

Computer aided design in education and its' interpretation through design thinking

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Abstract

The notion of “design thinking” can be regarded as a way of thinking that consists of both divergent and convergent phases. As a creative problem solving methodology, it first defines the problem with a human-centered perspective and then analyzes all the aspects of the problem as a part of a whole. This approach can be applied in all fields, including design education. With the emerging technology, computer-aided design tools and techniques have become an indispensable part of design professions, and therefore education. However, the way how computer-aided design tools and techniques should be integrated into current design education has not been discussed adequately. This study aims to frame the problems related to the current content, structure and timing of CAD courses. The alternative solutions regarding the integration of CAD courses to product design education will be proposed by using design thinking method.

Keywords: design thinking, computer aided design (CAD), design education

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1. Introduction

Scientific studies and technological developments are being experienced in every field in the world. Technology, from the past to the present-day, has always emerged as a response to a number of demands. These demands or search for innovation or the desire for differentiation or needs is the most intelligent meeting of requirements. Nevertheless, technology covers all of the tools and equipment of the knowledge and methods used in the fields of art, science and profession and is especially a concept that includes the applied natural sciences and is within an interaction to a significant extent with design (Şen, 2006). On this point, especially with the initiation of computers, which have become the most important component of technology, just as in every field, it has also created an unforeseen change in design.

Technology and design have started to influence the information technologies in an intensive manner. The greatest share in this development is the developing technologies during the Industrial Revolution. Nevertheless, it is possible to interpret the developing technology and advancements within this process by examining the technological developments and technological value of some buildings and elements, which have historical value in civilizations. No concept or object is formed suddenly and does not take its final form immediately. Undoubtedly it is forced to undergo various stages. Everything develops in time and reaches its real value within a specific period of time. This is the result of an interaction. The developing technology within this process has also increased the influence of technology on design and has played a role in the change of design (Ertaç, 2003).

The word design that is used commonly in all of the Western languages has a rather strong connotation and is quite successful in explaining the depth of activity. On the other hand, design displays differences according to the disciplines. While design is defined as completely within parametric boundaries up until the smallest detail for some disciplines, it is an activity completely within visual and aesthetic boundaries for some other disciplines. Whereas, there is not a one-way process in some disciplines that also include product design. Different disciplines come together in the design process. This situation is triggered by a dynamic coercion at the axle of disciplines on which the discipline of product design is based. The change and development occurring in every sector takes its place as a new input in the product design process. The developments experienced make the basic activities defined in the area of responsibility of the designer become insufficient and sets forth entire analyses and applications with a content that is unthinkable distant from a design system. The design and designer, rather than focusing on the product, the opinion that a perception is required, which gives priority to the thought of also taking the system into the design, acquires importance. This approach is a design thinking system that thinks with different integrated methods.

The change that is also the subject of continuous change of profession can be the cause of system problems for the process of educating designers. The process of education should also experience change connected to the dynamics of the profession. In other words, design education is forced to experience a greater and more rapid change than many other professions. In the essence of design, there is a plan or an idea for solving the problem. Every component is a problem and an idea is required that also includes the educational process of the designer.

This situation includes great difficulties, especially for computer-aided design (CAD) that has become strengthened and that displays a very rapid development. The outputs of any component in education are important and problematic in the definition of the relationship and contribution to the system. It is not easy to establish a dynamic structure to this relationship due to the strong and rapid change experienced in CAD. On the other hand, the system should also feed and assess the professional targets and CAD presents new inputs very rapidly from this aspect. There are studies by different researchers that analyze the advantages and disadvantages of CAD in design education (Bret, *et al.*, 2007). However, experimental studies for structural implementation are not very intensive. Decisions are changing, especially connected to educators. This matter is at the same time a design problem related to the process. The method of approach to this problem should include all of the joint

owners and the system. In this context, while the place of CAD in education is being discussed, it is obvious that there is a need for a thought system and outputs that assess the components and the process of educating designers focused on design.

This study that focuses on the place and planning of computer-aided design in design education is in the form of an approach discussion that targets strong outputs. The subject is treated within the steps located within the basic systematics of the design thinking in this process and the process is interpreted in light of these thoughts. In the study, by departing from the examples of the existing situation, the programs integrated with education, the decision systematics, the gains and the problematic results have been discussed and basic system proposals have been made for the analysis and assessments realized and for the implementation processes.

