources (Maurya, 2012).

We can say startup processes show similarity to design processes because they both usually start from a fuzzy or obscure stage and they are solution based. Startups pierce the obscurity fog by testing their hypothesis in other words by making mistakes to reach the valid business plan (Hoffman & Casnocha, 2012). To decrease obscurity, risks should be ordered in a right manner according to their priority and experiments by advancing problem solving approaches should be designed to solve the problem and risks should be tried to decrease; because risk and value are inversely proportional (Gilbert & Eyring, 2015). Practice based knowledge, ideas and plans are more valuable and can only be gained by making. Structure of the design thinking, which is user centered and leads to making, experiencing, iterating with results from experiences, show similarities with startups' process. According to Venkataraman et al. (2012), these creative approaches of problem solving resembles to design thinking because both being focused to create alternatives, being against the causal logic and, being research based rather than pre-defined.

When we look at specifically the design thinking and startup case, there seems to have limited resources. Nguyen (2016) explains that even though design thinking has gained considerable interest, most of the studies focus on large companies, therefore there is

not enough data for small scaled companies and startups, and she indicates that there still is a lack of empirical studies and literature on how design thinking is applied and how it is worked. These mentioned deficiencies about startup ecosystem are among the main motivations of this study. With this motivation, researchers made a series of interventions in technology startup ecosystem related with design thinking in the context of design curriculum, especially in "Design Thinking" graduate class. After pilot studies and first intervention processes, it is realized that design intervention is also needed in addition to design thinking interventions on technology startup ecosystem so the scope of the study was extended. It was designed a series of experimental and exploratory studies uniting technology, startup ecosystem, design thinking and design concepts in different projects and in different formulations, in different in-class or out-class activities. Qualitative and exploratory approaches have been chosen because it is suitable for the situations when there is no or very limited studies on the issue and also because of flexibility (Yin, 2009). Also an empirical, exploratory and definitive study have been constituted about how design and design thinking is used in technology based startups.

2. Merging Design, Design Thinking and Technology Startups
One of the important areas in which design thinking finds a place is academic learning programmes. According to Melles, Howard, and Thompson-Whiteside (2012), in business and management schools design thinking is introduced to students as a tool for decision making process in different areas. Design schools focus on thinking beyond the product output; modelling the work, system or service; and application of design students' innate design thinking abilities to subjects which are not design problems are emphasized in these schools (Melles, Howard, & Thompson-Whiteside, 2012). Design thinking approach finds a place in specific departments of different disciplines of different schools like Stanford D. School, HPI, MIT, University of Virginia, London Business School. For the last three years, Design Thinking Courses, at which this study was conducted, have been in undergraduate and graduate programmes of ITU Industrial Design Department, open for students of design and other disciplines.

Universities have evolved over time from being education centered to research centered and from research centered to innovation centered. Schools called as third generation universities like MIT, Stanford and Cambridge make technology entrepreneurship and economical contribution to society one of their mission. Erkut (2017) addresses that for a university system having engineering, business and design faculties and cooperation of them are important, in addition to that every faculty needs a series of elective courses like design thinking, SME management, business expansion besides their compulsory courses. As in the global context, technology entrepreneurship is one of the popular topics in Turkey, especially universities support this process within their organizational structure like incubation centers. Performing this study in ITU, which has the biggest university based ecosystem also defining itself as a third generation university and aiming at placing itself in top 20 entrepreneurship ecosystems in Istanbul, makes it also important Karaca (2017).

