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INTEGRATION OF GENERATIVE ARTIFICIAL INTELLIGENCE TOOLS FOR TEXT- PROMPTED VISUAL GENERATION INTO THE DESIGN PROCESS: A STUDY WITH ARCHITECTURE STUDENTS

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DEPARTMENT OF ARCHITECTURE

GAZİ UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

JANUARY 2025

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INTEGRATION OF GENERATIVE ARTIFICIAL INTELLIGENCE TOOLS FOR TEXT- PROMPTED VISUAL GENERATION INTO THE DESIGN PROCESS: A STUDY WITH ARCHITECTURE STUDENTS

(M. Sc. Thesis)

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ABSTRACT

With the rapid technological developments in the last 20 years, the use of generative artificial intelligence tools in many fields and their integration into production processes have become widespread. With these developments, some advantages, concerns, and uncertainties have emerged regarding the use of artificial intelligence tools in design fields and creative processes. This study aims to measure and investigate the advantages and disadvantages of the use of artificial intelligence tools in creative thinking and design processes. The study method was determined as a "practice-led research" method, including literature review, application, and evaluation stages. A three-step application was conducted as a teaching experiment with three participant groups: graduate students from Gazi University, Department of Architecture, and undergraduate students from Istanbul Technical University, Department of Architecture. The three participant groups were of different age groups and in different numbers, with a background in design education. The application data were analyzed using the explanatory sequential mixed model, which is defined as the type of model in which the analysis results obtained from quantitative data are supported and elaborated on with qualitative data. As a result of the analysis, it was concluded that there are criteria that affect the quality of the final product in the use of generative artificial intelligence tools in design processes, such as the interface quality of the artificial intelligence tool used, prompt length, abstract/concrete concept content, differences between analog and digital design tools, and the effective use of textual thinking and editing tools that increase the effective use of generative artificial intelligence tools are among these criteria.

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METİN İSTEMİYLE GÖRSEL ÜRETİMİ SAĈLAYAN ÜRETKEN YAPAY ZEKÂ ARAÇLARININ TASARIM SÜRECİNE ENTEGRASYONU: MİMARLIK ÖĈRENCİLERİYLE BİR ARAŞTIRMA

(Yüksek Lisans Tezi)

İrem YAŞAR

GAZİ ÜNİVERSİTESİ
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ÖZET

Son 20 yılda yaşanan hızlı teknolojik gelişmelerle birlikte üretken yapay zeka araçlarının pek çok alanda kullanımı ve üretim süreçlerine entegrasyonu yaygınlaşmıştır. Bu gelişmelerle birlikte tasarım alanları ve yaratıcı süreçlerde yapay zeka araçlarının kullanımıyla alakalı bazı avantajlar, kaygılar ve belirsizlikler ortaya çıkmıştır. Bu çalışmada üretken yapay zeka araçlarının kullanımının yaratıcı düşünme ve tasarım süreçlerinde avantaj ve dezavantajlarını ölçmek ve araştırmak amaçlanmıştır. Çalışma yöntemi literatür incelemesi, uygulama ve değerlendirme aşamalarını kapsayan "uygulama odaklı yöntem" method olarak belirlenmiştir. Öğrenme/öğretme deneyimi için Gazi Üniversitesi Mimarlık Ana Bilim Dalı lisansüstü öğrencileri ve İstanbul Teknik Üniversitesi, Mimarlık bölümü lisans öğrencilerinden oluşan üç farklı katılımcı grupla birlikte analog ve dijital kolaj çalışmalarının bir arada bulunduğu üç adımlı bir uygulama yürütülmüştür. Üç katılımcı grubu farklı yaş gruplarında ve sayılarda tasarım eğitimi geçmişi olan öğrencilerdir. Uygulama verileri nicel verilerden elde edilen analiz sonuçlarını nitel verilerle desteklendiği ve detaylandırıldığı model türü olarak tanımlanan açıklayıcı sıralı karma model ile incelemiştir. İncelemeler sonucunda; kullanılan yapay zeka aracının arayüz niteliği, prompt uzunluğu, soyut/somut kavram içeriği, analog ve dijital tasarım araçlarının farklılıkları, gibi üretken yapay zeka araçlarının tasarım süreçlerinde kullanımında sonuç ürün niteliğini etkileyen kriterlerin olduğu ve üretken yapay zeka araçlarının etkin kullanımını artıran metinsel düşünme ve edit araçlarının etkin kullanımın bu kriterler arasında bulunduğu sonucuna varılmıştır.

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SYMBOLS AND ABBREVIATIONS

The abbreviations used in this study are presented below, along with their explanations.

Abbreviations	Explanations
AI	Artificial Intelligence
GenAI	Generative Artificial Intelligence
2D	Two Dimension
3D	Three Dimension
txt2img	Text to image
img2img	Image to image
PDDFA	Principles of Digital Design and Fabrication
ML	Machine Learning
px	Pixel

1. INTRODUCTION

In the last 20 years, with the increase in artificial intelligence-based technological developments, it has been observed that the usage areas of artificial intelligence have also increased, and the user groups have expanded (Russel and Norvig, 2020). With the proliferation of digital design tools and technological developments, higher education models have developed in parallel with these advances, and computers and digital tools have become critical auxiliary tools in the design process (Gül. et al., 2013). With the development of the technical features of the tools, the relationship between creativity and designer in the visual design process is constantly evolving, enriching the designer's way of thinking and offering various new possibilities with the use of artificial intelligence in design (Sreenivasan and Suresh, 2024).

In addition to being a new technology that significantly impacts society and people, generative artificial intelligence has become controversial in creative fields with its use in design fields (Oppenlaender et al., 2023). Fields such as architecture and graphic design have been among the fields in the sphere of influence of artificial intelligence. While using artificial intelligence in these fields has caused debates regarding originality, it has temporarily increased productivity (Özdemir, 2022).

In this thesis, methods, and practices for the use of generative artificial intelligence tools as a tool for the designer are investigated. Artificial intelligence (A) applications, which have increased in many production areas, are also used in design. Among these, the widely used GPT language models and “text to image” based AI tools that work with these language models and their relationship with the designer and the design process have been chosen as the subject of this thesis.

This thesis investigates the methods and practices of using generative artificial intelligence (GenAI) tools as a tool for the designer. Artificial intelligence (AI) applications, which have been increasingly used in many production areas, are also used in design. Among these, the widely used GPT language models and “text to image” based AI tools that work with these language models and their relationship with the designer and the design process have been chosen as the subject of this thesis.

Rationale for the research and problem statement

Experimental studies are being conducted in today's design studios on using generative artificial intelligence tools and what role they will play in design processes shortly. However, there are no concrete answers to the relationship between the designer and AI, the ethical issues in design processes, or how to realize original designs with AI. This study examines the relationship between AI tools and the designer by reviewing the process and the final product.

Research question and hypothesis

“What are the potentials of artificial intelligence tools that enable visual production from text as an auxiliary tool in the early stages of design? “was the first research question, and the sub-research questions were;
-What are the positive and negative aspects of generative AI models as a representation tool in the design process?
-To what extent is it possible to improve the quality of the final product with the given text prompting and editing tools, and can these tools that produce singular images support three-dimensional thinking and design?

Hypothesis*:* Generative AI tools can be used creatively by architecture and design students as auxiliary representation tools and to develop students' visual expression skills.

Aim and scope

The thesis examines the role of GenAI tools in contemporary design practices and their relationship with the designer. It aims to design some student-centered programs to investigate the effective use of artificial intelligence tools not as a generator that can replace the designer but as an auxiliary tool that can increase the designer's expression, language, and creativity. In the applications carried out in the study, undergraduate and graduate-level architecture design students constitute the participant group. Two of the applications were carried out as part of a 14-week curriculum within the scope of a graduate course, while the third was carried out as a two-day workshop. The applications were carried out analogically in the workshop environment and with digital tools in the computerised

methods. The role of AI tools in the design process was discussed through the experiences of these architecture students. For this purpose, design practices using artificial intelligence tools were carried out with various groups of students who have studied/are studying architecture at the undergraduate and graduate levels. These studies were analyzed in terms of productivity, creativity, and originality criterias. During the practices, various visualisation methods were supported by productions made with genAI tools. In this study, artificial intelligence was not considered as a designer in design applications but an auxiliary tool for the designer, and its contributions to creativity in collaboration with analog and other digital tools were investigated.

Research contribution to knowledge and practice

In this thesis, various AI-supported design practices were carried out. The use of generative artificial intelligence tools with rapidly changing and evolving interfaces in these processes was recorded with variations, user evaluations, and final products, and the current use, contributions, and shortcomings of developing artificial intelligence tools were presented in the literature.

Thesis structure

The thesis consists of six main chapters. In the first chapter, the problem is presented, the purpose and objectives of the study are explained, and the objectives for the findings are briefly presented. In the second part, a two-part literature review is given. In the first part of the literature review, the working principles, historical development, and use of GenAI tools, which are used as auxiliary tools in the study; in the second part of the literature review, the design processes in which the use of GenAI tools is examined and comprehensive examinations of creative productions in design processes are included. The third chapter includes a detailed explanation of the research method, the practice led research method, and how it is specialized in the thesis study. The fourth chapter consists of the fieldwork and implementation steps of the three implementation studies in which the implementation steps are differentiated. The fifth chapter includes the workshop outputs of the three implementation steps, student evaluations about the production, and the questionnaire responses taken before and after the implementation. The last section

presents the extent to which the study's results meet the purpose, the problems encountered during the research, and suggestions for further studies (Figure 1.1.).

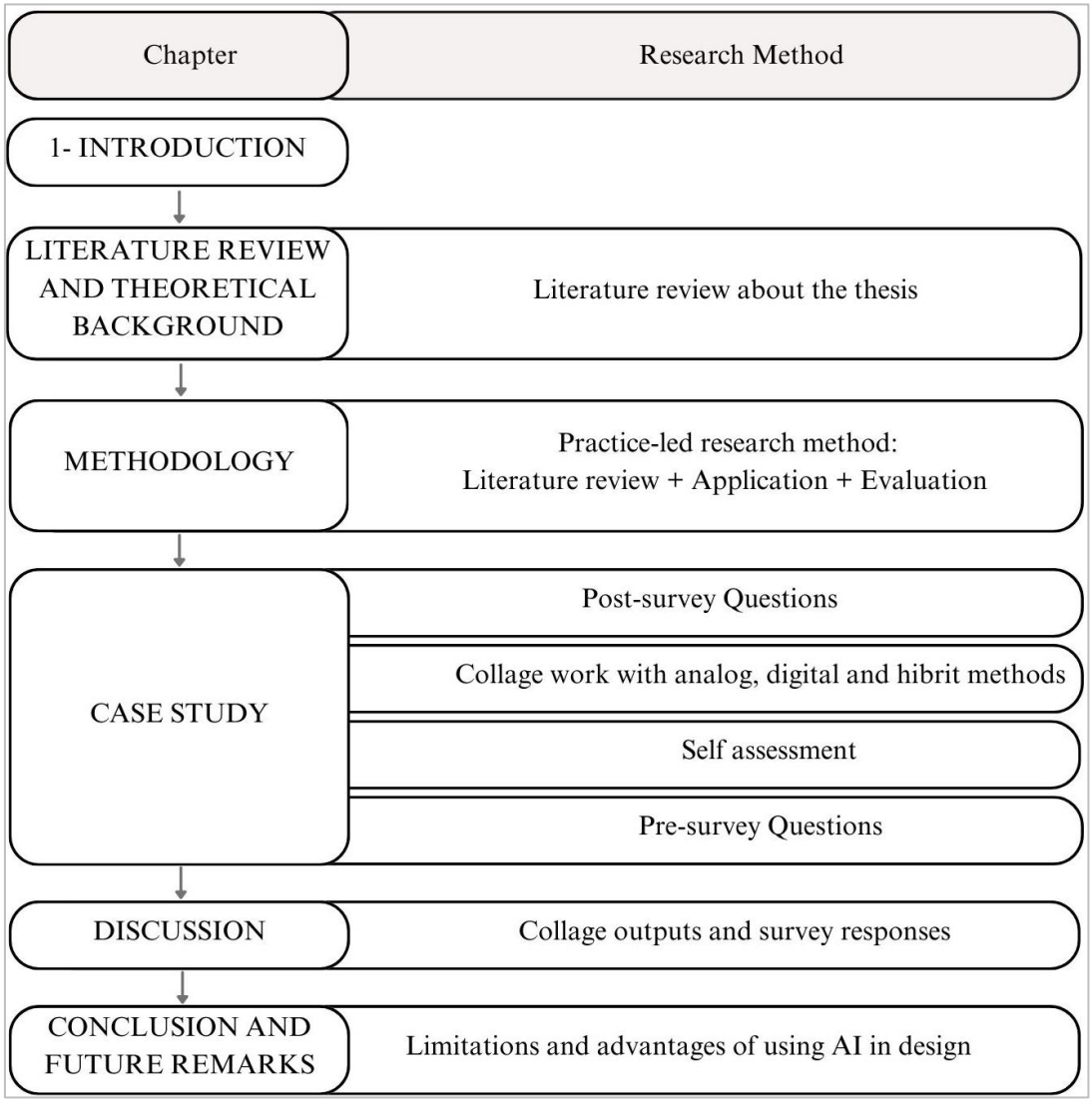


Figure 1.1. Thesis flowchart

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

This chapter presents research data on the concepts that constitute the thesis's theoretical background. The historical development of GenAI tools, which is the research topic of the thesis, and their current usage areas and possibilities are examined. Factors affecting creative thinking in a design process and the role of "learning by doing" method in design education are analyzed. The areas of AI used in design processes and the contributions of AI to this processes are discussed.

