

Integrating Text-to-Image AI in Architectural Design Education: Analytical Perspectives from a Studio Experience

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Abstract: This paper examines the integration of artificial intelligence (AI) into architectural design education, with a particular focus on the utilization of text-to-image AI tools in a third-year design studio project at Atılım University. The objective of the project was to examine the potential of AI-supported visual representation tools in conceptualizing future public spaces in Ankara. The study employs a combination of practical experimentation and theoretical analysis to examine the impact of text-to-image AI tools on design thinking and processes, as reflected in student projects generated through these tools.

The research underscores the potential of integrating AI into architectural design education to foster creativity and critical thinking, emphasizing the underlying design principles and methods beyond mere visual outputs. The principal findings demonstrate that AI tools have the capacity to considerably extend the scope of design possibilities, assisting students in transcending the conventional boundaries of design. However, the research underscores the necessity of striking a balance between visual outputs and conceptual depth, ensuring that AI serves as an aid rather than a replacement in the comprehensive design process.

A robust theoretical framework is vital for guiding AI integration and fostering critical understanding and thinking among students. This research contributes to the ongoing discourse on the role of AI in reshaping architectural practice and education, proposing a balanced approach that values both technological proficiency and conceptual depth.

Keywords: Architectural education, Artificial intelligence, Design process, Design studio.

1. Introduction

The instruments and media that facilitate architectural design and representation have had a significant historical impact on architectural practice and thought. Digital tools like computer-aided design (CAD) were initially used to produce drawings more rapidly,

but they have since had a considerable impact on the culture of architectural design. The design process has evolved beyond simple geometry through the use of technologies like parametric design and Building Information Modeling (BIM) (As & Basu, 2021, Chaillou, 2022). This has contributed to the development

of more intelligent systems capable of providing additional information such as material costs and properties (As & Basu, 2021).

Artificial intelligence (AI) has started to become an important consideration in the field of architecture in recent years. Artificial Intelligence is characterized as a form of programming that imitates the working principle of the brain's neural network system. AI is employed in various fields of architecture, especially concerning text-to-image diffusion models and Generative Adversarial Networks (GANs). These artificial intelligence techniques are essential to the design, representation, and data analysis processes in architecture (Chaillou, 2022)

AI has started to have a significant impact on architectural practice and education. A constantly evolving framework for architectural education ought to give the coming generation of architects a theoretical grounding in addition to emphasizing skill development. The use of AI in architectural design demands a reassessment of design process awareness, techniques, and representation. To emphasize the importance of concepts and ideas in the architectural design process and make sure that visual representations are understood as reflections of these ideas, it is imperative to incorporate AI into the educational setting and promote conversations about it.

The purpose of this research is to examine how AI can be incorporated into architectural design processes and assess how it affects design concepts and principles. According to this study, AI should offer a solid theoretical foundation in addition to helping with skill learning. In particular, text-to-image AI applications, although producing an extensive variety of results, give rise to concerns about reducing design to its visual aspect, prompting the need for further investigation. Analyzing the impact of text-to-image AI techniques on design concepts and principles is essential. The design studio serves as an ideal setting for undertaking such investigations.

In this regard, a project was implemented in the third-year studio of the Atılım University Department of Architecture. The project aimed to explore the contribution of text-to-image AI tools to the design process, discuss the integration of these tools, and understand their contribution to ideas and principles. Titled "Rethinking Public Spaces in the Second Century of the Republic: The Past-Present-Future of Public Spaces in Ankara," this project examined the use of AI as a design environment. By investigating the past and assessing the present conditions of public spaces in Ankara while envisioning their future, text-to-image AI applications were employed. The project aimed to recognize the significance of these spaces in stimulating community, democracy, and identity, and to use these skills to develop creative architectural spaces for the future.

This project included using text-to-image AI tools to transform texts and scenarios into spatial representations and analyzing the impact of this experience on design thinking and processes. The possibilities of these AI applications in architectural design education are discussed in this context, together with the difficulties and solutions posed by the quick advancements in technology that have a significant impact on architectural design.

