THREE-DIMENSIONAL THINKING IN ARCHITECTURAL DESIGN PROCESS: ANALYSIS OF TRADITIONAL AND DIGITAL METHODS

Lütfiye Yilmaz[1], Mine Batal Mirkan[2]

[1] Istanbul Yeni Yuzyil University, Department of Architecture, Istanbul, Turkey
[1] lutfiye.yilmaz@yeniyuzyil.edu.tr
[2] Istanbul Yeni Yuzyil University, Department of Architecture, Istanbul, Turkey
[2] mine.batal@yeniyuzyil.edu.tr

ABSTRACT

The architectural model is not only a visual product of design, but also a working tool that supports the three-dimensional thinking and perception stages of the design process. Studios or ateliers, the places where this tool is often used in architectural education, have now transformed to digital spaces that are gradually moving away from making physical models in the design process. This change of designing process also changes the designer's design concerns and puts the designer in a new role as the controller of digital screen interfaces. In this study within this context, Paulo Belardi's question “Why do architects still draw?”, which he asked to emphasize the sketch as a method of thinking, is re-directed to the users of today's architectural studios as “Why do architects still make physical models?”. Based on this research question, this study aims to analyse how model making, digital design programs and artificial intelligence applications change the perceptual scale and formal concerns in the design process through the advantages and disadvantages of these different methods. In this context, an experimental study was conducted with 15 2nd year students from the Department of Architecture at Yeni Yüzyıl University. The class level of the study group was limited based on the students' preferences being reshaped when they moved from the first-year design studio courses where they made models intensively to the second-year courses where they started to learn and use computer programs. The study methodology consists of three stages. In the first stage, a survey consisting of questions about the frequency of using model making, the use of 3D computer programs and model production through artificial intelligence (AI), which are used as three-dimensional thinking tools in design, and their level of knowledge about these tools was conducted. In the second stage of the study, the students participating in the experiment were given a design problem and were asked to generate solutions to this problem with artificial intelligence consisting of three-dimensional visuals. The results were evaluated and interpreted in terms of proportion/proportion, shape, form relations. In the third stage of the study, focused interviews were conducted with each participant and the difficulties they encountered during the study and the positive and negative aspects of their designs were asked. To summarize, it can be said that the students' verbal description skills contributed to the development of the final product obtained in the initiation of the three-dimensional thinking process with artificial intelligence software. However, in the model developed with only verbal descriptions, it is revealed that perception and scale problems will arise due to the lack of hand-eye coordination caused by model making, and this will negatively affect the next stages of the design process.

Keywords: Visualization with Artificial Intelligence, Digital Design, Model Making, Learning in Architectural Design Studio.

1. INTRODUCTION

The architectural model is a design tool that provides a holistic perspective and is frequently used especially during architectural education, as it creates a three-dimensional thinking space. By their nature, models are devoid of intricate details, allowing for spontaneity and instant modifications, thus constituting the initial phase of a process that translates two-dimensional sketches or conceptual thoughts into a reinforced perception of scale in three dimensions. However, with the widespread adoption of digital tools such as Computer-Aided Design (CAD) and Artificial Intelligence (AI), model-making has ceased to be a standalone design tool, and architectural design processes have gradually undergone a transformation from traditional approaches to increasingly digitalized methodologies. While this shift offers several advantages, it also presents certain disadvantages. On the one hand, well-defined approaches facilitate the generation of nearly all possible alternative scenarios within seconds, the extensive visual data pool fosters new design ideas, and universal and inclusive values can be comprehensively considered. On the other hand, critical discussions arise regarding the loss of scale perception, the risk of overlooking details, and the necessity of reevaluating the designer's role in this evolving landscape.

In this context, this study has been prepared to examine to what extent artificial intelligence software (ChatGPT and Prome AI examples), among the digitalized design tools, play an effective role in today's design processes. In this context, the focus of the research is to investigate how the first idea visuals prepared by the designers with the design data they recognize through verbal narratives shape the design process, how it affects the final product, the contributions of the process to the design and the difficulties it creates.