Field studies performed in ITU ecosystem within the scope of the industrial design department's courses began at 2016-2017 fall semester and ended at 2017-2018 fall semester (Figure 1).
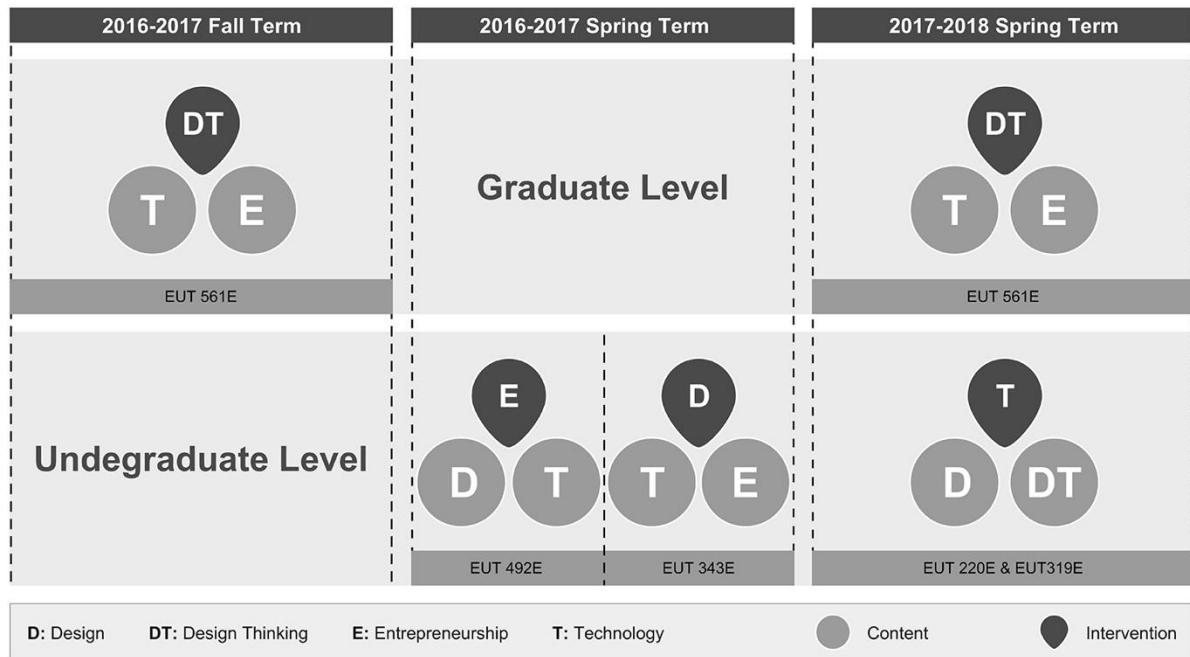
Figure 1: Summary of field studies and relations

Common characteristics of intervention studies, which were held in undergraduate and graduate courses of ITU Industrial Design Department for three semesters, are they all bring together design, design thinking, technology and entrepreneurship in an educational context. All the cases, processes and their results have been documented and discussed in the next sections.

2.1. Studies with graduate students: intervention to technology startups

First intervention was carried out within the scope of ITU Industrial Design Department graduate course name as EUT 561E Design Thinking, and further studies were inspired by the outcomes and reflections of this study. In the class, processes of technology startups in ITU Cekirdek Incubation Center have been intervened with design thinking approach. This intervention has been thought to be a *catalyst* in startups' process and to make them aware of being user/human-centered, more emphatic and design conscious. 15 weeks long processes were implemented in two different semesters, 2016-2017 fall and 2017-2018 fall semesters. Similar methods were applied in two semesters, minor revisions were conducted in the second intervention based on the outputs of the first term.

Within the scope of the course students and entrepreneurs were matched randomly regardless of students' experience or enthusiasm in the subject matter of startups. Reason for this can be explained with the ideas mentioned by some social scientists on how proficiency makes harder to create innovative ideas (Michalko, 2006). In addition to that, design thinking is closer to an approach at which methodological perspective and process management skills come first rather than proficiency.