2.1. The Concept of Artificial Intelligence

AI is defined by Pirim (2016) as an operating system that can physically respond to the algorithms given to it. Atalay and Çelik (2017) define AI as "basic techniques such as expert systems, genetic algorithms, fuzzy logic, artificial neural networks, machine learning, and artificial intelligence technologies in general." Say (2018) defines artificial intelligence as artificial systems that can perform all kinds of beneficial or harmful cognitive actions that natural systems can perform and the branch of science that aims to develop these actions. Artut (2019) defines AI as the broad category of technology that enables a computer system with a non-biological structure to demonstrate all cognitive capacities, such as logic, self-awareness, comprehension, reasoning, problem-solving, and creativity. AI systems are designed as a system in which brain behaviors are mapped with algorithms based on the functioning of the human brain (Avcı and Kavut, 2024). Figure 2.1 shows the subcategories of AI technologies.

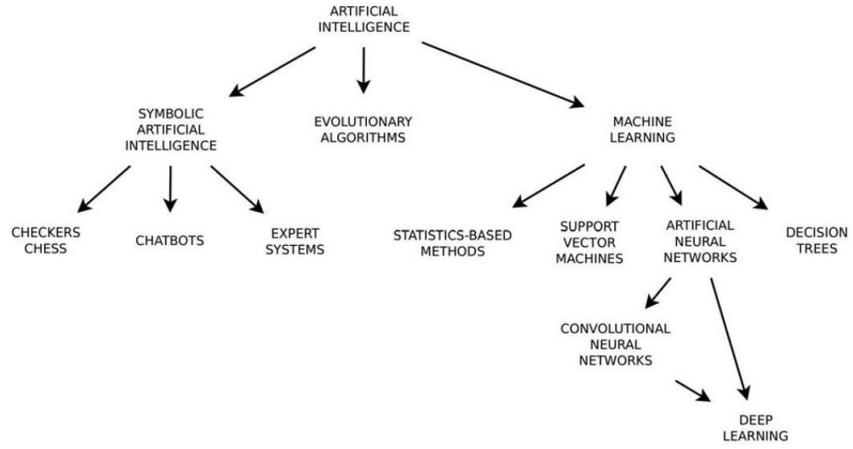


Figure 2.1. Classification of AI models (Cudzik et al., 2024)

Karabulut (2021) defined artificial intelligence as artificial operating systems that can fulfill functions such as thinking, learning, decision-making, reasoning, and communication specific to human intelligence. AI technologies, which have become an element that can assist in almost every aspect of human life, can imitate and learn in the intended direction (Sucu and Ataman, 2020, p. 45). According to Levy (2018), AI is an extension of human intelligence.

Within the scope of this thesis, the concept of artificial intelligence is divided into stages in subheadings, as shown in Figure 2.2.

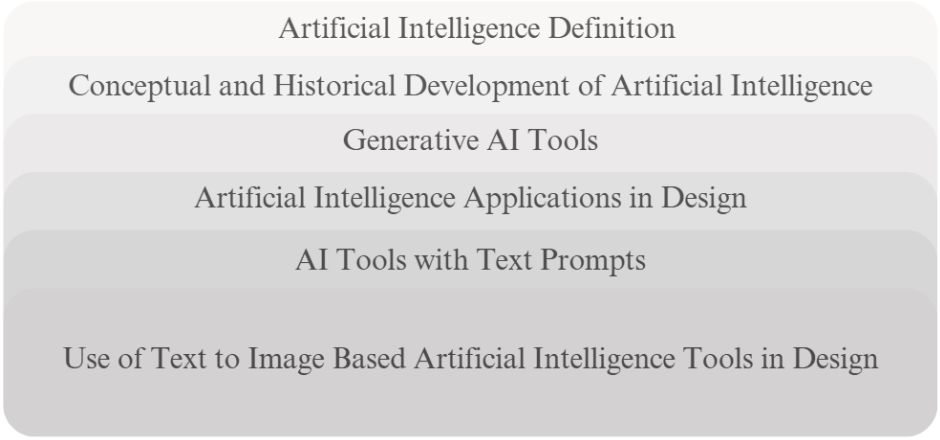


Figure 2.2. Stages of conceptual examination of artificial intelligence

2.2. Historical Development of Artificial Intelligence

This section examines the historical development of AI and developments in AI applications in design. The roots of the search for a mind free from human emotions, utterly free from human emotions, completely free from logical thinking and weaknesses to solve the problems that the human mind cannot solve are traced back to the Ancient Greek period (Erten and Göktepeliler, 2022). The emergence of the concept of AI and its philosophical foundations date back to the 17th century. In the mid-16th century, Descartes, one of the philosophers of the period, compared human intelligence to a machine that works on a similar principle to a clock (Coşkun and Gülleroğlu, 2021). The Golem, known in Jewish folklore as being with a soul, was a clay sculpture with semi-mechanical properties, with papers placed in its mouth by Rabbi Judah Ben Loew in 1580 in the 16th century (Britannica, 1998). This sculpture is a prototype of a semi-mechanical robot that responds to human

requests. This is considered the first development in the historical analysis of AI. The mechanical calculator “Pascaline,” developed by Blaise Pascal, and “The Step Reckoner,” created by Gottfried Wilhelm Leibniz, inspired by him, were the first tools that aimed to perform human actions such as calculation and counting with mechanical aids (McCorduck, 2019). In the late 19th century, Herman Hollerith's census machine, which passed rolls of paper representing individuals through holes in the surface, followed these two calculators. In the 1960s, computer support in architecture reduced the burden of architectural drawing, enabling more human involvement in the design process. In the 1970s, they became intelligent assistants in relaxing the designers and increasing their decision-making abilities (Mıhlayanlar and Tachir, 2019).

Herbert Simon defined the task definition of artificial intelligence as “computer science that aims to develop intelligent machines that can perform tasks that normally require human intelligence” (1995). Deep Blue, developed by IBM, is one of the leading algorithms developed with the help of artificial intelligence. Deep Blue defeated the world chess champion Gary Kasparov in 1997 (McCorduck, 2004).

The conceptual use of AI as it is used today was realized in 1955 in the USA with a paper presented to the Rockefeller Foundation by John McCarthy, Claude Shannon, Ray Solomonoff, Nathaniel Rochester, and Marvin Minsky (Arslan, 2020). Alan Turing, on the other hand, published an article titled “Computing Machines and Intelligence” in the 236th issue of Mind, a philosophical journal, in October 1950, during the Second World War period, asking the question, “Can Machines Think?” and conducted the “imitation game” test, which suggested that machines imitate human thought (Özdemir, 2022). Sketchpad (Robot Draftsman), a computer program written by Ivan Sutherland in 1963 during his doctoral study, facilitated computer-human interaction thanks to its graphical interface and received the Turing Award in 1988 and the Kyoto Prize in 2012 (Sears and Jacko, 2009) (Figure 2.3).

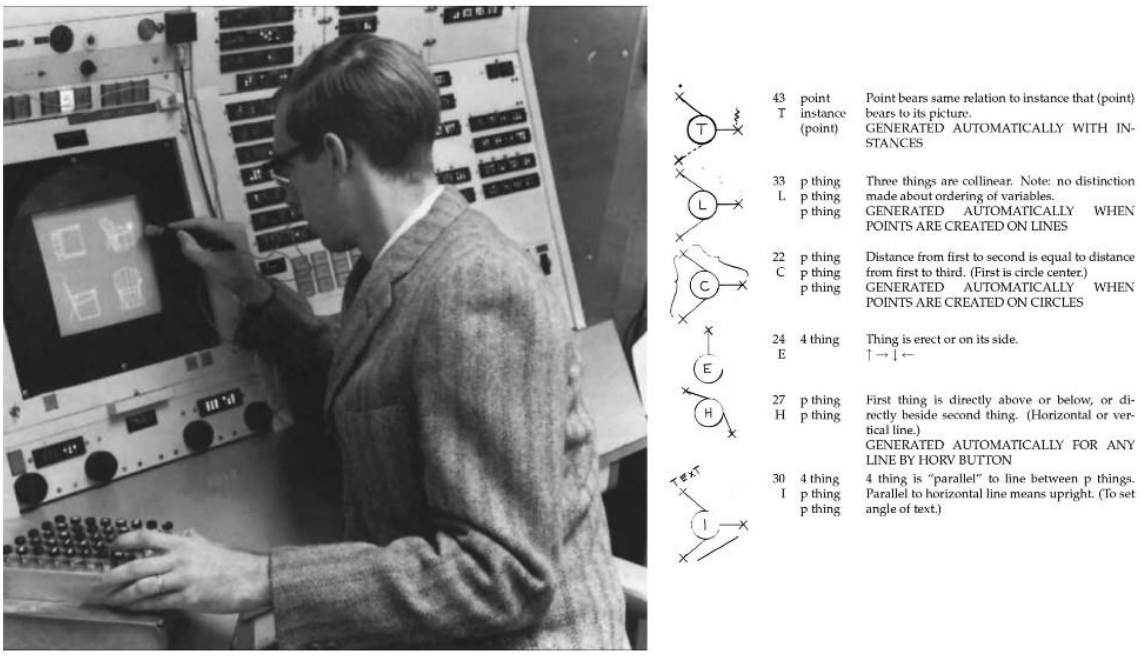


Figure 2.3. Ivan Sutherland operating Sketchpad and some of the software's behavioral diagrams (1963). Collaga by Errioli, 2020.

Several developments laid the foundation for today's artificial intelligence technologies from the 16th century to the beginning of the 19th century (Figure 2.4). Developments from the 19th century to 2024 are analyzed in detail in Figure 2.5.