2. LITERATURE REVIEW

Enhenique defines the architectural model not as a representation but as an object that embodies the potentialities of reality as it exists or could exist (Enhenique, 1970). With a similar interpretation, Dunn sees the model as an abstraction of reality and thus mentions that the use of the architectural model in the design process is the first moment when reality is encountered (Dunn, 2007). However, this state of reality should also be flexible and adaptable to change when necessary (Knoll & Hechinger, 2000). Today, digitalized technological interfaces provide designers with the advantage of change and flexibility. While the design process is changing with the development of digital design tools, the existence of traditional methods should not be denied (Svetel, Kosic, Pejanovic 2018). In the context of architectural design, although computer programs and artificial intelligence interfaces are now accepted as a design tool, it is important to distinguish between the independent roles of these tools and design concerns (Yıldızoğlu, 2024).

Although there are opinions in the literature that computer-aided computer programs or artificial intelligence projects negatively affect creativity in design (Van Elsas and Vergesst 1998, Robertson 2007); there are also studies that digital design tools contribute to imagination by expanding the visual spectrum (Madrazo, 1999). When digital design tools are examined in the context of artificial intelligence; especially in recent years, developments have been seen in many areas from the development of design ideas and conceptual project stages to the resolution of implementation details (Zhang et al., 2023).

The use of these tools has started to gain momentum, especially in terms of offering designers many possible alternatives together with their interfaces (Zhou, 2021). The fact that this software can be used through verbal text narrations or uploading images and sketches keeps the designer in the focus of the final product while leaving the design path to the side that the designer is good at.

3. METHODS AND FINDIGS

In this study, it is aimed to investigate the advantages and disadvantages of using artificial intelligence applications as a three-dimensional thinking tool in the design process according to today's changing digital usage habits. In this context, while designing the study, the research questions “How common is the use of artificial intelligence in the digitalization of three-dimensional thinking methods in design processes?” and “How does it shape the design processes with three-dimensional visuals produced with the use of artificial intelligence?” were asked and answers to these questions were sought with an experimental method.

The workshop designed for the study was attended by 15 2nd year students from the Department of Architecture at Yeni Yüzyıl University. The class level of the study group was determined based on the hypothesis that the preferences of the students are reshaped when they move from the first-year design studio courses where they mostly make models to the second-year courses where they start to learn and use computer programs.

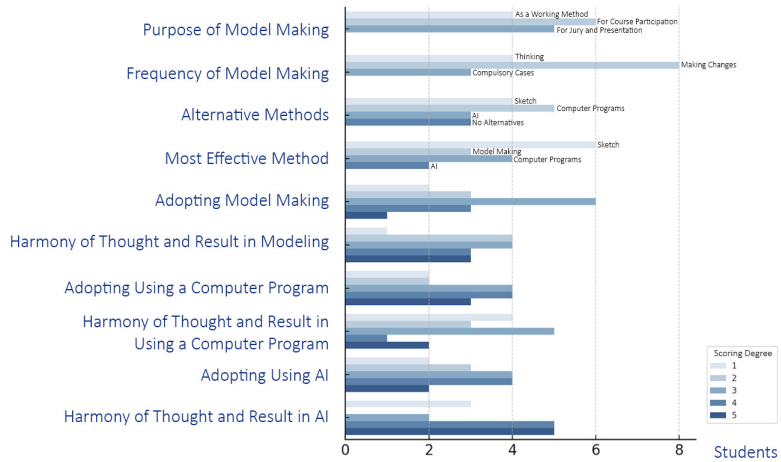

Figure 1. Survey Results (Prepared by the authors.)

The methodology of the study basically consists of three stages. In the first stage, a questionnaire consisted of questions about the frequency of using model making, the use of three-dimensional modelling programs and model generation through artificial intelligence, which are used as three-dimensional thinking tools in design, and their level of knowledge about these tools was administered to the students participating in the study. The distribution of the participants' responses to the questionnaire is shown in

(Figure 1). According to the responses obtained from the questionnaires, the effects of the students' usage preferences and the results of the workshops were also compared and interpreted in (Table 1).

In the second phase of the study, the students participating in the experiment were given a design problem and asked to produce simple solutions consisting of three-dimensional visuals to this problem with artificial intelligence. During the workshop, the students defined the design parameters they wanted with ChatGPT software under the supervision of the workshop instructors and converted the design data they obtained into visuals via PromeAI software.