1.1. The Relationship of Design, Technology and Computer-Aided Design

The facts about product design have passed through many stages up until the present-day, because every product should be shaped connected to the conditions that prepare and constitute it. It can be hypothesized that the thought of making design started together with the first humans taking anything in his/her hand and reshaping it. Thus, from those days up until the present-day, products have been designed and shaped for many purposes. All of these were produced and used and when their job was finished they disappeared. Without a doubt, throughout this long period, the tools and materials used in production have been renewed continuously (Küçükerman, 2006).

Besides the change in tools and materials, the knowledge and value systems of humans, the changes in the objects and events in the environment have caused new methods to arise. This search is continuous and attracts attention in an intensive manner. Everything conforms to the laws of change according to a certain rule of entropy. The buildings and roads in our surroundings, the houses we use and the tools within it, the infrastructure systems provided to us, the automobiles, trains and steamboats we board and the communication tools we use are within a continuous change. If the field where the change observed in designs of the surroundings is realized, then it is closely related to the activity of design. The structure of humans in parallel with changes, takes on a very complicated appearance, also with the decisions of humans. Reciprocal interactions, demands and requirements increase and become more complicated to the same degree. Finally, it is impossible to constitute buildings and products with the traditional design approaches. It is absolutely necessary to work with new methods for orienting to discoveries that are innovative and that would please humans. From now on, traditional methods have lost their validity within this complicated, changing environment.

The developments occurring from the aspect of method have brought profound searches. When these searches are treated from the aspect of some disciplines that also take within them product design, they have created differences that also affect the implementation and interpretation of practices spread to the historical processes. Especially, design that takes its place as an activity related to production has come into the forefront as a top activity that requires great assertions and solutions related to systems. In this period, the discoveries that have major outputs that could change the vital activities on the focus of design have been the cause of defined and new searches that trigger each other. For example, the discovery of the light bulb that was a solution on the subject of illumination affected the design of network systems that provided for the conveyance of electricity to every point. In future periods, the perception of innovation from the aspect of design will also change. Every solution is related to the component of another system and sometimes it can make an influence above what is expected.

The center of gravity of the components within the design processes has also changed in the contemporary meaning. Finally, design is not only designer-centered. This situation, as a requirement of the environment of competition, is the result and innovation of the search for advance of the process of design upon itself. In this process, computer-aided design inputs have now emerged from being new and have constituted a significant strength. In the beginning, the assertion of CAD, which

was defined as a new technology that replaced the drawing tools by many sectors, has gradually increased. In the contemporary sense, CAD is evaluated as a component that feeds creativity and that affects the output of design beyond being only a tool. On the other hand, the place and importance of CAD should be treated and interpreted with extreme care. Robertson et al. said, “CAD has an important role to play, it is but one of many skills needed for a complete design education, and it is one that is in danger of dominating the design education process and the students’ conceptions of design” (Robertson, et al., 2007).

The use of computers in design started in the ship designs towards the end of the 1950s (Kuo and Macmullum, 1994). Subsequently, this ratio of use that continued in a rapid manner, just as it also affected different industries; it also took its place in the educational processes. However, when the form of development is considered, the development provided from the aspect of its place in education is not as great as it is for the sectors (Khosrowjerdi, et al., 2005). This influence is at a much higher ratio in a contemporary connotation. Design has emerged from being an activity that is only carried out by a designer and has been transformed into a system carried from out jointly with the participation of different designers and experts. From now on, knowledge is not only for persons, but it is open to greater share owners in the cloud environments.

1.2. Foundation of the Study and the Design Thinking

The word ‘design’, which should be used together with a pre-definer with the justification of the broad world it covers in reality, is used for defining the product design within the study.

The use in an increasing manner of the informatics technologies in design has been the scene of new processes. Nevertheless, industrial design has approached extremely closely to the other specialist fields. The expectations from the design process of the new technologies and from the designer connected to this have increased and will increase even more. Finally, industrial designers are being used within a process where products are designed based on knowledge and informatics and they are encountering change. Consequently, the strong stance of the designer within this race is directly related to being able to embark with the required infrastructure and the dominance of these technologies.

The CAD education, as it is shown in the manner below, is founded on a multi-layered structure. This process, which feeds from the educational materials and study processes, has a dynamic structure that feels a need for research and development processes. It is the entirety of strong learning outputs that acquire value from the aspect of the sector of outputs and targets.