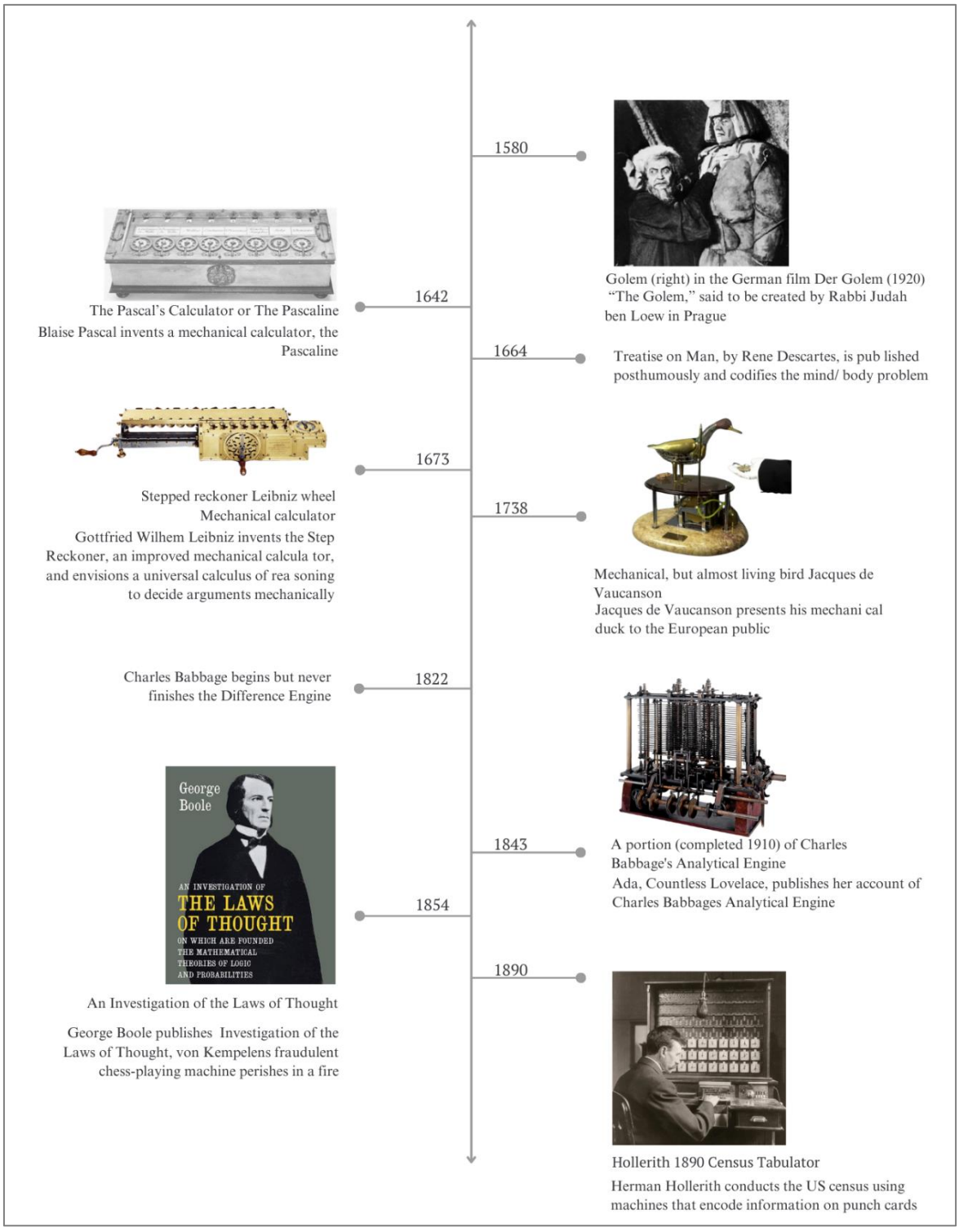


Figure 2.4. Timeline showing the development of artificial intelligence between the 16th and 19th centuries (Updated with reference from McCorduck, 2019)

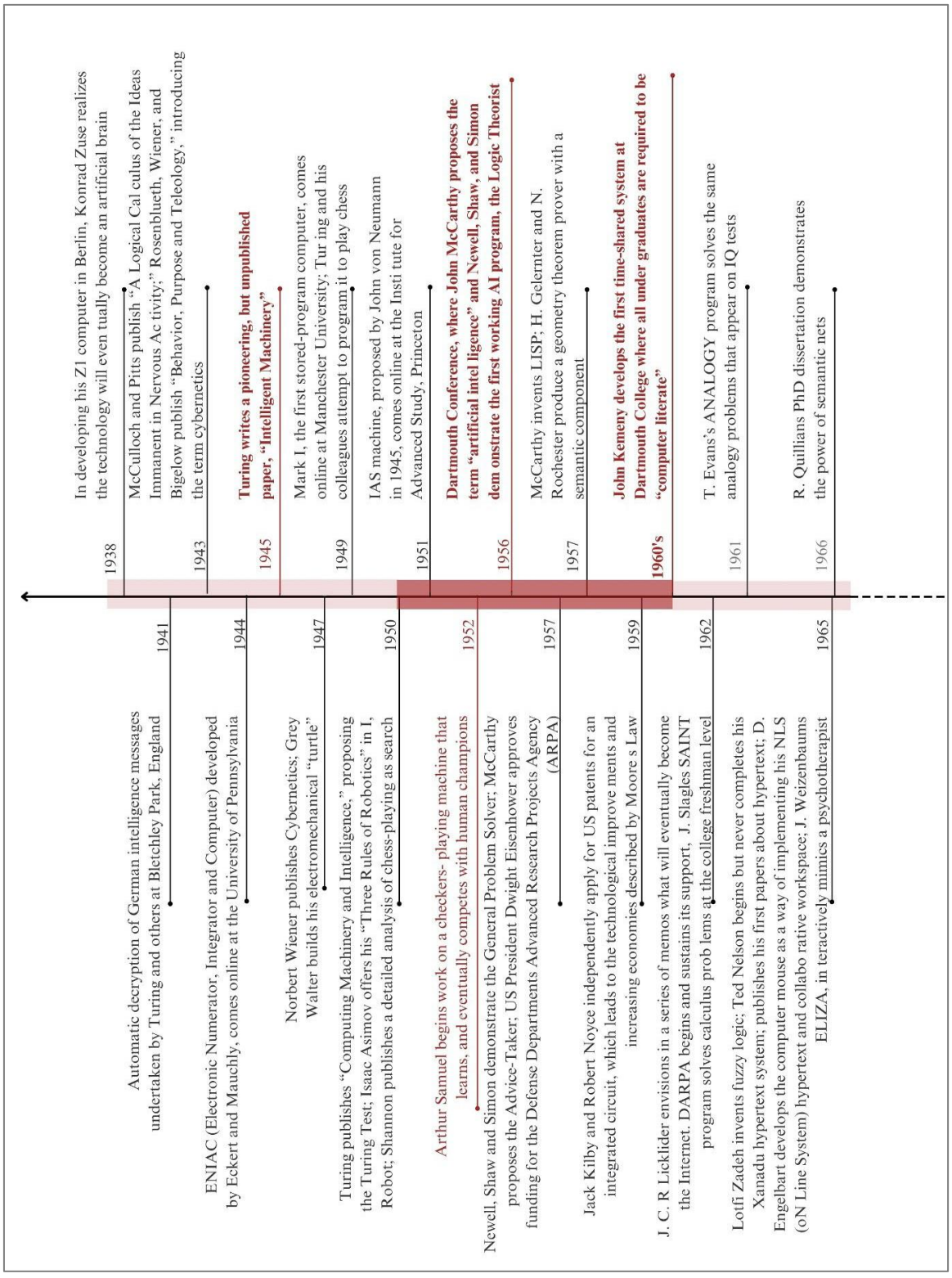


Figure 2.5. Timeline showing the historical development of artificial intelligence as of the beginning of the 19th century

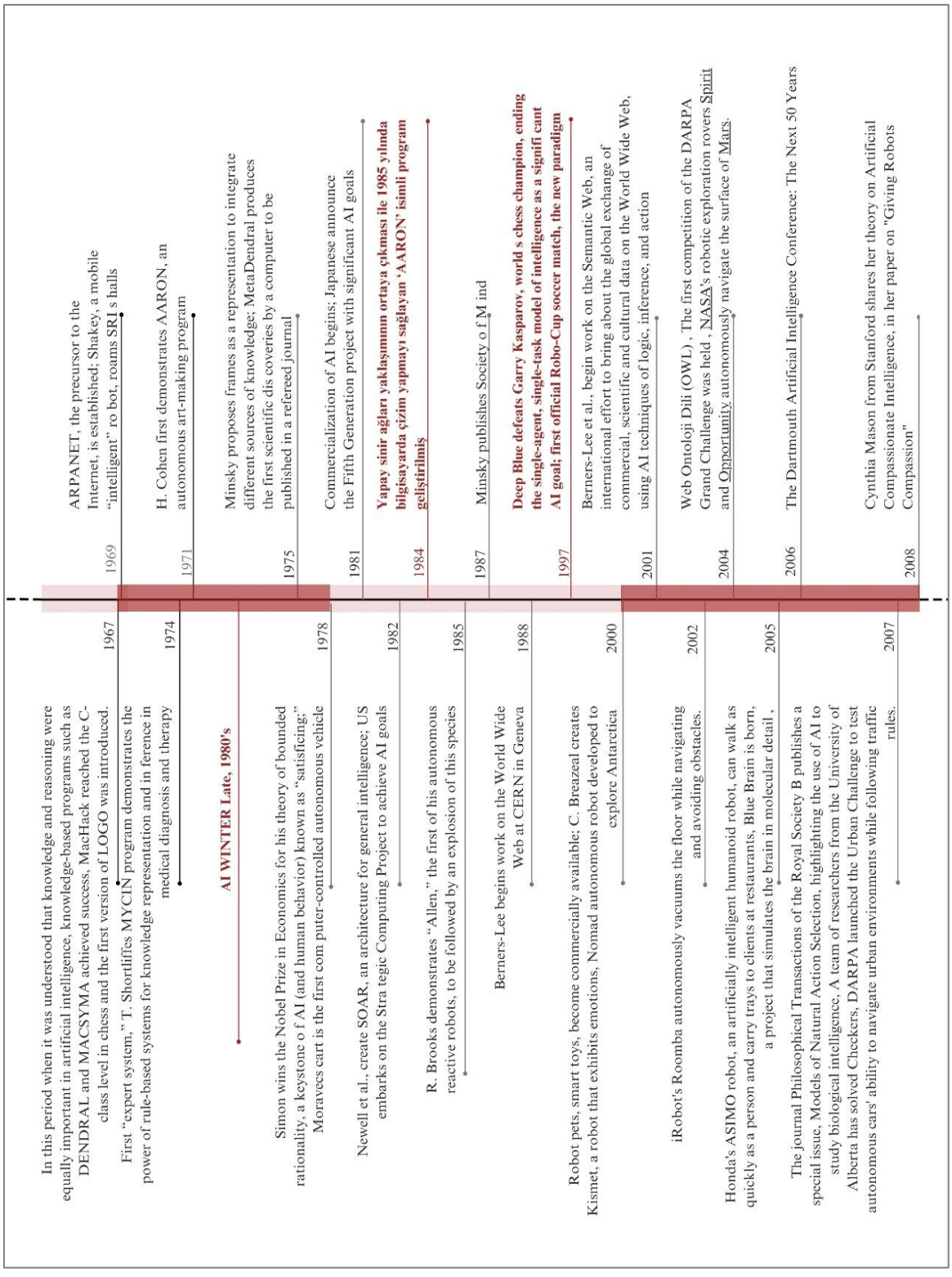


Figure 2.5. (Contiuned) Timeline showing the historical development of artificial intelligence as of the beginning of the 19th century