This study employs both qualitative and quantitative research methods to explore the incorporation of AI tools into architectural design education. The literature review on AI in architectural design and education establishes the theoretical framework. Selected projects created by students in an AI environment are introduced and analyzed with an emphasis on the effectiveness of the utilization of AI tools to convey their design ideas and principles. The findings are discussed across several key topics, including the relationship between architecture, expression, and space; the necessity of a conceptual foundation; the development of AI skills; the importance of textualization; and the ongoing development of AI discourse.

2. Theoretical Framework

2.1. Artificial Intelligence and Architecture

Artificial intelligence (AI) is defined by Russell and Norvig (2020) as a form of programming that provides the ability to mimic human reasoning and problem-solving. According to this definition, AI includes the ability of a computer system to analyze data, learn from it, and make similar decisions as human beings.

As humans cannot individually create, calculate, and assemble billions of data, computers can perform many tasks extremely quickly. This ability leads to a major change in how problems are solved, as computers can do things much faster and differently than humans. The term “Big Data” describes this difference, referring to data that is too large for humans to handle, but manageable for computers (Carpo, 2023).

According to Carpo (2023), intelligence as a design tool is limited to tasks involving measurable factors although architectural design is not easily converted into numbers. It can provide and process analytical data which helps the decision-making process. Architectural drawings have been digitized for a long time but no standard metric exists to evaluate architectural design values (Carpo, 2023). AI applications range from predictive analysis to optimization of building performance and user experience to form-finding, space planning, and fabrication in construction phases (As, 2021). Carpo (2023) claims that only certain parts of a design can be optimized using AI tools, as long as they

produce measurable results and even then, most quantifiable problems will have multiple parameters, requiring someone to prioritize and make choices.

Similarly, İmdat As (2018) claims that architectural design relies on abductive reasoning, so these tools aren't very helpful in the early stages of the design process. Architecture allows for multiple solutions to the same spatial problem, meaning there isn't just one correct answer but current computer-aided design (CAD) tools are based on inductive and deductive reasoning, which work well for engineering, not for design (As, 2018). They are more useful in the later phases when most design decisions have already been made. It is important to produce alternative solutions for decision-making therefore, students are more encouraged by their instructors to use sketch rather than CAD programs which allows them to quickly come up with multiple design ideas without getting overwhelmed by CAD details (As, 2018). However, As (2018) claims that, the lack of computational tools for the early design stages is a gap that machine learning might help fill.

With the recent development, GANs and diffusion models can be used as generative models in non-measurable architecture-related fields. Like diffusion models, GAN technology is used as an image processing tool trained to identify similarities between a collection of images categorized under the same label or concept using a discriminator and a generator (Figure 1) (Chaillou, 2022).

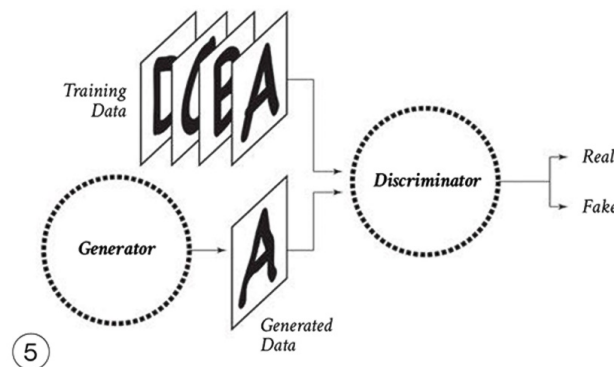


Figure 1: GAN Technology explained. Source: Chaillou, 2022

For example, a dataset containing millions of classified images can be trained to recognize patterns and commonalities within this group of images (Carpo, 2023). Both GANs and diffusion models produce data similar to the data on which they are trained; however, diffusion models-including models that generate images from text-have proven more successful than GANs in this regard, and their use has recently increased in many fields, including architecture (Dhariwal & Nichol, 2021).