After one to one matching students and startups, 15 weeks long intervention process to startup process has begun. Theoretical knowledge about design thinking was shared in lectures only in the first two weeks of the semester, other weeks were spent with practices, field works and presentations. For both years, an introductory meeting was set to present the team, project and theory and examples of design thinking, also take questions and comments about the project (Figure 2).
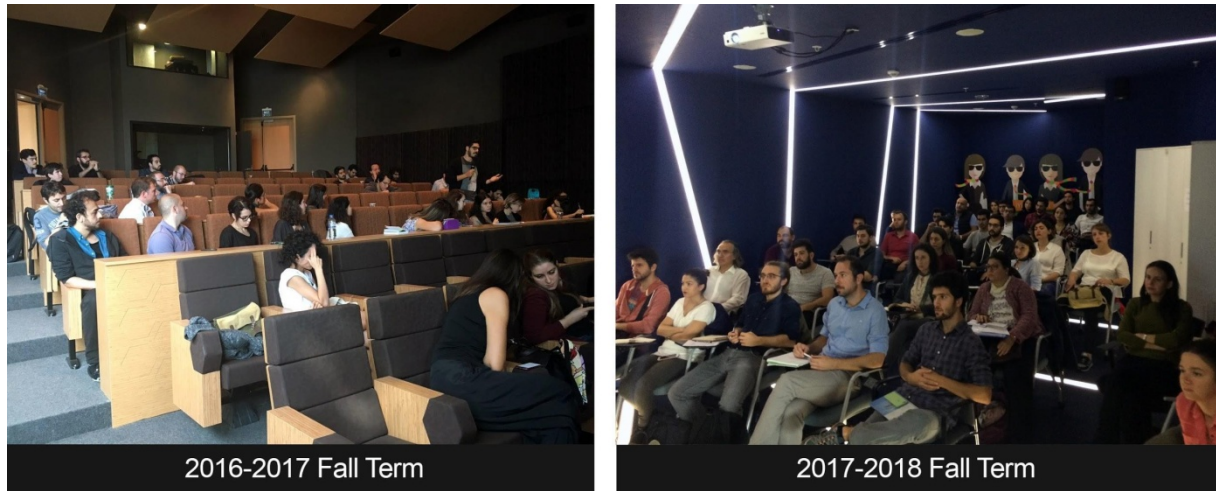
Figure 2: Introductory meetings with students and startups

By the meeting, potential misunderstandings of startups about the process were tried to be prevented. Within this context, entrepreneurs were informed to be ready for redefining some areas in their firms as problems which are not treated as problems initially, to prepare themselves for fuzzy nature of the process and not to treat this project as a design support from people with design abilities. In the meeting, aims of the project were generally defined as;

- creating a user centered perspective for startups by design thinking rather than technology based;
- developing alternatives for current problems,

At this point, it will be beneficial to mention about the types of startups that are studied with in this project. Startups involved in the study vary from end user products to b2b solutions, healthcare technologies to financial technologies. The ones focused on business model innovation more than R&D are also based in ITU Cekirdek Incubation Center. The last group was the most challenging to work with the methodologies of design thinking because human aspect was more limited as technology itself was very dominant.

After giving information about the startups worked with, it is also important to give information about the student profile who took the course. Students enrolled to the course had their undergraduate degrees from different disciplines. Most of the 2016-2017 fall semester students had their undergraduate degree in design disciplines, however most of the 2017-2018 fall semester students had undergraduate degree in engineering disciplines. Students, who took the course, comes from different backgrounds such as; industrial design, architecture, interior design, ship construction engineering, computer engineering, business and dentistry. In first study 19 students and in second one 17 students enrolled the course and participated the study.

In each study, one student worked for his own startup, others matched with ITU Cekirdek Incubation Center startups randomly. In 2016-2017 fall semester, the number of volunteer startups almost matched with the student number. However, in 2017-2018 fall semester, because 36 startups indicated their willingness to work, 19 willing startups could not be involved into the study. At sum of the two semesters, 34 independent data clusters about the effects of intervention methods on different startups have been reached.

To reach a deeper knowledge, to draw a holistic frame by adding ideas of different stakeholders and to provide data triangulation multiple data collection methods were applied (Figure 3). Minor revisions were conducted in 2017-2018 fall semester study after realization of 2016-2017 fall semester study. In 2017-2018 fall semester study, an interactive blog was added as a data collection method to improve interaction, to follow

up the process more closely and to document the study in a more detailed way. Students were asked to share their process and comments on others via blog in the beginning of the semester. At the final presentation of 2017-2018 fall semester, in addition to collecting startups' opinion during the final presentations, written feedbacks of startups were also collected. Also, project brief of the first term were revised and made less detailed for the second term.