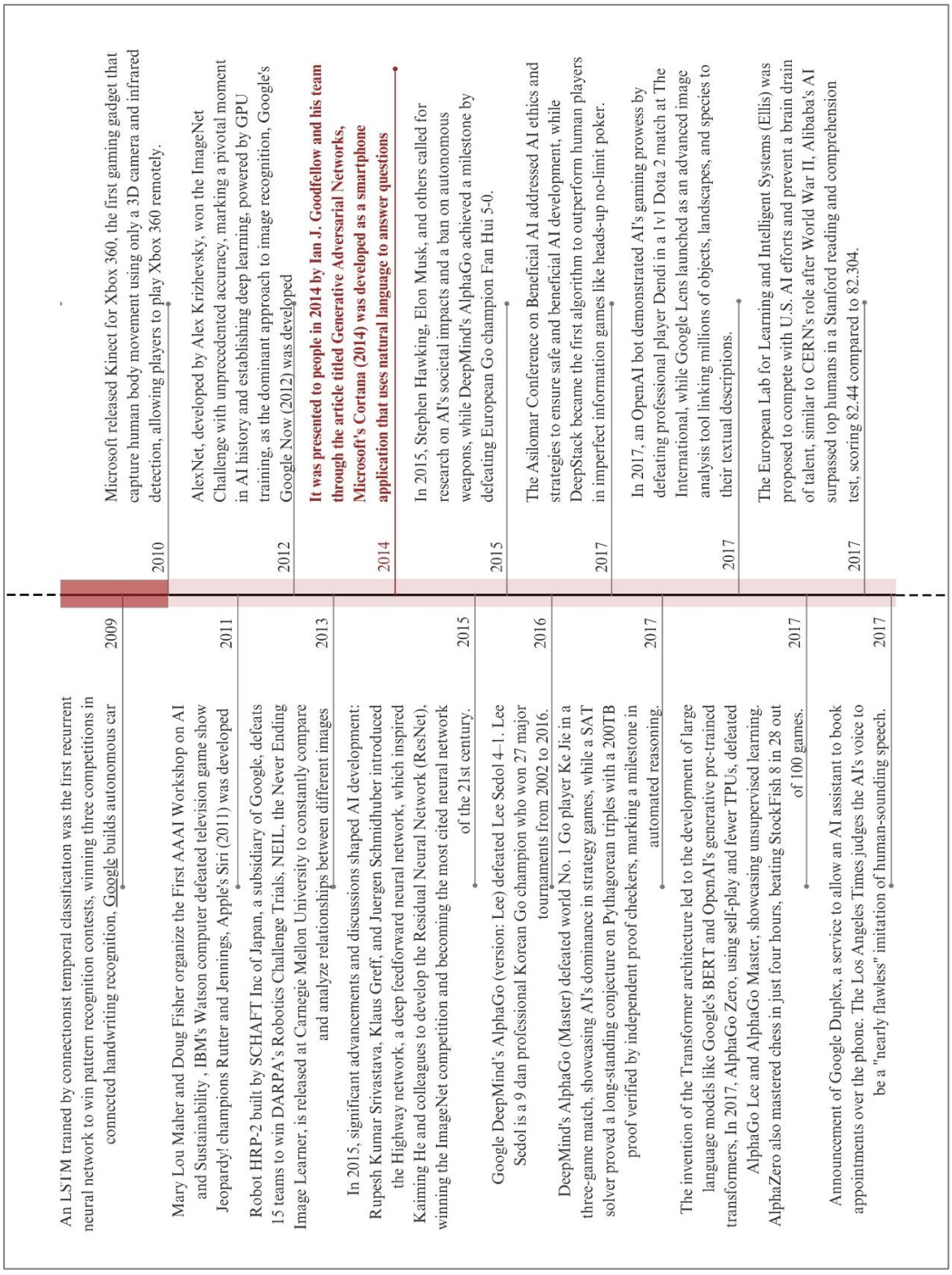


Figure 2.5. (Contiuned) Timeline showing the historical development of artificial intelligence as of the beginning of the 19th century

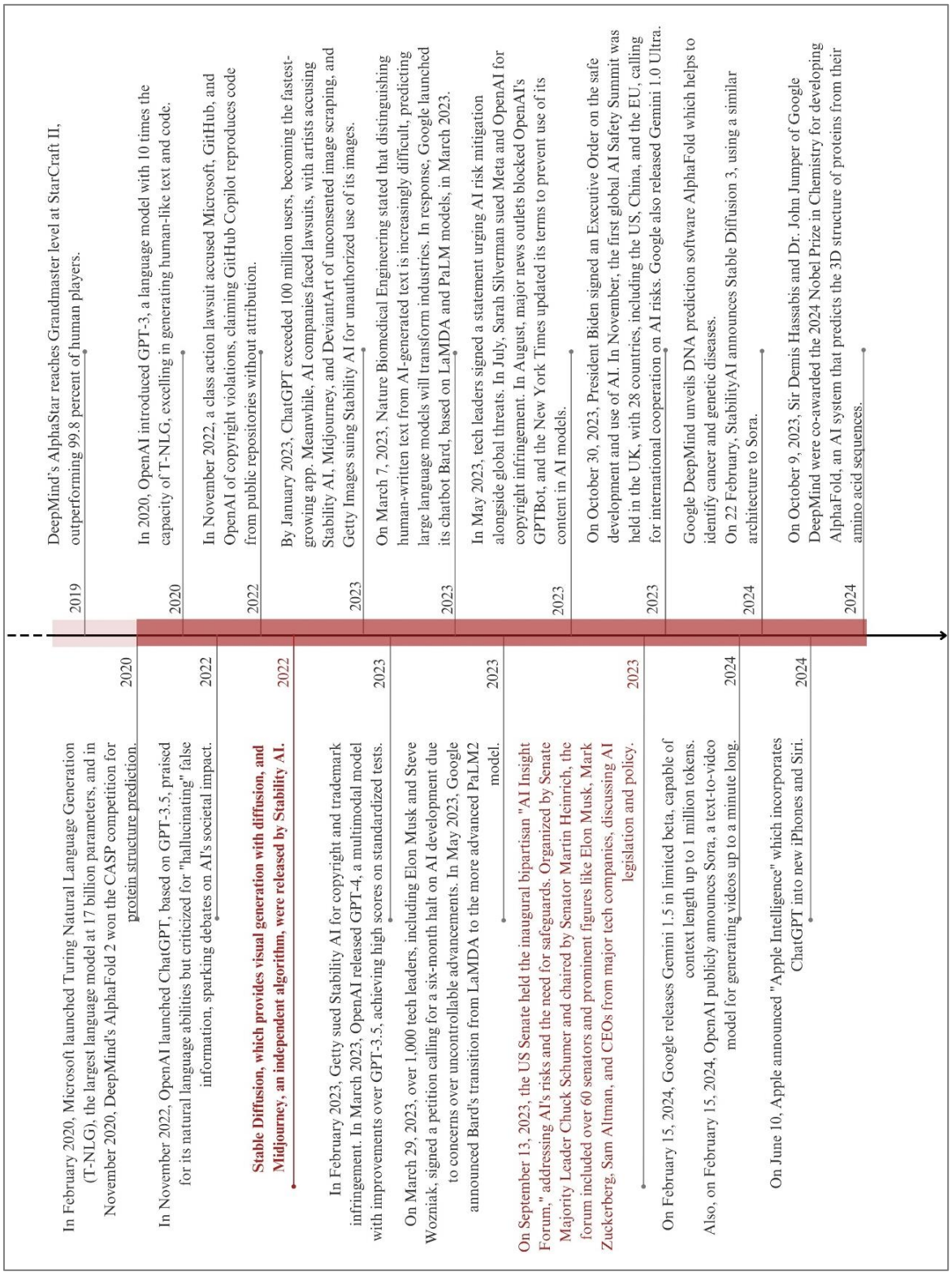


Figure 2.5. (Contiuned) Timeline showing the historical development of artificial intelligence as of the beginning of the 19th century

In Figure 2.6., from 1940 to 2024, the critical developments related to artificial intelligence in the extended timeline are shown in 10-year periods. According to this graph, developments in the last 20 years have increased compared to the 20th century.

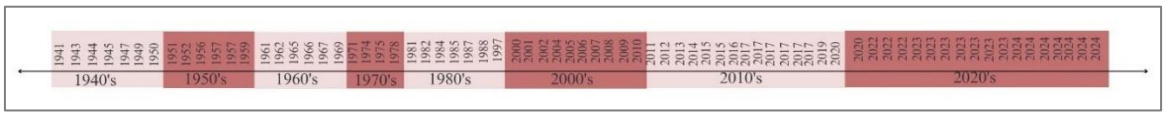


Figure 2.6. Timeline showing developments in artificial intelligence between 1940 and 2024

Turing's work has pioneered today's artificial intelligence studies by revealing both the practical and theoretical aspects of machines and AI, showing that universal computation is possible (Coşkun, 2024). The Turing test is when the experimenter knows which of the two subjects, a computer, and a human, gives which answer. If the subject matches the answers correctly with the subjects, the machine is considered to have learned from human actions and passed the test (Karabulut, 2021). Russel and Norvig (2010) stated that a computer must meet the following six criteria to pass the Turing test.

- Natural language processing: communicating successfully in a chosen language.
- Knowledge representation: storing what the computer knows or hears.
- Automated reasoning: using stored information to answer questions and draw new conclusions.
- Machine learning: adapting to new conditions, detecting and predicting patterns.
- Computer vision: the vision needed to perceive objects
- Robotics: manipulating and moving objects.

Following these criteria, Russel and Norvig (2010) analyzed artificial intelligence studies from Turing's “imitation game” test to the 2000s in 4 different classes (Table 2.1)

Table 2.1. Classification of AI according to Stuart Russel and Peter Norvig (Russell ve Norvig, 2010)

Artificial Intelligence Studies Developing After the Turing Test		Group
Automation of activities we associate with human thinking, such as decision-making, problem-solving, and learning	Bellman, 1978	Systems that think like humans
Exciting new efforts in thinking computers – mental machines	Haugeland, 1985	Systems that think like humans
Examining mental skills using computational models	Charniak and McDermott, 1985	Rational thinking systems
The art of creating machines that perform functions that would require intelligence when performed by humans	Kurzweil, 1990	Systems that behave like humans
The study of how computers can do things that humans are currently better at	Rich and Knight, 1991	Systems that behave like humans
The study of computations that enable perception, reasoning, and action	Winston, 1992	Rational thinking systems
Using computational intelligence is to explain and study the design of intelligent behavior.	Poole et al., 1998	Rational behaving systems
Artificial intelligence is about artificial intelligence behavior	Nilsson, 1998	Rational behaving systems

In 2014, the first Generative Adversarial Networks (GAN) studies were presented to the public in a paper by Goodfellow et al. (Kopuz, 2022). The focus of GANs (Generative Adversarial Networks) is to generate data from scratch, primarily for image generation, but these networks can operate in many different fields, including music (Hui, 2018).

The first version of OpenAI's GPT (generative pre-trained transformer) model was released around 2020, and these new transformer models are called big language models. Large language models are trained to cover open-access online resources such as Wikipedia, which provides a significant source of textual data and can respond to the user based on the linguistic information in the data source (Coskun, 2024).

2.2.1. Current uses of artificial intelligence tools

The areas of use of artificial intelligence are expanding day by day. Since the 2000s, users have increasingly adopted artificial intelligence-based technologies (Russel and Norvig, 2016). AI is used in many areas, such as data analysis, recommendation engines, and automatic simulations (McCorduck 2004). With the development of AI tools, tasks such as managing calendars, detecting natural languages, using sensor devices, and managing spatial automation can be performed without human intervention (Galbusera et al., 2018). However, studies in the literature emphasize risks related to using artificial intelligence, especially in labor and ethical issues, and these changes need regulatory compliance processes (Gölgelioğlu, 2023). Figure 2.7. shows the current usage areas of AI tools and compares human performance and AI performance.