AI has become increasingly important in architectural design due to its ability to analyze and generate patterns and symbols. Image generators can translate abstract architectural concepts into tangible forms, revolutionizing the creative process and redefining the traditional limits of human design. The advent of artificial intelligence (AI) has introduced new possibilities for architectural design, particularly through the use of AI-generated images. It makes a significant contribution to the design process by providing a wide range of outcomes, providing a set of exemplar outcomes, and filtering them to select the most appropriate one (del Campo & Maninger, 2022). However, Del Campo and Maninger (2022) argue that if the notion of a singular design is replaced by a set of potential exemplars, these should be referred to as "outcomes", and if the process of generating these exemplar options is based on such a set of "outcomes" rather than the generation of a singular design, this process should be referred to as "searching" rather than "designing".

According to Del Campo and Maninger (2022), when all possible solutions already exist, it is only a matter of doing the right "searching". In other words, it is not about the designer "inventing" some new proposals by using his or her own "genius", but about choosing the best solution among the possible options available. As a result, it can be said that artificial intelligence does not need to catch up with human intelligence, and is already much more efficient than human intelligence in exploring the set of possible "outcomes" in any "design" search process. In this context, the concepts of

"consciousness" and "search" in the design process are directly related, and this relationship can provide an important awareness of the danger of architectural practice becoming a visual game, and the danger of creating an architectural language through "isms" or styles. Design problems involve a multifaceted process. The more deeply one examines the ideas, problems, and values behind architectural design, the more "conscious" the design produced and the more successful it is considered to be when it is successfully synthesized and translated into an architectural language.

2.2. Integrating Artificial Intelligence into Architecture Education and the Importance of Discussing it in Education

The characterization of paper-based design thinking as the basis of design education is generally accepted (Tepavčević, 2017 as cited in Schön & Wiggins, 1988; Oxman, 2008), and the introduction of CAD (computer-aided design) did not revolutionize the process of design thinking. While CAD is seen as a tool that mimics paper-based design, DAD (digital-architectural design) replaces the paper-based media approach with new concepts such as digital design models (Tepavčević, 2017 as cited in Kalay 2004), new design thinking (Tepavčević, 2017 as cited in Oxman, 2017), and new concepts of space (Tepavčević, 2014). For this reason, it is important to integrate artificial intelligence into education and even discuss a theory of architectural education and design pedagogy that incorporates the theoretical, professional, and technological changes that digitally mediated architecture is beginning to implement.

In the design and decision-making phase in architectural education, it is a healthy process to evaluate possibilities and search among available alternatives up to the threshold of acceptability. The role of AI can be seen as expanding these possibilities and as a source of inspiration.

Accepting that artificial intelligence is a means of generating possibilities, it would not be wrong to say that its inclusion in the educational

process is necessary both to explore the potentials of artificial intelligence and to discuss the consciousness in these possibilities, and to take the discussions on the relationship between architecture and artificial intelligence beyond the dimension of mere visuality. In this way, instead of looking at the visuals produced by artificial intelligence in a result-oriented way, it is possible to emphasize the ideas behind the visuals, the process and method of their creation, and to discuss.

Neil Leach (2022) explores how AI image generation can serve as a tool for engaging students in critical inquiry and challenging conventional design norms (Leach, 2022). He argues that AI-generated images can inspire creativity by presenting unexpected design solutions and encouraging students to think beyond traditional boundaries.

Similarly, Kudless (2024) claims that if generative AI images are thought of as artistic sketches, then sketches are often used in the ideation phase to help generate concepts valuable to artists and designers because they are fast, iterative, and cost-effective, despite their lack of precision. Generative AI images capture the essence and atmosphere of an idea, but instead of being seen as finished renderings, they can be seen as possibilities and examples that can help expand the designer's repertoire. Kudless (2024) adds "As we navigate the intersection of AI and creativity, it is crucial to strike a balance between coherence and creative nonsense to harness the potential of AI as a tool for exploration, dreaming and the creation of new architecture" by drawing attention to the danger of these rapid image-making tools, namely the irrelevance or inexpressiveness of the images produced.