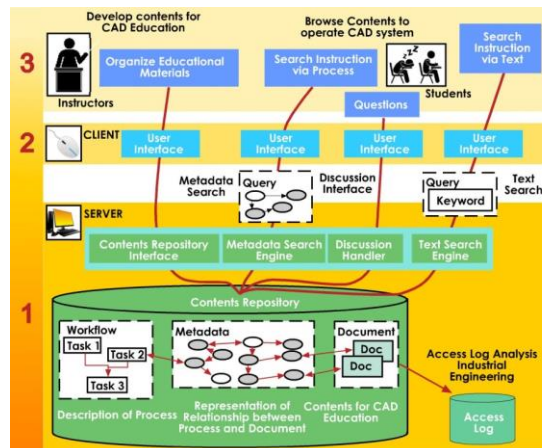


Figure 1. Schematic of proposed CAD education framework (Hiekata, et.al, 2008).

When the strong examples are examined in a contemporary meaning, CAD design holds a very important place in education. However, different examples are observed for the preferences of CAD elements in different applications. It is not very important which tools are used, the logic is clear of holding within the system strong tools that are alternative to each other that serve the targets. However, on the other hand, it appears that the hierarchy and confusion within the system are effective on the learning outputs.

In this context, the curriculum of the department of Industrial Design at the Gazi University was treated as a case study. Fundamentally, place is held by the basic components of design and it appears to be a system in conformance with the world examples. However, the CAD course contents, just as in many places, show different preferences. In this context, different preferences are constructed according to the periods based on the CAD usage process of the student.

Table 1. The content and timing of CAD courses at the department of industrial design of the Gazi University.

Programs			Semester									
			1	2	3	4	5	6	7	8		
1	Graphic Programs	Adobe Photoshop										
		Illustrator										
2	Modelling and Digital Visualisation	Rhinceros										
		Fusion 360										
		Key Shot										
		Solid Works										
		3D Studio MAX										

As it can be observed from the table above, basically an extensive program spectrum has been integrated into the educational process that could be analyzed as Graphics, Modeling and Digital Visualization. However, this example application that could be defined as a rich structure reflects important results with different observations and outputs. Consequently, it appeared to be important to discuss from the aspect of conformity the third region defined in Figure 1 with the second row defined in Table 1. In this discussion, it is defined within its own process and the functions and targets define a definite problem. If it is necessary to define with short headings:

- Basically, all of the components included in a design problem contain different identities.
- Humans are located at the center of the implementation.
- What are the inputs is important and is defined.
- The expected outputs are defined.
- The problem is not only with its own outputs; the need arises to assess from the aspect of relationships with other fields as well.

It is a problem that should be read on the effect to the system by the entire system. It is an ecosystem component. In this context, when the subject is treated, it cannot be left by only searching for the answer to the question of what are all of the CAD components' alternatives for which a need could be felt by the designer. The process and methods applied bring some problems into the forefront. What are the alternatives? Which ones should be brought into the forefront? With what methods will these decisions be made? What will be the results? Will it give results that are contrary to the expectations?

By thinking that there is a need for a dynamic assessment systematics for these types of questions that could be multiplied within the scope of the study, the designer discusses it within the thought system. In a study made by Kelly (2013), the design thinking is defined as a method that could present searches for solution proposals, new or innovative means as opposed to many types of personal, social and commercial difficulties.

There are many studies and definitions related to design thinking which has become very popular over the last decade. Dorst (2010) defines design thinking as a term which can be explained in two ways: as “an approach to design reasoning” and as “a human-centered problem solving process”. As an approach, it determines ‘ways of knowing’ that is applicable for different levels of abductive problems. In order to create a well-constructed and original approach, the professional practices surrounding problem framing and reframing must contain a sustained effort (Dorst, 2010). It is described as a discipline that utilizes the designer’s sensibility and methods to satisfy people’s needs with a strategy that is valuable and technologically feasible by Brown (2008). In addition, Brown and Wyatt (2010) states that design thinking is also important in terms of an approach to dealing with social issues. According to Kimbell (2011), design thinking can be defined in three different ways: as “a cognitive style”, as “a general theory of design”, and as “a resource for organizations”. Furthermore, from Nigel’s perspective, it refers to the collection of qualities that make us human (2011).

2. Assessment of the Existing Structure in the Light of the Design Thinking

Primarily, when the existing situation related to the Department of Industrial Design of the Gazi University is examined, it emerged in the diagram below that the CAD education structure is treated within the basic processes of the design thinking. According to this diagram, it is observed that the needs of the designer are focused on 3 basic outputs. This structure is an expected result and it is observed that the 2D graphics, 3D modeling and dijital visualization that are also the expectations of professional life, are located in the system as components of CAD education.