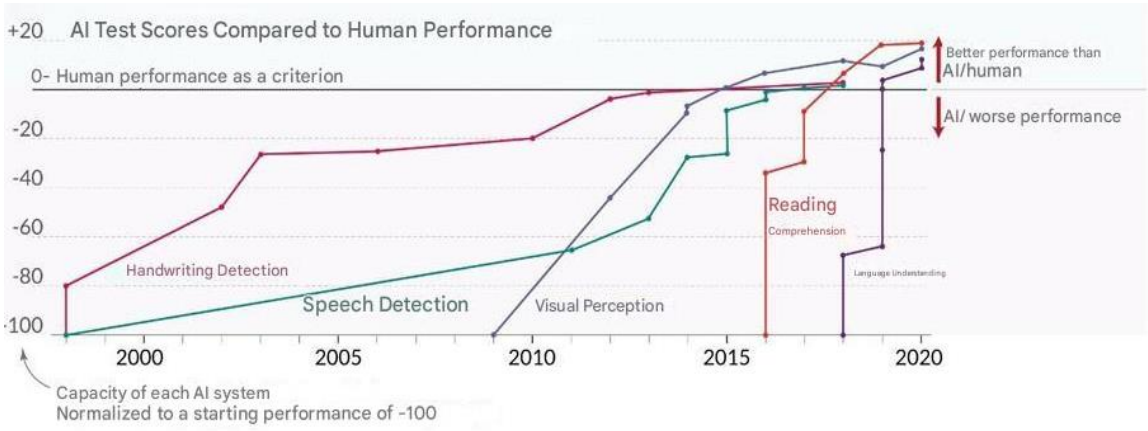


Figure 2.7. Areas where artificial intelligence is used, Comparison of artificial intelligence and human performance in multitasking (Giattino et al. 2023)

2.2.2. Development of artificial intelligence applications in design

With the rapidly transforming nature of the modern world, design practices and the architecture sector are also transforming ((Jaruga Rozdolska, 2022). With the developing technology in architectural education, methods involving the designer's participation and using available technological tools are becoming widespread (Akansel and Şuta, 2022). Scientific and technological developments have led to paradigmatic approaches in many fields, including the discipline of architecture (Arslan Selçuk and Mutlu Avinç, 2022). The adaptation process of architecture to the information age is taking place with a rapid change in the context of tools, methods, and cognitive processes, and the adaptation of digital and

innovative approaches to design processes and architectural design pedagogy has become mandatory (Bayram et al., 2023).

With the developing technology, designers started to act and produce with approaches such as “standardization” and “fabrication” since the 1920s; these phases include examples of intervening in the design process for the first time and developing a systematic (Mun and Arslan Selçuk, 2018).

In mid-2021, text-driven generative AI tools such as DALL-E and Midjourney made it possible to produce rapid visual productions (Radhakrishnan, 2023). According to Chaillou (2020), AI has the potential to become a powerful auxiliary tool for architecture in the future, even though it is not yet developed enough to meet the needs of architectural design, which is a complex process. Today, thanks to AI tools, anyone without a design background can create various visual design products (Sindhura and Abdul, 2021).

2.2.3. Generative Artificial Intelligence tools

Generative AI refers to deep learning models whose models can “learn” to produce statistically probable outputs when prompted given raw data; at a high level, generative models encode a simplified representation of their data and leverage it to create a new work that is similar but not identical to the original data (IBM, 2024).

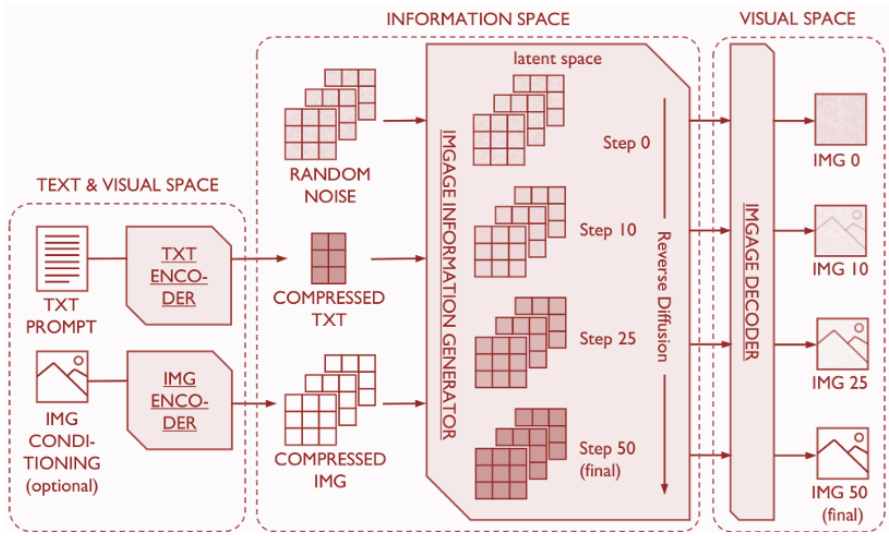


Figure 2.8. Flowchart of the forward diffusion process in generative AI models (Mancini and Moncenero, 2023)

Generative artificial intelligence (genAI) tools are artificial intelligence tools that transform text, images, video, and other production objects to serve new wholes using their existing data (Figure 2.8.). During production with GenAI tools, the process of decomposing the existing data by removing noise/distortions and generating a new result from the existing pixels on demand is called forward diffusion (Mancini and Moncenero, 2023). Figure 2.8. shows the workflow of this process. Figure 2.9. shows the collaboration with ChatGPT, the language model of Midjourney, a generative AI tool.

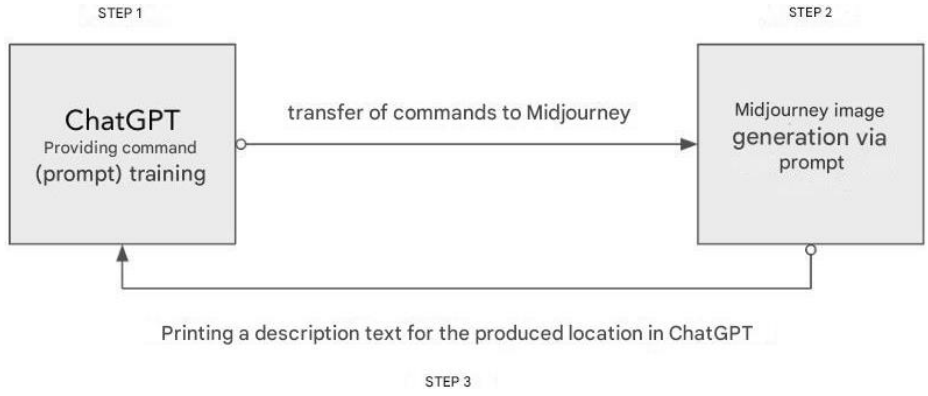


Figure 2.9. Use of generative AI (Gölgelioğlu, 2023)

Table 2.2 shows the production processes of genAI tools with five different principles and some AI tools that produce this type of production.

Table 2.2. Various Generative Artificial Intelligence based manufacturing process

Process	Explanation	Example Tool
Text to Image	Visuals are created based on textual descriptions combined with other functions.	DALL-E Stable Diffusion
Image to Image	An input image is transformed to provide the characteristics of the target image. Examples of this process include object manipulation, color changing, and increasing image resolution.	Vizcom AI Playground AI
Image to Video	It creates a video animation from an existing image with textual instructions.	Leonardo AI Runway AI
Text/Image to 3D	Examples of this process include creating point clouds, textured meshes, or 3D models with text orientations.	Point-E Shape-E
Image to text	It is obtaining textual description from an existing image through natural language models.	Midjourney Chat GPT

2.2.4. Generative AI tools with text prompts

DALL-E, the first of the three text-driven generative AI tools that perform generation by forward diffusion, was accessed by OpenAI in 2021 (Ramesh et al., 2021). Unlike AI tools that are trained to predict the output "y" with input "x," text-driven AI tools use pre-trained language models to transform the raw text, input "x," to produce the final output "y" (Liu et al., 2023). One of the pioneers of text-prompted generative AI tools is Chat-GPT, an AI tool produced by Open-AI, a text-prompted text output AI tool that provides quick answers to questions in daily life (Lee et al., 2023).

Generative AI models can collect and transform daily data, expanding the learning capacity of students (Lee et al., 2023). Generative AI (GenAI) uses a variety of media, such as text, graphics, audio, and video, to automatically generate new content through generative modeling, which is made possible by astonishing advances in deep learning technology (Jovanovic and Campbell, 2022). Stable Diffusion, one of the earliest examples of these tools, includes outpainting, which is the ability to extend and complete the outer frame of an image, and inpainting, which is the ability to make visual edits to selected regions within the image. Two early examples of text-driven generative AI tools are DALL-E, produced by Open-AI, and Midjourney, MidJourney, which is developed in an independent laboratory is a generative software system developed by a team of programmers led by David Holz based on the Phyton high-level programming language, with the ability to generate digital images based on inputted text parameters. The MidJourney generative tool and the similarly developed DALL-E, NightCafe, Wombo Dream, or Latent Majesty Diffusion can generate highly aesthetic digital images based on text output or a web link to a digital image (Jaruga Rozdolska, 2022). DALL-E has been trained with approximately 650 million image-text pairs from the Internet (Ramesh et al., 2022). While DALL-E aims to produce more realistic images, Midjourney is preferred by artists for its high-quality, surreal conceptual images (Borji, 2022). In the process of using these tools in design, factors such as the visual database of the genAI tool and the natural language model it works with affect the quality of the final product (Yaşar et al., 2024).

2.2.5. Prompt literacy

The genAI tools used in the study are AI tools that aim to produce a visual, textual, and animated output with a given text prompt. The ability of these tools to provide the most appropriate output to the given prompts is related to the fact that they are trained with natural language models (Liu et al., 2020). Although AI models that work with text prompts are related to the language usage, comprehension, and interpretation skills of large language models, some issues need to be improved regarding the ability of these models to interpret text (Kasneci et al., 2023). In these processes, which aim to produce qualified visual output with textual input, artists search for ways to increase visual quality. At this stage, the quality of the visual product is directly related to the textual input. This relationship has brought along the concept of "prompt literacy" using GenAI tools in design fields.

The "semiotics" and "conceptual thinking" processes were investigated to understand better the relationship between textual and visual thinking and concept-visual. Semiotics tries to understand signs by addressing their symbolic structure, meaning, meaning production, and interpretation; the action here is the interaction between the signifier and the word, resulting in meaning (Özeren, 2023).

2.3. Design Process and Creativity

The design process evaluates the designer's design philosophy and experiences with the solutions available in the social value system; the productive process in design is structuring abstract ideas in the mind with concrete expressions (Akgün, 2002). Creativity is a cognitive skill that has emerged as a new, original, skill-based product or has not yet turned into a product, includes a unique problem-solving process, and uses one's intelligence elements for originality and production (Aslan, 2001). However, creativity in architecture is about producing a new and valuable result and applying one's creative skills during the creative design process (Paananen, 2023).

Murahari et al. (2022) referred to the situation where the creativity levels of human and artificial intelligence are influenced by each other as "artificial creativity" when AI tools and designers work together. Guo et al. (2023) evaluated artificial intelligence applications

as “creative” because the productions realized by artificial intelligence are indistinguishably close compared to human-produced works.

Creativity is the creation of a new form or a different interpretation of an existing form. Mitchell, Inouye, and Blumenthal (2003) argue that creativity plays various roles in other times and places and is directly related to culture.

2.3.1. Design and creative thinking in architectural education

According to many researchers, design is a problem-solving process; for some researchers, it is a process of decision-making; for others, it is a process of trial and error (Önal, 2011). Architecture is a dynamic profession open to constantly changing innovations (Lökçe, 2002). In the last fifty years, many artists have included painting, sculpture, and cinema in their architectural works, and many architects have started to interact with visual arts (Al Şensoy and Özdemir Işık, 2018). In addition to its relationship with other visual arts, architecture is also in a relationship with all kinds of tools and fields that can be used in design and its representation.

The approach, which is tried to be explained with the concepts of “hands-on learning” and “learning by doing” in the literature, is a design education approach that aims for students to learn by doing and building rather than representation-based productions in architecture (Toy and Gökmen, 2023). In design studios, design students are in a unique educational environment based on the traditional “learning while doing” (Akdağ, 2017). In this thesis, the concept of “hands-on learning” in architecture is considered the experience of digital representation tools, and the concept of “learning by doing” is regarded as the transformation of the design process during the experience of applications.

Tschumi (2013) explained the role of visual media in architecture in a lecture: “It is not the images that matter, but what the images do.” Since architecture, as part of contextualized creative practice, can be seen as a field that communicates through images, what matters is the impact of the photos and what kind of political and social effects they have (Paananen et al., 2023). In other words, the ability to create design in architecture depends on the ability to express design.