The expression of architecture with fancy visuals is a critical issue that causes it to be reduced to an image instead of complex design ideas and it is in danger of being undervalued with this reductionist approach. The widespread use of AI-generated images may lead to an overemphasis on images at the expense of functionality and contextual relevance. Therefore, it is essential to critically evaluate

the role of these tools and ensure that they complement rather than overshadow the comprehensive design process.

A vast number of studies are interested in the effect of text-to-image AI tools on transforming architectural education (Ceylan, 2021). These studies, based on first-year basic design education, directly address key topics such as the impact of artificial intelligence on visualization with storytelling (Sadek & Mohamed, 2023) and the effect of AI on representation forms like sketches and orthographic drawings (Yıldırım, 2022). Tong et al. (2023) have also definitively shown the effect of using artificial intelligence on learning outcomes (Başarır, 2022). Furthermore, research has also examined the impact of AI on creativity in form and façade. (Sadek & Mohamed, 2023, Kavakoğlu et al., 2022). Yıldırım (2022) in his research mentions the use of text-to-image AI image-generation tools as a part of the design process comparing it with sketching as the conventional method of conveying ideas focusing on the textual data from novels. Cudzik and colleagues (2024) encouraged students to use artificial intelligence tools as part of a green campus design project, especially as a source of inspiration, and the new images generated by artificial intelligence were intended to enrich students' understanding and imagination of campus transformation aspects and practices in the same way as visual materials consisting of existing architectural examples. Cudzik et. al. (2024) claims that the images generated allowed new ways of thinking about possible solutions, sparking students' imaginations and stimulating their creativity.

In another study by Yazıcıoğlu and his colleagues (2024), first-year architecture students were given a project topic with the theme of "underground" and were asked to create scenarios about which universe's underground they would design and to sketch and write them down in detail. This study focuses on how and with which task artificial intelligence programs that produce visuals from text can be positioned within the rational and action-oriented way of thinking in the

architectural design process. During the workshop, no artificial intelligence program was employed by the student groups in the elaboration of their underground scenarios. In the final stage, descriptive short texts produced for each underground model were written as input to the Dall-e2 program, and visual outputs were obtained. In this study, unlike other studies, artificial intelligence was used only to evaluate the texts produced in the context of accuracy.

While these studies utilize the potential of artificial intelligence, they do not address the issue of architecture being limited to mere visual appeal, neglecting its conceptual, contextual, and functional aspects. In this context, the research conducted in the third-year studio at Atılım University Faculty of Architecture offers a distinctive approach to the subject.

3. Scope and Process of the Project

At the beginning of the Fall 2023-2024 semester, a conceptual project was initiated in the third-year studio of the Atılım University Department of Architecture. The project sought to explore ways of incorporating AI within the

design studio process, rather than addressing it as an isolated subject. The objective of the project was to uncover the potential and possibilities of AI as a creative design environment and understand its contribution to architectural design. The project highlighted design concepts, principles, and processes to expand beyond conversations about visual features. The subject matter was theoretically and intellectually challenging, requiring students to do extensive study, have thoughtful discussions, and apply critical thinking skills before coming up with design proposals. The project was entitled "Rethinking Public Spaces in the Second Century of the Republic: The Past, Present, and Future of Public Spaces in Ankara."¹ This two-week conceptual project encouraged students to focus on the transformation of public spaces in Ankara as Türkiye approached its second-century of the Republic.

3.1. Project Process

The project developed along two main axes: an exploration of design content and the application of text-to-image AI tools, which initially proceeded separately but later integrated. Studies related to the design content

Table 1: Architectural Design Studio Information

Architectural Design Studio Information	
Institution	Atılım University
Department	Department of Architecture
Academic term	2023-24 Fall semester
Project Title	Rethinking Public Spaces in the Second Century of the Republic: The Past, Present, and Future of Public Spaces in Ankara
Student Level	3rd year Undergraduate Students
Number of students	44
Project Duration	2 weeks

¹ The studio instructors who participated in the project together with the author Sinem Çınar and Melek Demiröz: Elif

Yurdaçalış, Yeşim Hatırlı, Günay Erdem, Kumru Alpaydın, Hakan Evkaya.

aimed to understand the design problem and establish a conceptual foundation, necessitating thorough analysis and research processes. Parallel to this, the other focus was on developing AI usage skills. These initially separate processes converged during the development of design proposals.