Data Collection Method	Source of Data
Online Questionnaire	• Graduate Students • Startups
Observation	• Graduate Students • Startups
Document Review	• Term Papers • Student's blog entries

Figure 3: Data collecting methods used in intervention process to technology startups

Since this study was conducted within the scope of the weekly course, it had been easy for researchers to follow up the process regularly. Students and startups shared their processes and criticized by not only lecturers but also other participants in three hours long courses done in every Thursday morning during the term (Figure 4).
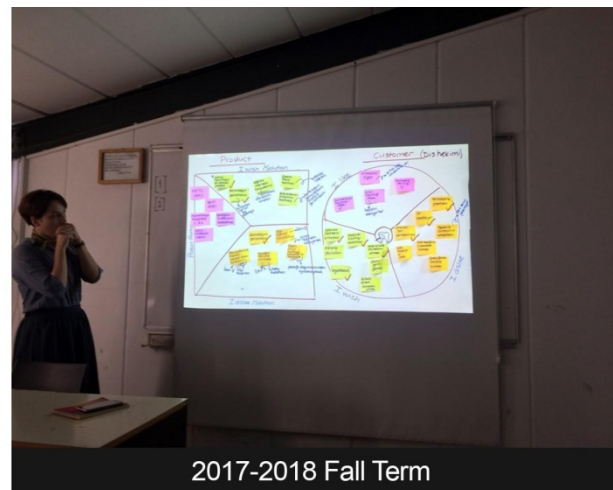

2016-2017 Fall Term   2017-2018 Fall Term

Figure 4: Studies made in lecture hours during the term

During the term, students both practiced their own work with startups in the field and criticized collectively other works in course hours. In addition to that, some of the course hours were used actively to apply methods and some structured and semi structured practices like focus group interview, brainstorming etc. All of the practices made throughout the term and their outputs were shared by presentations open to all participants at the end of the term in ITU Teknokent where the startups are based (Figure 5).

Figure 5: Final Presentations in ITU Teknokent

Entrepreneurs, during the presentations which they made together with the students they worked with, shared the detail of processes with their own perspective and reflected about the effects of the project on their startups. This active participation of the startups in the last presentation and their feedbacks made this activity more valuable and more interactive.

2.2. **Studies with undergraduate students**
In 2016-2017 semester during design thinking interventions to technology startups, the general tendency from startups to ask for design service was identified as an important data, so the scope of the field studies were extended accordingly. Details of the interventions held in the design classes towards technology startup ecosystem about the aspects of technology and entrepreneurship in terms of design service rather than design thinking are mentioned below.

2.2.1. Intervention to the Process of Graduation Project
In 2016-2017 Spring Semester, EUT 492E Graduation Project Course of ITU Industrial Design Department was run in two sections. Different from the other courses, in graduation project students are more independent in the process of developing solution to a given problem, where they don't have regular, weekly course hours like in other previous project courses.

This intervention process was run with a group of volunteer students working on medical devices. From the very beginning, the reason why medical devices were chosen as the subject of graduation project depended on the teachers' experience about the startup ecosystem that medical entrepreneurship is very popular recently. Questioning the importance and potential effect of industrial design in technology startup ecosystem was another reason, again based on the previous experience about technology startups.

At the beginning of the process voluntary students were informed about all these and became aware about the importance of entrepreneurship and the given project's suitability for such an initiation. After starting the process of graduation project, a series of informal meetings were organized to make students and different stakeholders interact with each other and to provide suitable conditions. How this process is documented is presented in Figure 6.

Data Collection Method	Source of Data
Online Questionnaire	• Undergraduate Students
Observation	• Undergraduate Students • Participants of meetings
Interview	• Undergraduate Students

Figure 6: Data collection method using in intervention of graduation process

Students and different stakeholders from startup ecosystem got together in three meetings done in every month of graduation project term (Figure 7).