2.3.2. Use of artificial intelligence in education

While technology causes a significant change in all areas of life, a similar change is expected in education and training processes (Akgün, 2019). Technological opportunities in education have become widespread with the developments, especially after the pandemic due to the COVID-19 effect, and the integration of technology and artificial intelligence tools into education has accelerated (Güzey et al., 2023). Although there are different approaches to using AI in design, these approaches are not designed with the primary aim of learning to increase creative thinking and productivity in the long term.

Examining the integration of AI technologies into the educational environment is critical. The combination of pedagogy and AI can provide opportunities to extend creative learning in disciplines traditionally associated with creativity, such as art, design, or business. AI may offer some advantages in these processes (Lim et al., 2023).

While AI models in education offer promising developments to enhance the learning experience, it is essential to consider these models' limitations and potential biases in combination with these advantages (Kasneci et al., 2023). The relationship between artificial intelligence and education has developed in recent years and accelerated the inclusion of artificial intelligence products in education and training processes (Yağcı, 2024). Although the applications of artificial intelligence technologies in education and management are increasing, it remains unclear what advantages these technologies will offer to educators, students, parents, and teachers, so examining the advantages and disadvantages of artificial intelligence tools and gaining awareness about the negative aspects will enable more beneficial use of artificial intelligence in education (Güzey et al., 2023).

Artificial intelligence in educational processes is information processing systems that perform human actions such as education and training, adaptation, synthesis, self-regulation, and use (Güzey et al., 2023). While the use of artificial intelligence tools in education is increasing day by day, the use of these tools improves the efficiency of design courses and students' learning experience (Huang et al., 2021).

According to Noe (2009), the factors that make artificial intelligence different and unique from other technologies utilized in educational processes are as follows.

- The educational process meets the personal expectations of the student,
- Responding to the student's questions as a result of effective communication
- The ability of the student to model the learning process one-on-one,
- Identifying the information needed according to the student's past performance,
- Making student-specific decisions about the level of learning,
- Determining the results of the education and training process.

Güzey et al. conducted a comprehensive literature review in 2023 and examined the distribution of the studies in the literature on education. As a result of this study, it is stated that the use of computer technology and artificial intelligence technology in education/training can improve the quality of education.

2.3.3. Use of artificial intelligence in creative processes

There is a strong relationship between the historical development of art and technological transformation; with the advancement of technology, new techniques and materials have begun to be used by artists, and forms of expression and creative thinking processes have transformed with this development (Sarıca, 2023). While this transformation has expanded the boundaries of art, it has also provided artists with opportunities for new experiences and discoveries (Kızılaslan and Ismailoğlu, 2021). While the world is in constant change, art is not static, and artistic processes show a parallel development with the intellectual development of human beings. Creative expression started in the past by drawing pictures on cave walls and continues today with different methods (Süzen, 2017).

Definitions of creative thinking and designing, which have a complex background, have diverged from their existing definitions by integrating computers and other digital tools that come with computers into these fields. Creativity is an interdisciplinary research topic (Kaufman and Sternberg, 2019). According to some researchers, creativity is the ability to produce something valuable and new with a prerequisite of domain knowledge and experience (Ericson, 2002). In creative processes, designers often look for various sources of inspiration, such as photographs, artworks, and artificial or natural objects (Keller et al., 2006). These external sources of inspiration can contribute to creative thinking by providing forms, materials, patterns, colors, or textures that stimulate designers' imagination (Eckert

and Stacey, 2000). There is a view that computer-based technologies facilitate the expansion of the designer's imagination and the emergence of more original designs. Still, various criticisms exist that digital production and representation tools in creative processes reduce the design process to a visual image (Pallasmaa, 2007).

According to Eckert and Stacey (2000), almost all designs result from transforming, adapting, and combining elements of designs and ideas created in the past.

> In design processes, computers have been involved in many roles such as creating only a digital copy of the representation of the design object, enabling the design and representation to be thought together, supporting the decisions to be taken in the design process, focusing on a specific problem and producing solutions, using existing data and storing the data produced to create a new design (Terzi, 2023).

With the advancement of technological developments, the role of computers in design processes has expanded with the development of algorithms and auxiliary tools. With the beginning of the computer-aided design process, designers met with the virtual drawing environment, and the next stage of this change was artificial intelligence-supported design applications (Avcı and Kavut, 2024).

Yu (2016) states that digital art offers a new perspective on human history. "*There is a need to explore the roles of AI in creativity development, in line with theories on sociocultural perspectives of creativity where creativity is seen as a phenomenon emerging from a complex learning system*" (Sawyer, 2015). Some studies argue that with the developments in computer science and changes that can be made in art education, mixed method works can be accepted as works of art (Leonard, 2020). On the other hand, Mikel Arbiza Goenaga's 2020 research argues that works produced with such hybrid methods should be evaluated in a different context as "contemporary artworks" and that human and machine creativity should be reconsidered.

Nowadays, it is inevitable to establish a link between machine creativity and art; this is similar to the emotional and social goals that artists have when creating art, but this link should not be thought of as connecting two opposing elements; by thinking of the two concepts in relation, the creative potential of both parties can be maximized, and a coordinated link between human and machine creativity can be established when necessary

(Mazzone, Elgemmal, 2019). According to Boden (2020), artworks are based on human interactions and human traces. AI, which processes data obtained from human actions through algorithms and learns from human production in the context of artificial creativity, potentially contains an element of creativity (Erten and Göktepeliler, 2022). According to Liu (2020), the creative transformation of art can be facilitated by intertwining science, technology, and art.

With these technological developments in the modern world, the use of new technologies and artificial intelligence-based automation applications in architecture, as in other design fields, has become widespread in areas such as performance evaluation, optimization of structural solutions and assembly process, parametric design, architectural form creation, 3D modeling and print production (Jaruga-Rozdolska, 2022).

Akdoğan and Balaban (2022) conducted a study based on training generative adversarial networks using ready-made architectural plan models and generating new plans concerning the data.

Designers need help from time to time in their work. In contrast, designers deal with the creative part of the work, and artificial intelligence lightens the workload by speeding up the visualization processes, thus saving designers extra time in their work (Teixeira, 2017). Design processes are multi-stage processes that include different stages, such as sketching, modeling, and representation. Generative AI tools currently collaborate with the designer in various applications of these processes.

Autodraw (Figure 2.10), developed by Google and based on the principle of artificial intelligence and machine learning based on converting simple sketches made by the user into linear drawings, is an example of a plug-in used in the field of sketching (Artut and Kanat, 2024).

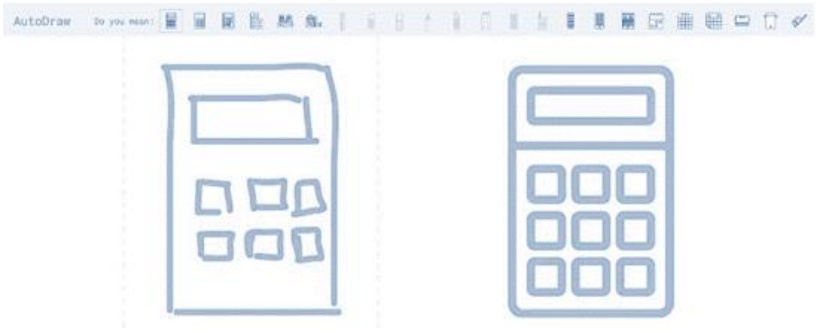


Figure 2.10. An example by AutoDraw (Artut and Kanat, 2024)

The exhibition “Unsupervised - Machine Hallucinations,” which Refik Anadol created in 2021 from various types of images and texts in the museum collection, features digital sculptures produced in collaboration with complex generative artificial intelligence systems (Coşkun, 2024) (Figure 2.11).



Figure 2.11. Refik Anadol, Uncontrolled-Machine Hallucinations Exhibition, MOMA. (https://refikanadol.com/works/unsupervised/)

Artificial intelligence programs have different features such as generating images from text, generating text from images, generating and developing variations of existing images, transforming the abstract design image created intuitively into photorealistic images produced through word clients, and different possibilities emerge for the concretization of

the image through the act of drawing (Yıldırım and Kavut, 2024). Figure 2.12 shows abstract forms produced with artificial intelligence tools and models made in a physical environment.

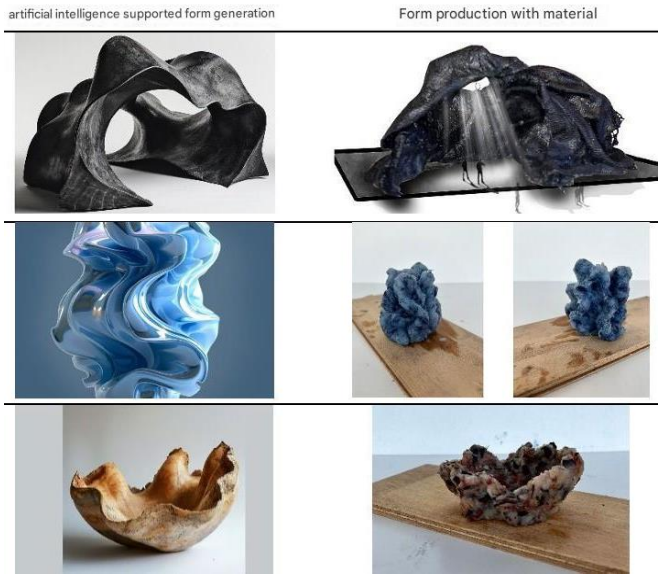


Figure 2.12. Examples from Midjourney and physically produced forms (Bayram et al., 2024)

AICAN, which works with a system that produces new artworks by adapting existing artworks but penalizes itself when it finds the level of originality insufficient, was developed by Elgammal and his team to increase the ability of artificial intelligence to produce creative content (Aydın, 2024) (Figure 2.13).



Figure 2.13. AICAN + Ahmed Elgammal, Faceless Portrait of a Scientist, 2018 (Aydın, 2024)

Today, artificial intelligence can produce different visual outputs through various algorithms. In contrast, artificial researchers have different predictions about what the results and effects of using artificial intelligence in design fields may be in the future (Sarıca, 2023).

Figure 2.14. shows the steps of the traditional approach in the design process. According to Cudzik et al. (2024), actions that require physical action, such as sketching, visual and physical models, and literature review, are the steps of the design process. While these steps could be realized with more significant physical labor in the past, today, they can be realized with more digital methods and in shorter periods.