The first axis, exploration of design content, involved research, analysis, and discussions to understand the design problem, typical of a classical studio project. New challenges and opportunities for redesigning Ankara's public spaces in the 21st century were considered. The rapid urbanization, growing population, and changing demographics in Ankara have created a necessity for a reconsideration of the city's public spaces. The significance and function of public spaces, transformations in their character, and the conceptualization of public life in the Republic's second century were among the pivotal issues addressed. Creative approaches to inclusive, sustainable, and actively used public spaces were highlighted.

The second axis dealt with the improvement of AI abilities. Students familiarized themselves with AI applications that generate visuals from text, comprehended their operation, and learned fundamental skills through an introductory seminar and workshop.² The objective was to

understand the limitations, controllability, and potential of AI tools rather than getting involved in the complicated and intensive tasks associated with running algorithms, modifying codes, installing new libraries, or searching for appropriate datasets. Students were encouraged to concentrate on developing textual representation skills of architectural and spatial concepts in order to gain control and approach the best-desired solutions during this two-week project.

Following their analysis of the design problem and theoretical and technical learning of text-to-image AI tools, students began experimenting in an AI setting with their design concepts. With this, the process of creating design concepts for Ankara's public areas was initiated. They explored the potential of AI tools to synthesize design ideas and inspire creativity. This phase involved working with textual representations of design ideas, visualizing new concepts, and refining the design process through discussions on spatial features, key terms, and core principles (Figure 2).

3.2. Student Projects

Four projects were selected for their successful use and understanding of AI as a tool, and they are evaluated in this section.

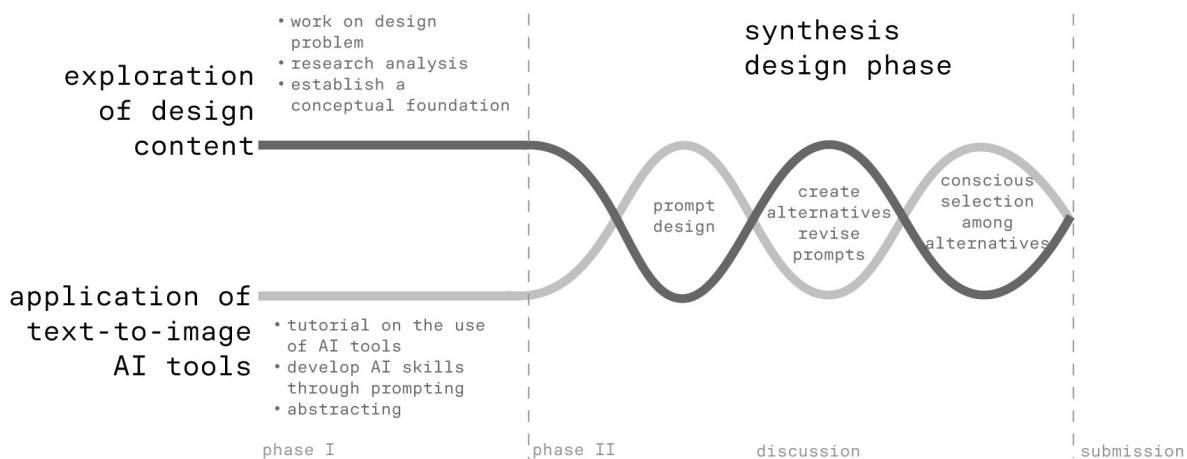


Figure 2: Project Process. Source: Author

² Melek Demiröz, research assistant at Atılım University GSTMF Department of Architecture, conducted an online

workshop titled "Artificial Intelligence Applications in Architecture".