First Meeting (23.02.2017)　　Second Meeting (23.03.2017)　　Third Meeting (03.05.2017)

Figure 7: Meetings organized with graduation project students and other stakeholders

Two specialists of ITUNOVA TTO (ITU Technology Transfer Office) joined first meeting to inform the students about startup ecosystem, specifically ITU Cekirdek Incubation Center. Specialists narrated the general framework of startup ecosystem and mentioned that the general tendency of startups not working with designers has a negative effect and there lies a potential in startup ecosystem, encouraging design students to be a part of such processes. In second meeting, students got together with healthcare technology startups, related academicians, an industrial designer of an incubation center and two graduate students from Design Thinking Course who worked with healthcare startups in previous intervention studies. There has been an interactive session about the students' product ideas, including the participation of all parties. In the third meeting, an entrepreneur having industrial design undergraduate degree, a specialist from ITUNOVA TTO and design students got together. Some students continued their communication and shared their experiences with different stakeholders of startup ecosystem which they met in these organized meetings in further process of the project.

Intervention process was planned dynamically, and following meetings were organized according to the feedbacks and students' requirements. And also an online survey was conducted to get feedbacks from students. In addition to that, semi constructed interviews were made with students towards the end of the process to reach detailed data.

2.2.2. Intervention to Undergraduate Design Studio Project: "From Project to Product"
This study was made with undergraduate level industrial design students who took 4th and 5th semester project courses. However not the main requirement of the project, it is formulated as an initial step to enter this ecosystem, especially in terms of building a technological startup. In this project, the phenomenon of maker culture and its platforms were used in formulating the project brief. Students were asked to choose a maker project from one of the online maker platforms such as "instructables" and "hackaday" and transform it into a technological "product" in its designed sense. Since students in design education is not technologically equipped enough, process was planned to start with a chosen maker project and focus on the design problems in a detailed way. At the very beginning of the process, students were asked to choose and share three maker projects potentially to work on. Variety of methods were used in this process such as, "persona" method to determine potential customers and "a day in a life method" to shape usage scenarios. Also, students were encouraged to communicate the owner of maker projects and interact with them. At the beginning of the 8 weeks long project term, three active makers were invited to the course to share their own experiences and projects and answered the students' questions. In preliminary and final juries, the same guest makers were invited to support and give technical feedback to the students' processes.

2.2.3.Intervention to Startups' Visual Identity
One of the preliminary findings of Design Thinking study was that visual communication of startups was insufficient. A startup from this semester tried to direct the student they worked with to design a new logotype for their company. As the aim of the intervention in that semester was based solely on design thinking, but not design service, this request has not been welcomed. However, based on this experience, a new study, involving direct design interventions, was formulated for startups' to develop and improve their visual communication within the context of EUT 343 Typography course.

At the beginning of the process, students were again matched with startups one by one and they were asked to create a corporate identity set for startups they were going to work with. Similar to the design thinking process with the graduate students, outputs of the projects were shared in the final meeting of the term to which all startups from the incubation center were invited (Figure 8).

Figure 8: EUT 343E Typography course final presentations

Participation of different startups to this meeting and sharing their feedbacks makes the study more valuable. One of the important instances from this presentation was some startups that haven't been a part of this process in the semester stated that they became eager to be involved if a similar process is repeated.

3. Findings

This journey beginning with design thinking intervention to technology startups was extended with the help of the preliminary findings and evolved through a series of intervention processes. Findings from different intervention processes are entitled and explained below.

3.1. Findings on "design thinking" graduate class

2017-2018 semester intervention process held in "Design Thinking" graduate class was composed again in the light of the outputs of the same course held in 2016-2017 semester. Since there has been successful interventions run by students from non-design related disciplines, having a design background didn't seem to be a compulsory element to run design thinking intervention. However, after the second study, this point of view has been revised, because even though design background is not a must for design thinking, comparatively, it seemed to have a positive impact in the process. For students from other disciplines, not being familiar to methods and their usage and not having been tackled with design thinking and design problems before, created a challenging effect. On the other hand, in the first study, project brief was very detailed and strict with too many parameters to follow. It was observed that it has limited their methodological creativity so it is thought that every project has to be carried out in their own nature and be unique in design thinking approach. Hence, for the second Design Thinking graduate class, a less detailed project brief with only general information about the process were shared with students to avoid previous methodological limits.