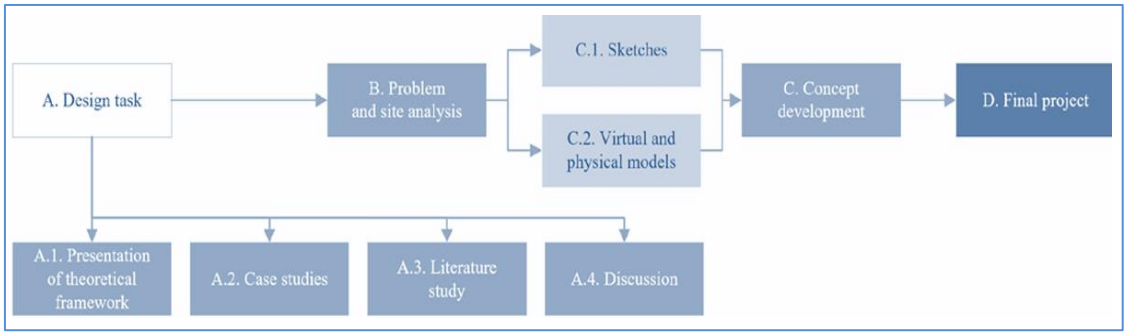


Figure 2.14. Traditional approach to the design process. (Cudzik et.al., 2024)

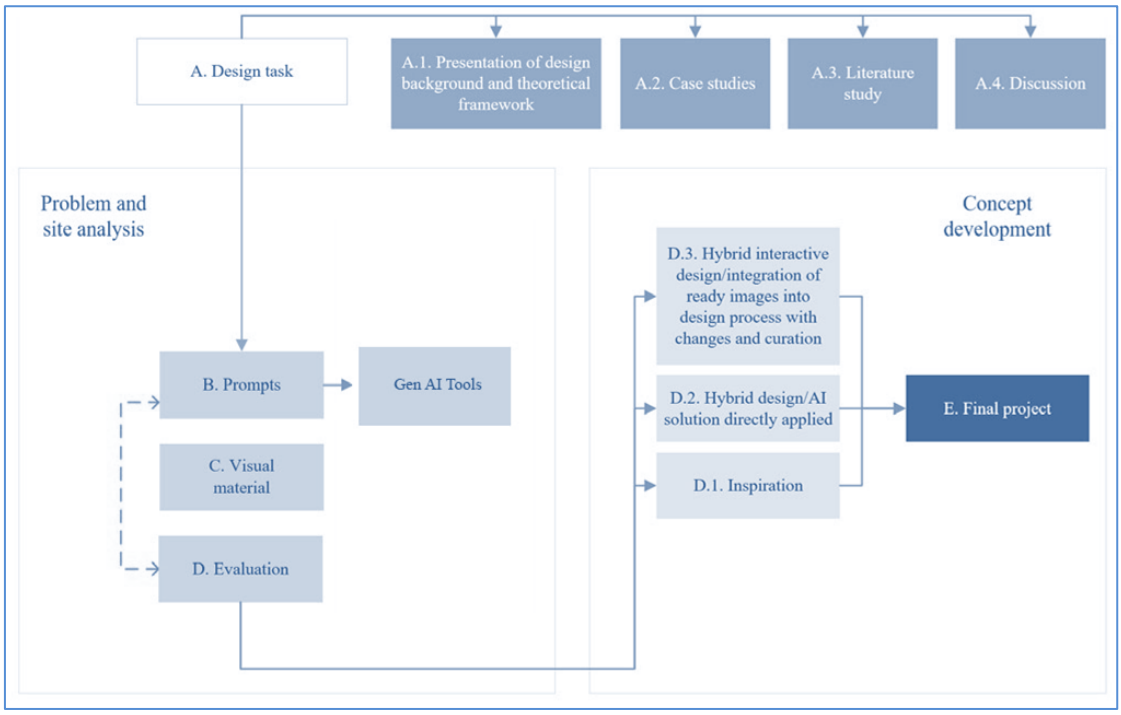


Figure 2.15. Approach to the design process supported by AI tools. (Cudzik et.al., 2024), (edited by author).

Figure 2.15 shows the approach of Cudzik et al. (2024) to a design process based on using five different artificial intelligence tools. When these two diagrams are examined, it is seen that the sketching and modeling steps are replaced by prompt generation, visual material generation, and evaluation steps.

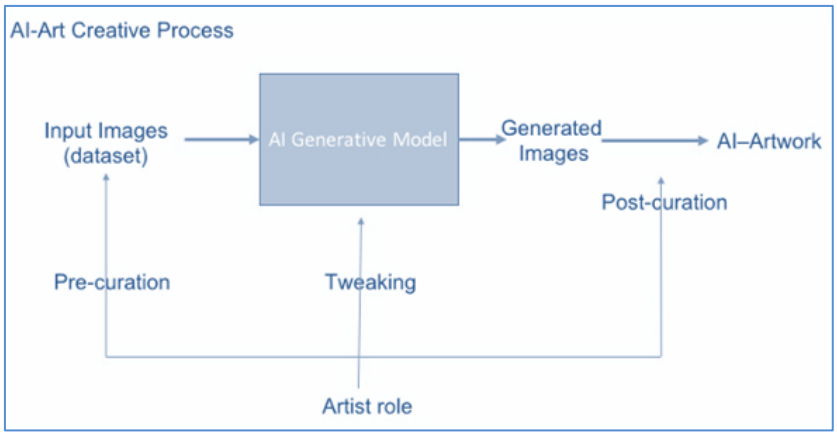


Figure 2.16. A block diagram showing the artist's role using the AI generative model in making art (Elgammal and Mazzone, 2019).

Figure 2.16. Shows the role of generative AI tools in creative processes and their relationship with the participants.

2.3.4. Visual production with collage technique

The collage technique has been used in painting since the early 20th century. Although the collage technique, whose pioneers include Picasso and Braque, began to be used intensively in the early 20th century, it is possible to see examples of the cutting and pasting action that forms the basis of the technique throughout the history of art (Çağlayan, 2018). The use of the collage technique in painting has been driven by 20th century developments that encourage different forms of perception and vision between space-artwork-viewer instead of searching for "beauty," and where the concepts of multidimensionality, movement, and space come to the fore (Süzen, 2017). The word collage derives from the French word "coller," meaning bringing together, combining, or gluing. The collage technique in the art of painting is the gluing of various materials, such as writing, newspaper pieces, textile patterns, etc., which have different qualities from each other, on the ground in a way that provides a whole with new meanings (Süzen, 2017). The collage technique gained a new discourse with the cubism movement with Picasso and Braque and became a technique used

extensively by Dadaist artists (Akman, 2020). Figure 2.17. and Figure 2.18. show examples of collages produced under the influence of Dadaism and Cubism movements.

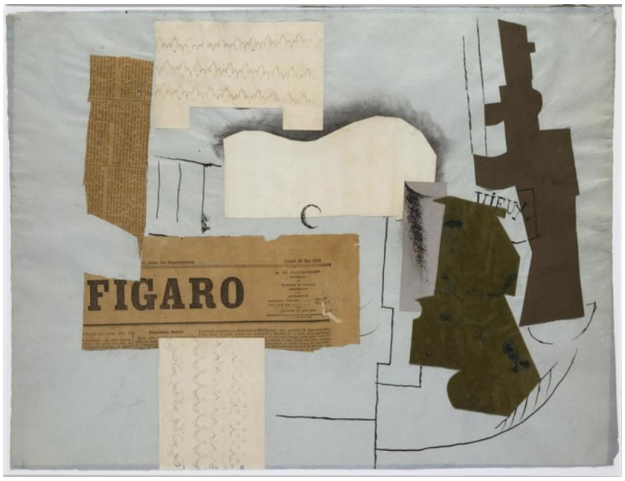


Figure 2.17. Bottle of Vieux Marc, Glass, Guitar, and Newspaper - collager by Picasso, Weiner Elementary, Tate Images (2024).

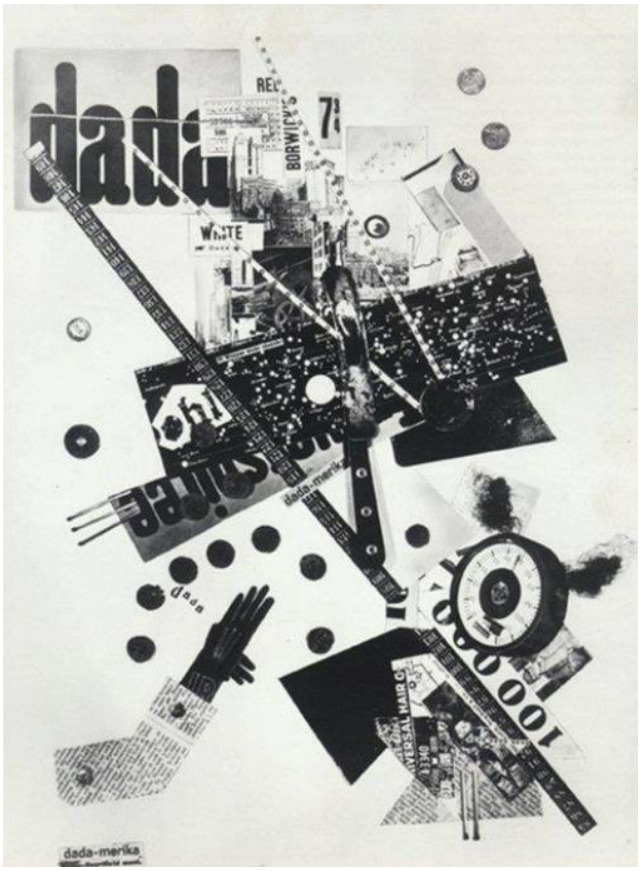


Figure 2.18. Dada-Merika, Kolaj (George Grozs ve John Heartfield, 1920 cited by Akman, 2020)

Following the Dadaist artists, Surrealist artists in the 1920s also realized collage works dominated by irrational, surreal, and random principles, and names such as Salvador Dali and Max Ernst were among the prominent figures of this movement (Akman, 2020) (Figure 2.19 ve Figure 2.20).



Figure 2.19. Celebes (Turpin, 1979: 26)

After Cubism, Dadaism, and Surrealism, the collage technique was also used in the Pop Art movement. Hamilton's “What Makes Today's Houses So Different and Attractive?” (Figure 24), seen in Figure, is one of the works with a strong expression of the Pop Art movement (Beyoğlu, 2015).



Figure 2.20. Richard Hamilton, “What Makes Today's Houses So Different and Attractive?”, 1956, 26 x 24,8 cm, Tübingen, Kunsthalle (Cumming, 2008, s. 440)

2.3.5. Digital collage

Unlike the painting technique that has been shaped with brushes and paints for many years, the collage technique, in which ready-made images and objects are pasted on the canvas surface, has changed the perception and plastic possibilities against the visual elements in painting in modern art; however, with the digital culture brought by the advancing technology, the digital collage technique, in which the visual manipulation technique is applied in virtual environments, has emerged (Soner, 2024). With the opportunities that came with the development of digital tools, the visual components used in collage work have become rapidly accessible and reproducible products, and thanks to computer tools, these objects can be easily transported to digital environments (Yıldırım, 2019).

Traditionally realized using paper, scissors, and glue, the collage process can now be prepared with computer simulation, creating a new environment for contemporary art and architecture discussions (Aksu et al., 2008: 336). Digital collage, seen as a technique that supports creativity for designers, is becoming widespread with technological innovations (Turan, 2018, 86). Computer programs such as Photoshop, Illustrator, and various phone applications are used during digital collage production (Figure 2.21).



Figure 2.21. Digital collage works produced by collage artist Selman Hoşgör (Akman, 2022).

After using digital tools such as Photoshop and artificial intelligence in digital arts, collage experiments with these tools have also started to be realized (Figure 2.22).



Figure 2.23. Minimalist and modernist furniture, ash wood, lilac color palette, interior design bedroom concept collage, mood board, grid style, cut, and pasted elements -v 6.0- made with AI, (Avcı and Kavut, 2024)

2.4. Methodological Review of Selected Papers

When the studies conducted with the practice-led method on the use of GenAI tools in the field of design are examined in the literature, it is seen that there are a limited number of studies of this nature. These studies are analyzed in tables to identify methodologically similar and different aspects.

Tong et al. (2023). (Table 2.3), in the article titled "Can AI Function as A New Mode of Sketching," conducted an orthographic drawing and visual production study with a group of 1st-year students within the scope of a Visual Communication course.

Table 2.3. The methodological analysis of "Can AI Function as a New Mode of Sketching."

Input/ Output	3d object	→ortogpraphic sketch	→ spatialization
	Visual	→ visual	→ verbal → visual
Analog/ Digital	Analog		Digital
	Combine-draw		Text-image
Participant/AI	Participant		Participant+ AI

Kavakoğlu et al. (2022), in a study titled "AI-Driven Creativity in Early Design Education: A Pedagogical Approach in the Age of Industry 5.0", conducted a facade analysis study with a group of students in the early stages of design education (Table 2.4.). Some specific facade

images were given to the students as initial input; students visualized the details they found memorable in these facades through sketches, then these images were grouped, and a secondary data set was created.