Square spaces, intersecting spaces, group activities, relaxation spaces, interconnected spaces



Wooden structures of different sizes following a straight axis, open spaces, urban fabric, public space formed between its intersection, green texture, sustainability, city square, walking, climbing



Thick wooden structures of different sizes located on a linear axis, transitional spaces

Figure 3: Sude Er, Project images and texts produced at Midjourney

The first project (Figure 3) aims to create a symbiotic relationship between nature and the built environment. It emphasizes integrating nature with urban life and promotes an active lifestyle through movement and social interaction. The design features a linear axis connecting two prominent urban centers and it envisions public spaces as interconnected platforms enabling three-dimensional spatial relationships across various levels. The wooden frame structures supporting the platforms are adaptable. The platforms of flexible dimensions prioritize human scale, and they serve as transitional spaces for walking, climbing, and cycling, and as spaces for community activities. The spaces between platforms receive sunlight and allow for the growth of trees and plants,

enhancing the ecological wellness of the urban environment.

The second project (Figure 4) exemplifies how urban design can adapt to and mitigate environmental challenges, offering sustainable and interactive solutions for future urban living. It envisions a future scenario that addresses the challenges of a growing global population, excessive urbanization, and the resulting reduction of natural resources. It proposes elevated public spaces in the sky, where clean air is provided within spheres, allowing people to breathe without masks. These spheres create ideal living conditions and incorporate advanced technologies such as holograms and digital libraries. Interactive spaces facilitate communal activities and communication,



Gym in a glass sphere in the sky, inside space, sport, swimming, relaxation, futuristic



Futuristic architecture, digital library, people walking around, people sitting, reading books, futuristic architecture



Various plants in a glass sphere in the sky, People walking around, reading books, glass capsules, exhibition, people

Figure 4: Yeşim Soysal, Project images, and texts produced at Midjourney

encouraging a sense of community amidst environmental deterioration.

The third project (Figure 5) envisions a more sustainable environment through the integration of green spaces within a multi-layered urban design. The design involves replicating and layering the ground plane in three dimensions. The upper layer features a public green square that connects across a vehicular boulevard to a park on the opposite side. Below the upper layer are enclosed commercial and dining spaces that support public life. When the upper layer intersects with the lower layers, it creates amphitheater-like spaces. The configuration of the layers allows for the creation of semi-

enclosed and enclosed areas that facilitate pedestrian and bicycle circulation, thereby enabling a range of activities and social gatherings. Structural openings and voids are incorporated to ensure that the lower layers receive natural light, enhancing the overall spatial experience and sustainability of the design.

The fourth project (Figure 6) aims to revitalize the Republican axis, which was historically planned but compromised due to vehicular traffic. It pedestrianizes Atatürk Boulevard and links significant urban landmarks. The design envisions a linear passage and activity area along the boulevard, characterized by



On the right of the green amphitheater public space, with stepping stones passing through the center formed by a walking axis, semi-open eating areas, membrane roof on the left side, floor, stratification, pedestrian and bicycle path only, people, socialization



People sitting in green cavity, people are walking on green ground layers, on the left side outdoor eating areas, happy people socializing

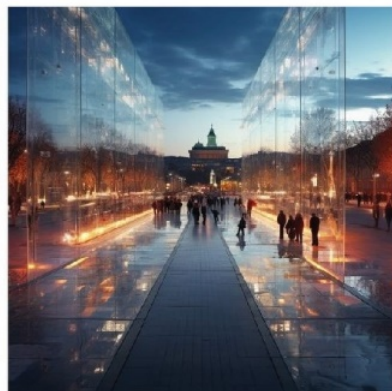


One on the right side of the central walking axis, amphitheater, semi-open with membrane roof on the left side, public space with dining areas, pedestrian and bicycle path only

Figure 5: Zeynep Sude Arslan, Project images and texts produced at Midjourney



Glass surfaces, people following a single contrary path, Ankara's urban identity, an axis in the middle of the square, linear



Created with glass surfaces in the center of the square, road, glass passage with continuity on the axis, light reflecting glass surfaces, following the axis, people, continuity, Ankara urban fabric, in between created public rest areas, linearity



Linear glass passage following a single axis passage, people following the axis through it, linear passage with resting areas, glass surfaces, reflected lights, glass pane urban texture, linearity, axis

Figure 6: Tuğçe Serinken, Project images, and texts produced at Midjourney

transparent glass surfaces that lightly and gently intervene in the urban fabric. Along this axis, resting areas are incorporated, and historical exhibitions are projected onto the glass surfaces, creating an effort to revive historical consciousness and engagement.