Even though, in the first meetings startups were informed about this intervention having only design thinking scope, some startups had a tendency to request design services throughout the project. Also, because startup founders were generally from the engineering background, they focused on mostly technological development of their products. With the help of design thinking approach, their insufficiencies in defining their problems based on potential user groups have been tried to be eliminated depending on gathered qualitative data. Different entrepreneurs stated that they usually focused on engineering problems and with the help of this project they gained awareness on empathy and user centeredness:

Entrepreneur 1: *"After being a part of Design Thinking case study, I learned not being in contact with people and feeling empathy with them and defining the problem were main reasons why we mostly fail although our products were sophisticated enough. I learned why we must make empathy with customers, make focus group study and how these things can accelerate our entrance to market and make us avoid from failure."*

Entrepreneur 2: *"After making the prototype we never interacted with users. We were two engineers and focused mainly technical problems and their solutions. With the help of user and specialist data, we think we would have a more user-friendly product and interface."*

Startups stated that they took theoretical lectures regarding design thinking in their incubation center. However, is seemed that they did not or could not apply this concept into their processes. Reason for this can be counted as design thinking approach is a process permeating in time by practicing not by a compact education session or workshop of a day or two. This idea stems from teachers' experience of class projects of design which needs a time span of a semester, or at least a half semester. Actually, this idea is one of the major starting points of the whole process of design intervention in this

study that could be based on the belief in the paramount role of design schools or experiences from design education in the ecosystem.

Within this process, design needs which are observed in technology startups trigger planning and realization of further interventions and different subtopics not been thought before by the startup company.

Another important finding that can be stated here is embedded in the whole process; design thinking as a popular term or a series of activities was transformed into user centered and grounded design research methodologies. Sometimes discussions in the class were rather based on the principles of how to make a successful research in design and how to rethink about the methodologies itself in a creative way. We think that this is a qualitative aspect resulting from the context of the study; a graduate class in a design faculty.

3.2. Findings of intervention to graduation project process
First of all, students who were involved in the process for designing a user centered medical device, expressed that they had challenges due to not knowing medical terminology and not being familiar to technologies. On that issue, one of the participant students stated that:

"Having a multidisciplinary problem; managing different dimensions of it such as user group, medicine and technology was very challenging. Above all, defining a subject area took lots of time."

Whole process were planned to make students stronger on mentioned aspects and they were supported by meetings arranged with engineering based entrepreneurs who were working on medical products. Students stated that at first, they had seen entrepreneurship and transforming their projects to a business idea as very challenging however in time they had managed to overcome with this prejudgment and increased their motivations. Their increasing knowledge about the subject, being familiar with the ecosystem with the help of the project can be counted as the reasons for this positive change. Within this perspective, one of the participant students shared her opinion:

"It was so important having designers, entrepreneurs and moderators who understand both sides. I think, in our project, we were able to understand which participant would be supportive within different stages, and thanks to you we have got the opportunity to reach and communicate with them at a later time."

In a similar way, another participant student stated that:
"We met with the specialist from incubation center just after the meeting and he informed us about how we could use the center. After that, another specialist working on EKG suggested us his support in engineering stage."

Some students' work and projects has been advanced successfully during the process with the help of organized meetings of the mentioned network. Continuation of communication constructed in meetings between entrepreneurs and students, support of startups in later processes of student projects are the signs of success of the method. One of the graduation projects who become a part of the intervention process was chosen as a finalist in TÜBİTAK Entrepreneurship and Innovation Competition for Graduation Projects and other one was awarded with third prize in ITU Arı Teknokent Graduation Design Entrepreneurship Projects Awards. All these achievements also prove the success of the intervention processes held during the semester and the ones held before, conducted all in a design education ecosystem.