The details of the design requested by the students are as follows.

- Design Purpose: Participants are expected to produce a three-dimensional visual by imagining a playground with indoor and outdoor areas for children aged 6-12.
- Environment Conditions: The playground to be designed should be in a region with a warm climate and rainy season and in an urban fabric that is not too dense in terms of population density.
- Desired Criteria: The design should be designed in a language that has suitable environmental and safety conditions for children, has innovative and educational spaces and includes appropriate furniture, as well as architecturally appropriate solutions and material details suitable for its context. The design to be made will be in an area of approximately 100 square meters and should have a closed area of 40 square meters

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- Duration: 15 minutes

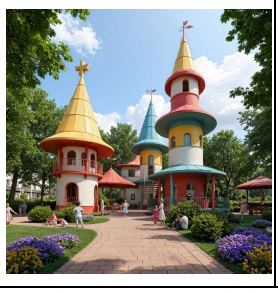
In the third stage of the study, focused interviews were conducted with each student. In the interviews, students were asked to answer the following questions about their work.

- To what extent does the final product you designed overlap with the visual you initially imagined?
- What are the difficulties you had while producing your work?
- If you were to turn your work into a project to be prepared for production, how would you manage the next processes?

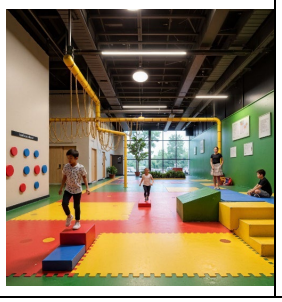
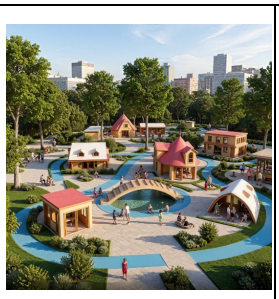
The findings obtained in the workshop designed in this context are compiled and presented in the table below (Table 1).

Table 1. Workshop Findings (Prepared by the authors.)

No	**Survey Evaluations**	**Design Final Product**	**Interview**		
			Design Thinking	**Difficulties**	**Future Desing**

1	Habituation: Model Making Deficiency: 3D Computer Program		*"I dreamed of a design with modular playgrounds made of natural materials such as wood and stone, with an outdoor area shaded by trees."*	*"I struggled with limiting the size of the space and renewing the contextual conditions."*	*"I start by drawing the study visual on the site plan and drawing it according to its dimensions."*
2	Habituation: 3D Computer Program Deficiency: Sketch		*"I wanted to design a natural space suitable for hot weather, with shades, water games with fountains, and a fountain to keep children cool while they play."*	*"I had a hard time customizing the indoor design. I wanted to create a visual with a lot of green space. I couldn't reflect what I wanted as an architectural form."*	*"Since it is a simple design, I would like to reorganize it in form. I continue by making a model"*
3	Habituation: 3D Computer Program and AI Deficiency: Model Making		*"I imagined a place that interacts with nature, with a sense of discovery and adventure, with secret passages and climbing areas that fit the natural topography."*	*"I had a hard time calculating square meters."*	*"I start drawing the plans by making a three-dimensional model in accordance with the actual dimensions."*
4	Habituation: Model Making Deficiency :3D Computer Program and AI		*"I wanted to design a space that resembled a fairytale world, with play structures in fantastic shapes."*	*"I got a more favorable result than I expected. I struggled to identify all the data in a limited time."*	*"I start by trying to calculate the appropriate dimensions, I decide firstly on the height of the towers."*