4. Discussion & Conclusion

The project made a substantial contribution to the integration of AI tools and techniques into architecture as well as creativity in the design process. Despite initial challenges in controlling AI-generated visuals of conceptually designed spaces, students gradually developed skills in using language accurately, creating abstractions and concepts, and expressing and conveying these through prompts. Upon the conclusion of this experience, a discussion of the subjects that provoked reflection can be conducted under the following headings.

Relationship Between Architectural Concepts, Spatial Qualities, and Their Representations

Throughout the project, the relationship between the spatial qualities and architectural concepts and their representations was investigated. The features of different artificial intelligence tools were examined for each phase of the architectural design process—concept and idea development, representation, and realization—and the distinctions between them were examined. Throughout the process, students were asked to avoid concepts aimed solely at creating visuals, such as -isms, historical architectural styles, and formal approaches. However, they were not prevented from experimenting with these concepts in keywords during the program discovery process. As a result of the studies conducted, it can be said that artificial intelligence can assist in uncovering architectural knowledge, based on the necessity for the text used in visual production to contain architectural information.

Need for a Conceptual Backbone

The project's outcomes showed that the more focused the design problem and thoroughly examined the ideas, the more satisfying the results. The project process demonstrated that the more the design problem was focused upon and the concepts were extensively scrutinized,

the more satisfactory the outcome was. During the design process, generic concepts frequently produced highly standard and uncontrolled consequences, which led to dissatisfying visuals. Clarifying design concepts and principles, as well as the structural system and material selections, was therefore crucial.

Development of AI Skills

The development of AI skills is a gradual and crucial process. Students need ample time to explore both the controlled and uncontrolled aspects of AI. During this journey, students familiarized themselves with AI applications that generate visuals from text, comprehended their operation, and acquired fundamental skills. The objective was to understand the limitations, controllability, and potential of AI tools. Throughout this two-week project, students were encouraged to focus on developing prompting skills for architectural and spatial concepts to achieve the best possible outcomes. Initially, some projects began with very general concepts, but it was later recommended that these concepts be detailed and selected from spatial concepts, architectural design elements, and strategies, rather than architectural styles or periods. General concepts did not enhance the quality of the student's results, whereas more detailed and expressive spatial and architectural concepts yielded more satisfactory outcomes.

Development of Prompting Skills

In the design process, the quality of results obtained from AI-generated visuals directly depended on the detail and architectural knowledge embedded in the text. Students developed their skills in using language precisely, creating abstractions and concepts, and expressing and conveying these visually. They recognized the importance of detailed textual descriptions in achieving high-quality outcomes. Through this experience, students learned that the more nuanced and informed their prompts were, the more sophisticated and accurate the resulting AI-generated visuals became.

Evolving Nature of AI Discussions

Given the rapid development of AI, it must be acknowledged that discussions on this topic are constantly subject to obsolescence. The fact that this project was conducted at the beginning of the 2023-2024 Fall semester indicates that the use of AI reflects the state of a specific period. Consequently, these discussions are destined to become outdated even as they are being conducted. However, the emphasis on ideas and principles –rather than visually-focused designs– in architecture transcends the passage of time and technological changes. This enduring focus ensures that while the tools and methods may evolve, the core values and objectives in architectural design remain unchanging.

Project outcomes suggest that AI can contribute to innovative and contextually relevant public space designs, enriching the educational experience and preparing future architects for contemporary design challenges. The project demonstrates that AI technologies encourage creativity by producing a variety of design solutions, which motivates students to think creatively and beyond the box. Nonetheless, it is crucial to achieve a balance between conceptual depth and visual representation to make sure AI supports rather than dominates the design process. To support students' critical understanding of AI-generated outputs, the project emphasizes the necessity of a strong theoretical foundation for navigating AI integration in architectural design education.

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