3.3. Findings of "from project to product"

This project was important for students to tie the relationship of technology and design together, by personally experiencing the technology itself following the open source maker culture. In this project it was important to empathize with the tech builders from the designer point of view. However, lack of technological knowledge of students was the most challenging aspect of the project. Students were expected to make prototypes of their projects by using supportive tools such as Arduino, Raspberry Pi and sensors. Being unfamiliar to electronics and coding language made this process harder and more challenging. Support of specialists and makers was not enough to overcome these difficulties. One of the reasons for this could be the need for long time period and strict focusing to constitute a basic background knowledge in software and electronics.

In addition to that, some of the students stated that they got help in technical issues of their project from their friends in ITU ecosystem. Social places such as dormitories, general courses where students interact with each other can be seen as platforms supporting interdisciplinary work, gathering different skill sets, potential base of startup projects.

Some student projects with developed prototypes in terms of technology and design were encouraged by the teachers and guest makers to further develop as startup or kick starter projects. To exemplify, one of these students adapted the humidity level tracing technology to dry food storage and designed a kitchen good that informs the user about humidity and heat level in the kitchen and its appropriateness to storing. Another student working on a "Yoga Breathalyzer" stated after the semester that she is trying to find the right contacts to collaborate and planning to make it produced as she has the prototype already.

All these experiences show us that a successful technological project depending on a working model, with a good design touch and developed in an original and innovative way is almost a half way to be retreated as a startup project.

3.4. Findings of visual identity intervention

After working with startups, it was recognized that, in forming corporate identity, every startup develops their own solution. Some of the startups mentioned that they outsourced this service and the others created their own corporate identity elements. At the end of the process, direct graphic design interventions that was carried out according to the previous feedbacks taken from Design Thinking class, got mostly positive feedbacks from startups and some of them was directly adopted by the firms. However, because most of them are at the very beginning of the path and not based on an established identity, they had their own challenges in defining their needs in terms of identity.

An entrepreneur expressed the situation like that:
"We did not know what was good for us and what was needed since we are at the beginning of the process. We had difficulties in giving feedbacks. However, we are glad to have this result."

To support that one startup stated that even name of the firm was determined within the light of studies run with the student. This information can be a good example of being open-minded to effects of the project.

Even if there are challenges, this intervention to the graphic design process created a win-win situation for both design students and startups. From the design students' perspective, undergrad students of industrial design had a chance to work with a real firm in a subject like graphic design by having extensive feedbacks in the class from the design teachers and students. For the firms, however the development of corporate identity is not one of the major subjects for them, they realized the importance of it

during the process and most of them were thankful at the end of the process. Other firms that were not part of this process stated that they are voluntary for the next round.

4. Conclusion
Common aspect of these four interventions made within ITU technology startup ecosystem is that they all are design education based in a university context and planned to fit the existing design education curriculum, both graduate and undergraduate level. Process beginning with a design thinking intervention to technology startups was extended to cover design intervention or processes after preliminary findings. Terms like design, design thinking, entrepreneurship and technology have been intermingled and formulated in different ways in each case of intervention process in different levels (Figure 1).

Although design thinking is usually placed before lean startup stage at the beginning of the process to define the problem in most of the cases, in this study it was used as a catalyst with startups in their later stages. It can be said that, design thinking in this context was mostly used to verify the solution not to define the problem. In this study, we found that design thinking stands as an investigation and verification tool in every stage of startups, rather than an initial tool for user centeredness merely.