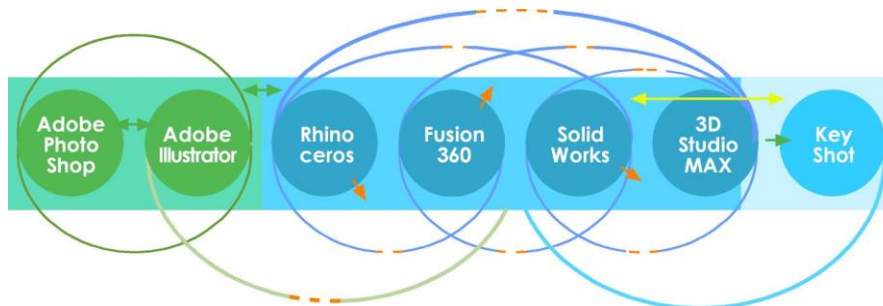


Figure 2. The diagram of the structure CAD education

When the diagram that emerges in the application is evaluated, it is observed that there are some interruptions in the relationship of the programs used, especially in the 3D modeling. These interruptions also exist partially in the connections between 2D graphics and the 3D modeling process. However, this situation that intensifies especially in the modeling region, which also shows that there are problems in the meaning of the relationship and contribution to each other of the programs found within the educational system. The meaning of this is that even if all of the programs reach their defined targets from the aspect of learning outputs, it will not express strong outputs as a whole. In the basic meaning, programs do not present inputs to another program. The student appropriates the first program he/she becomes acquainted with by the shortest path and the most dominant and most times at a high level of interest and rejects the transition to the other programs. Consequently, there are partial faults and energy losses in the educational process targets and a decrease in output success is experienced.

This situation is assessed with the design thinking approaches. The basic justification of the need for a design thinking is a proposal, activity or product that is realized related to the solution of a problem or even if sometimes a product is prepared with all of the functions, it may not be a solution. Also, in this diagram, each one is held in the system as one each strong input, the functions are defined and strong solutions are being operated. However, the problems those are discontinuous and worth being assessed are continuing as mentioned above.

Although there is basic agreement about the stages of implementation of the design thinking that constitutes the foundation of the assessment, there are different details in different studies. Brown (Brown, 2008) summarized the design thinking stages as inspiration, ideation and implementation. These include within themselves the prototype, experiment and improvement stages. Inspiration is stated to be the starting point for the subject in seeking a solution. This point can be any problem, opportunity or both of them. Whereas, the concept that is the second step is the stage in which ideas are produced, developed and tested on behalf of reaching a solution. Whereas, the third implementation covers the activities made for finding a response to the ideas tested. While sometimes these processes give rise directly to the processes related to a product and sometimes they focus on problems based on a system. In a study made by Dunne and Martin (2006), it evaluated and discussed the effects on the management unique to the postgraduate educational processes of the design thinking (Dunne and Martin, 2006). On the other hand, the use of thought maps and the place of the design thinking within the design education (Oxman, 2003). Plattner et al. (2009) presented in the following order the detailed condition of the design thinking as a method in another study.

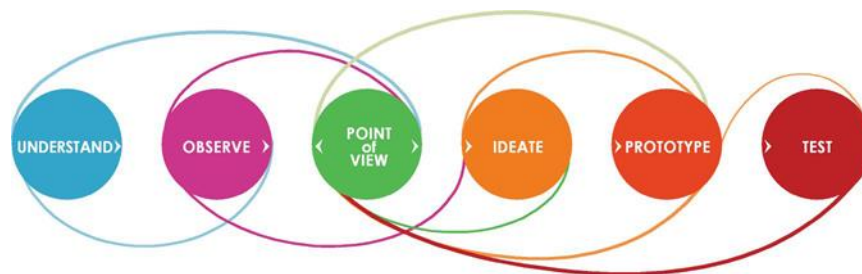


Figure 3. Didactic design thinking process model (Plattner *et al.*, 2009).

Plattner *et al.* advanced iteratively the design thinking process that was shown in Figure 2 as based on definitions. In other words, to learn by experimenting and being wrong and to make corrections by returning to the previous stage in case there is a need. The greatest aim in advancement of the process in this manner is to go quickly to success with early tests.

Within this scope, from the definition and design thinking system of the existing on a system on which an examination and analysis had been made in the focus of the design thinking, the analysis of the existing situation was discussed in a sub-title.