5	Habituation: Model Making Deficiency: AI		*"I thought it would be good to design modular play blocks that children can assemble and rearrange as they like."*	*"I wanted to produce a module suitable for flexible use, but I reached a more fixed design visual. I guess I didn't define it well."*	*"I continue by making models of how to use different modules. I design alternatives."*
6	Habituation: Sketch Deficiency: 3D Computer Program and AI		*"I wanted to design an interactive space with tactile, auditory and visual."*	*"I described a place that responds to different senses, but I could not understand the options presented to me in the visual."*	*"I couldn't get any data to continue with this design."*
7	Habituation: 3D Computer Program and AI Deficiency: Model Making		*"I wanted to design a special space for children with disabilities. I defined accessible ramps, wheelchair accessible floors."*	*"I couldn't produce an image that fit the definitions I made. Only a child in a wheelchair was in the image."*	*"I start by rethinking indoor outdoor access connections. I also define interiors and furniture for children."*
8	Habituation: Sketch Deficiency: Model Making		*"I thought that a playground in touch with nature could be combined with an ecological garden."*	*"I had a hard time seeing the architectural details in the produced image. I got a wide-angle photo."*	*"I start by thinking about more intimate details. Then I draw the plans."*
9	Habituation: 3D Computer Program		*"I thought I should create a design that would be suitable for wet*	*"The image gave me an inspiration to start. I am happy with the*	*"I continue to produce the project by making measured*

	Deficiency : Model Making		*weather conditions. Underneath the enclosed space could be a sheltered outdoor area."*	*product."*	*modeling."*
10	Habituation: Model Making Deficiency : 3D Computer Program and AI		*"I imagined a design with jumping areas, balance boards, climbing structures and interactive floor games."*	*"Instead of the designer furniture of my dreams, I was able to produce an image that looks like a simple and ordinary playground."*	*"I'll redesign it."*
11	Habituation: 3D Computer Program and AI Deficiency : Sketch		*"Thinking of the urban fabric, I wanted to make a thematic playground with small houses, roads and miniature city elements."*	*"I produced a more beautiful image than I imagined."*	*"I'll start drawing the blueprints of the places."*
12	Habituation: 3D Computer Program and AI Deficiency : Sketch and Model Making		*"I wanted to design playgrounds for children between the ages of 6-12 with different levels of difficulty according to their age group."*	*"Despite defining the difficulty, I produced an image with different layers. I could not understand the value of the definitions from the result."*	*"I start by redefining the details of the playgrounds and associating the spaces accordingly."*
13	Habituation: AI		*"I imagined a digital space,*	*"Since I generally*	*"I try to integrate*

	Deficiency : Sketch		*integrated with smart game panels, interactive projections and digital games that promote physical activity."*	*defined closed areas, I did not get a visual for the data I wanted in the open area."*	*indoor and outdoor spaces."*
14	Habituation: Sketch and Model Making Deficiency : AI		*"I thought that the playground could also turn into a learning space and I made definitions for this."*	*"I couldn't produce an image like I imagined."*	*"I define the learning spaces in more detail, what they will learn and how they will learn..."*
15	Habituation: AI Deficiency : Model Making		*"I wanted to make a creative design where children can create their own playground by combining modular elements."*	*"It was a design as I imagined. I imagined block modules. I didn't have any difficulties. I couldn't define the closed space well because of the limited time."*	*"I design furniture by measuring the modules."*

4. CONCLUSION AND EVALUATION

Model-making has traditionally been an essential tool in advancing the design process in three dimensions. However, due to increasing costs and time management concerns, architecture students are increasingly replacing physical model-making with computer-aided design (CAD) programs and artificial intelligence (AI)-supported software. When evaluating the impact of AI software on the design process within the scope of the workshop, several key contributions of technological advancements emerge:

- For a well-defined design problem at the initial stage, AI can generate an unlimited number of alternative solutions, continuously updating the proposed approaches.

- Rapid decision-making and implementation, often regarded as one of the greatest advantages of technology, also play a significant role in design processes.

- Digital approaches enable collaboration independent of physical space, offering greater flexibility compared to traditional methods.

- The ability to convert textual data into visual representations and vice versa allows for the transformation of different types of information into effective design tools.

On the other hand, despite these advantages, some challenges remain in these relatively new applications:

- For architecture students in particular, the shift away from traditional methods in favour of aesthetically appealing digital visuals may risk overshadowing fundamental design concerns.

- Issues related to scale perception may be overlooked in the design process.

- Poorly defined textual inputs may result in design outputs that significantly diverge from the intended vision, potentially undermining the role of the designer, thereby emphasizing the importance of language skills.

- The absence of hand-eye coordination in the design process may hinder the development of rational and intuitive solutions.

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