Design requirements and demands of startups were determined and intervention processes were planned to test these requirements and demands. It is very obvious that design thinking and design service (graphic, product etc.) for startups, are essential connectors from problem to solution or from individual to corporate processes of startups (Figure 9).
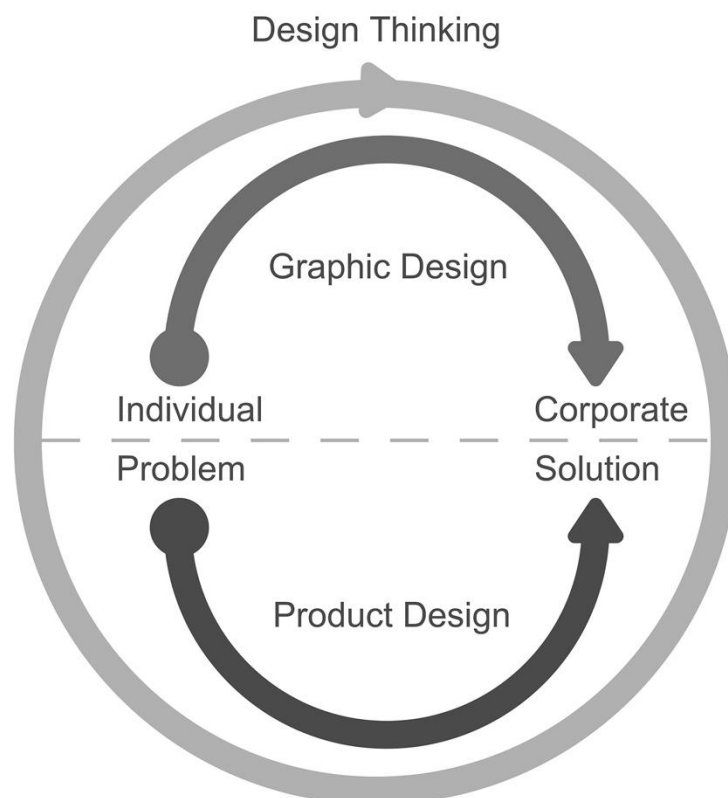

Figure 9: Integration of design with startups within the scope of this study

It was also observed that because of its user centeredness and field dependent nature, design thinking works better with startups that develop end user product.

Based on the fact that most of the founders of startups have backgrounds from engineering disciplines, one industrial design based entrepreneur stated that engineers had advantages in minimizing external dependency in solving technical problems and gaining time in startup processes. However, eventually need for designers' abilities is revealed to be as important as engineering skills for the early stages of startup processes. For this reason, the inclusion of a designer in startup process from the very beginning as co-founder, employee or consultant is found critical. We can say that startups should be made conscious about this need to demand and beware of design actions. Studies made within the educational frame like this project or externally funded studies could be used as a tool to raise consciousness. In other words, design interventions in design schools and departments in the universities should be considered as an important hub of the network of the startup ecosystem, as the basis of this interaction.

In this journey, we tried to build a new ecosystem consisting of startups, graduate students, undergraduate students and other stakeholders with the help of these interlinked interventions that can be named as an artificial or sub-ecosystem. So, what makes this artificial ecosystem valuable is the ability of providing an interaction among all participants and is worked well as a hub of relationships and expertise. To illustrate this, a specific and special case can be given as an example: a participant startup in the "Design Thinking" intervention process that asked for a design service and became a part of the "From Project to Product" intervention process, also got graphic design support from one of the students who took Typography class. We can multiply samples of the network of connections in this artificial ecosystem: Supporting attitude of some startups to the studies of graduation projects or voluntary participation of a startup to the "Design Thinking" graduate class after joining visual identity process in the "Typography" class are the other examples.

We as researchers, who planned and tested the design education based interventions on technology startup ecosystem, can state that there is a need for increasing the number of interdisciplinary educational projects containing and combining the concepts of design, technology and entrepreneurship.

In addition to above-mentioned completed projects, it could to proposed to make two new projects as to create new improvements: one of them could be a new formulation to combine again the issues of startup ecosystem and design/thinking, but this time by making students to define a problem area by using design thinking methods and mimic to build a startup to solve that problem to empathize with the whole actors. Second one could be playing and intervening with a popular technique of startup ecosystem, lean canvas, as a creative tool for design students, by using and modifying it, "designing" new business ideas starting from the canvas itself. Other methods and techniques can be multiplied by innovative approaches stemming from design thinking and design methodology, all derived from the so called sub-ecosystem in academia.

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