3. Conclusion

As it can also be observed from the definitions related to design thinking, it starts primarily by taking humans into the focus of design thinking with innovation processes. The exit points of the accustomed innovative proposals are focused on either technology or operations. This situation also displays itself in the decisions of the educational system. When it is assessed for CAD, the decisions can be distant from students and systems.

As it can be observed in Figure 4, the existing system is fed from an information pool and a structure is constituted where the components withdrawn from this pool are located.

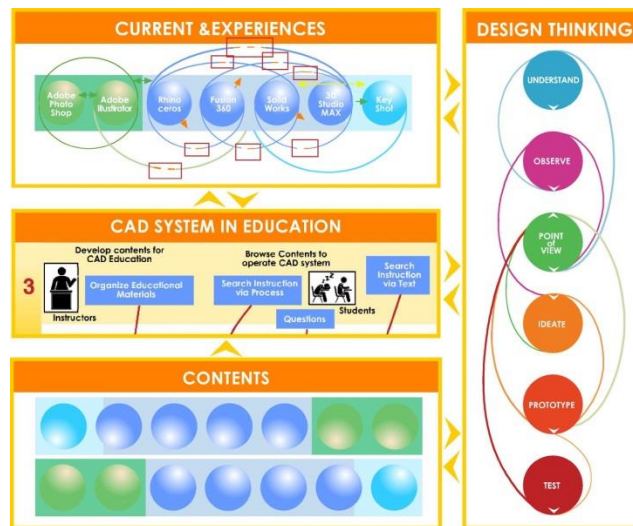


Figure 4. Structure of the system

The scope of the subject is also observed in the existing situation analysis above. The process is fed from the programs that are the inputs to the CAD education systematics given in Figure 1. These inputs are used in the organization and decision processes of the CAD education. However, there is no standard procedure for this stage of the field of design, just as for many fields. On the graph also located in Figure 2, the Gazi University Initial Professional Development (IPD) example has been given. However, when this implementation that give details in the top caption is assessed, the discussions that constitute the foundation of the study are also continuing. In fact, the planning that is the foundation of these implementations has been operated with the rules given below:

- Humans are located at the center of the implementation.
- The needs are defined and understandable.
- A start was made by examining the existing example structure and the world examples related to the subject.
- The basic targets are definite and clear.
- Ideas have been presented related to the subject.
- It has been implemented and tested.

However, these definitions have not hindered the formation of a large number of interrupted areas. In this situation, there is also the effect of factors, such as the student factor and that the priorities are limited to the academic success. However, despite everything, the construct in this field is a lot more defined compared to many fields and a structure that can be controlled a lot more. Consequently, the measurable outputs are clearer and this presents the possibility of being successful in this field to a greater proportion.

It is possible to have weakening factors that could also be interpreted as student-sourced. However, when the subject is treated in a process entirely with the design thinking, it brought up different observations and assessments. In this context:

- The programs that students first encountered with were considered to be more valuable. It was observed that their knowledge regarding the program that they first met has been found to be more durable and they were more enthusiastic to develop their skills.
- If there is a program that they already know how to use it, they put up resistance to learning another one even though the new one has more powerful features than the other. This situation, even if it focuses on different purposes, is negatively affected with perceptions on the use of multiplying programs one after the other.
- With the ongoing needs throughout their education, their skills in the programs that they first started to learn remain strong due to more opportunities to exercise.
- CAD practices do not include an algorithm to enforce a transition from one program to another.

Consequently, directed towards the process design that would be realized under this heading:

- It is important for the student to start with innovative methods that would provide for the creation of a new excitement for every piece of information and a new program decision should certainly define a new skill.
- In meeting with a new program, the significant new gains provided by the program should be placed in the focus.
- While providing information inputs for programs, a process should be operated independent from the program name and the thought system and meaning of the program should be brought into the forefront.
- The decisions related to new CAD software should transition to the powerful aspects of another program to the extent possible and should be based on the foundation of establishing reciprocal communications.
- The relationship between the other courses of programs should be strengthened. If there is the probability of feeding every process from another process, then this should not be neglected. This situation would assist in the formation of permanent effects of every course and consequently, of the CAD elements.

Finally, this study can be considered as the prototyping stage of the design thinking process. In this context, every experience presents important inputs for a subsequent stage and should not be neglected. Hence, the creation of an iterative loop is an important need under the responsibility of the educators. Rather than from the name of the program, loops should be created that seek outputs based on a connected system and the interrupted regions should be decreased. This approach should be assessed and operated with the same comprehension for the relationship between CAD and the other areas.

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