Table 2.4. Methodological analysis of "AI-Driven Creativity in Early Design Education: A Pedagogical Approach in the Age of Industry 5.0"

Input/ Output	Facade Picture →sketch → sketch (Visualizing with AI)			
	Visual → visual → visual → visual			
Analog/ Digital	Analog + Analog + Digital			
	Drawing/data collecting → Drawing/data collecting → Teaching to machine			
Participant/AI	Participant	Participant	Participant+ AI	(stylegan2-ADA)

Lim et al. (2023), in a study titled "Artificial Intelligence As Relational Artifacts in Creative Learning," conducted an application that involved the comparison of sketches drawn by a group of students and artificial intelligence product sketches containing a robotic arm trained with an ML algorithm by educators. The production processes were video recorded and part of the evaluation (Table 2.5).

Table 2.5. Methodological Analysis of "Artificial Intelligence As Relational Artifacts in Creative Learning"

Input/ Output	3d object→sketch →Sketch with AI (robotic arm and ML algorithm) →Evaluation		
	Visual → visual → visual → verbal		
Analog/ Digital	Analog, Digital, Analog		
	Drawing/data collecting → Drawing/data collecting → Quantitative evaluation		
Participant/AI	Participant	AI	Design professors

Jaruga Rozdolska (2022). "Artificial intelligence as part of future practices in the architect's work: MidJourney generative tool as part of a process of creating an architectural form," used the text-prompted AI tool Midjourney to generate images of an underwater conceptual space with keyword groups describing selected architectural elements. The second students and the AI were asked to produce sketches reflecting an architect's style; the visual outputs were analyzed comparatively, and it was observed that the sketches made by the AI had inconsistent perspective ratios.

Table 2.6. The methodological analysis of "Artificial intelligence as part of future practices in the architect's work: MidJourney generative tool as part of a process of creating an architectural form."

Input/ Output	Keywords →digital collage		Sketch → Sketch with AI (Visualizing with AI)	
	Verbal → visual visual		Visual	Verbal → visual visual
Analog/ Digital	Analog + Digital			
	Drawing/data collecting → collecting keywords → Teaching to the machine.			
Participant/AI	Participant	Participant	Participant+ AI	

Vartiainen and Tedre (2023), in their study titled "Using Artificial Intelligence In Craft Education: Crafting With Text-To-Image Generative Models," conducted a workshop in which 15 craft educators participated (Table 2.7). These instructors were first introduced to the interface of the Midjourney tool, and then, using this tool, they were asked to visualize their design productions, which they usually make analogically under normal conditions, by describing them textually to the artificial intelligence tool. After the workshop, the instructors were interviewed. The participants agreed that the designs made with Midjourney could not be considered sufficient and that they had ethical concerns.

Table 2.7. Methodological analysis of "Using Artificial Intelligence in Craft Education: Crafting with Text-to-image Generative Models"

Input/ Output	Keywords →digital collage
	Verbal → Visual → Visual
Analog/ Digital	Analog + Digital
	collecting keywords → Teaching to machine
Participant/AI	Participant + AI

Paananen et al. (2023), in their study titled "Usıng Text-To-Image Generation For Architectural Design Ideation," conducted a laboratory study aiming to measure the level of creativity in the creative production of 17 architecture students using artificial intelligence tools that generate images from text (Table 2.7). In each step of the 3-stage study, three different AI tools, Midjourney, DALL-E, and Stabble Diffusion, were used. Participants' gender, age, professional experience, and knowledge of the AI program they used were evaluated as factors affecting creativity.

Table 2.8. Methodological analysis of "Usıng Text-To-Image Generation for Architectural Design Ideation”

Input/ Output	Keywords →digital collage
	Verbal → Visual → Visual
Analog/ Digital	Analog + Digital
	collecting keywords → Teaching to machine
Participant/AI	Participant + AI

Sarıca (2023), in his study titled “Experimental Design Workshop of Artificial Intelligence Applications,” conducted with a group of Visual Communication Design students, asked the students to visualize the story fiction they prepared through sketching and with the help of AI tools (). The students took a city walk and brought photographs of various objects they had taken during this walk to the workshop. They constructed a story based on these photos, and based on this story, they made multiple sketches and AI-supported visualization studies. At the end of the process, the instructor evaluated these workshops based on student reports and productions.

Table 2.9. Methodological analysis of "Integration of Artificial Intelligence Applications into Experimental Design Workshop Courses: Evaluation from a Student Perspective”

Input/ Output	Photograph → Story → Sketch → Visualisation w/AI
	Visual → Verbal → Visual → Visual
Analog/ Digital	Digital+ Analog+ Analog+ Digital
	collecting objects, selecting keywords → Teaching to machine → Quantitative evaluation
Participant/AI	Participant+ AI

Şen Bayram et.al., (2024), “A Proposal for a Material-Focused AI Supported Design Process: From Natural Material to Artificial Intelligence,” a group of Architecture, Interior Architecture, and Yacht Design students worked together to produce a form (Table 2.10). An AI collaborative visualization study was conducted where the participants were asked to define an attribute, and the word groups that provided these attributes were used as input. The students evaluated the form visualizations obtained with AI; after the evaluation, the forms described by the students were modeled in a physical environment, and after these two form production stages, the students were asked to update the definitions and word groups that make up the form.

Table 2.10. Methodological analysis of "A Proposal for a Material-Focused AI Supported Design Process: From Natural Material to Artificial Intelligence"

Input/ Output	Keywords → Image of Form →Pyhsical Form→ Keywords
	Verbal → Visual → Visual → Verbal
Analog/ Digital	Analog+ Digital+ Analog+ Analog
	Collecting keywords → Visualisation with AI →Form modelling→ Editing keywords
Participant/AI	Participant+ AI

Yağcı (2024) conducted a study with graphic design students to measure students' relationship with AI regarding using artificial intelligence tools in design processes. Some survey questions were asked of the students. Students gave the following answers to the survey questions.

Table 2.11. Survey questions about the practices of Yağcı (2024).

For what purpose do you use artificial intelligence applications in the graphic design process?	Number of Students
I do not use	4
Get inspired	11
Make things easier and reduce workload	7
Obtain royalty-free images	2
Save time	2
Improve in design	2
How often do you use artificial intelligence applications in graphic design?	Number of Students
I do not use	4
Rarely	4
Occasionally	3
Regularly	10
What are your favorite features in artificial intelligence applications?	Number of Students
Providing practical work opportunities	9
Providing ideas and inspiration	6
Producing good work, Being productive	6
Saving time by reducing workload	3
What are the features you dislike about artificial intelligence applications?	Number of Students
It dulls creativity and makes one lazy	6
It does not develop enough; It does not produce satisfactory results	3
It is disturbing that it enters every area of life	2

Table 2.11. (Continued) Survey questions about the practices of Yağcı (2024).

Would you say you work with artificial intelligence applications in all your classes? Why?	Number of Students
Yes	9
No	14
It provides ideas and inspiration, and lessons are learned better	6
Artificial intelligence is a part of our lives. It saves time and makes our work easier	4
We need to work with our ideas and imagination	8
Artificial intelligence applications make people lazy and design a single type	3
What do you gain from implementing graphic design with artificial intelligence support?	Number of Students
I do not use it; it does not provide any benefits	2
It saves time by reducing workload; It provides practical working opportunities	14
It provides ideas and inspiration, develops imagination	10
It contributes to making the design more beautiful	4
It provides confidence by eliminating anxiety in the design process	2
It provides different experiences by making the process fun	2

The responses to these questions showed that while most students used AI regularly and for inspiration, many responded that AI tools dulled creativity and provided inadequate end products.

During the literature review, practice-based studies using generative artificial tools were examined. Table 2.12. shows selected studies, and the AI tools used according to the use of applied genAI in the literature.

Table 2.12. Table showing selected studies and the AI tools used according to the use of applied genAI in the literature

	Midjourney	Stabble Diffussion	DALL-E – (Bing)	Playground AI	Ideogram	Leonardo AI	Prome AI	Runway Ml	Adobe Firefly	Vizcom AI	Canva AI	Microsoft Designer AI	Fooocus AI	DreamStudio AI	Freepik AI
"DALL-E: Creating Images from Text" (Murahari et al., 2021)			x												
"Artificial intelligence as part of future practices in the architect's work: mid-journey generative tool as part of a process of creating an architectural form" (Jaruga-Rozdolska, 2022)	x														
"Hierarchical Text-Conditional Image Generation with CLIP Latents" (Ramesh et al., 2022)			x												
"Using Text-To-İmage Generation For Architectural Design İdeation" (Paananen, 2023)	x	x	x												
"Can AI Function as a New Mode of Sketching: A Teaching Experiment with Freshman." (Tong et.al., 2023)	x														
"Using Artificial İntelligence İn Craft Education: Crafting with Text-To-İmage Generative Models" Vartiainen and Tedre (2023)	x														
"Integration Of Artificial Intelligence Applications Into Experimental Design Workshop Courses: Evaluation From A Student Perspective" (Sarıca, 2024)	x			x											
"Evaluation Of Artificial Intelligence Applications In Landscape Design Presentation Techniques" (Benliay and Kılıç, 2024)											x	x			

Table 2.12. (Continued) Table showing selected studies and the AI tools used according to the use of applied genAI in the literature

	Midjourney	Stabble Diffussion	DALL-E – (Bing)	Playground AI	Ideogram	Leonardo AI	Prome AI	Runway Ml	Adobe Firefly	Vizcom AI	Canva AI	Microsoft Designer AI	Fooocus AI	DreamStudio AI	Freepik AI
"Creation Of the Sketching Phase in Architectural Design with Artificial Intelligence" (Avcı and Kavut, 2024)	x	x													
"Introducing A Stable Diffusion Visual Scripting Interface in A Computational Design Course to Supplement The Design Process Beyond 3d and 3D-printed Mockups" (Mondello et al., 2024)		x													
"The Use of Text-To-Image Generation Artificial Intelligence Tools for the Production of Biophilic Design in Architecture" (Mutlu Avinç, 2024)						x									
"Artificial intelligence in architectural education - green campus development research" (Cudzil et al., 2024)	x	x	x								x	x			
"Artificial Intelligence Supported City Visions" (Oral-Karakoç and Karakoç, 2024)						x									
"A Proposal for a Material-Focused AI-Supported Design Process: From Natural Material to Artificial Intelligence" (Şen Bayram et al., 2024)	x	x	x												
"Evaluation of Artificial Intelligence Applicatıons in Landscape Design Presentation Techniques" (Benliay and Kılınç, 2024)													x	x	x

The literature review examined 13 academic studies, including practices that used genAI tools. As a result of this review, it was observed that no studies were using more than five different AI tools and that the diversity in AI tools has improved over the years.

3. METHODOLOGY

In parallel with the development of today's digital design and production technologies, especially in architecture, there is a need to evaluate the role of computer use in educational models and design processes (Gül et al., 2013). The number of examples of GenAI tools in design processes is increasing daily. GenAI algorithms in architecture have become widespread in recent years (Mancini and Moncenero, 2023). However, there are not enough studies in the literature to examine the advantages and disadvantages of these tools in creative processes and to draw clear conclusions. For this reason, following the literature review, various practices were carried out in this thesis. During the thesis studies, three different practices were carried out with varying numbers of participants from the discipline of architecture at the undergraduate and graduate levels. The variables in the three practice steps are the participants' education level, their experience and relationship with GenAI tools, the subject and scope of the design process.

3.1. Practice-led Research

The “practice-led research method,” a mixed method including literature review, implementation, and evaluation phases, was used in the thesis study. Smith (2009) defines practice-led research method as “research in which the professional and/or creative practices of art, design or architecture play an important role in an inquiry.” This method encompasses situations where practice and observation of the practice process serve a research question (Frayling, 1993). This method aims to examine the process of using participatory and AI collaborative text-prompted visual production tools, which are visual production methods, in design processes by students who have received/are receiving architectural education.

The practice-led research method includes the following.

1. Literature review

2. Application section.

- Data creation

- Workshop

- Evaluation: Survey questions, Self-assessment

3. Evaluation

Practice-led research method include “practice-led learning” processes. Tselepis et al. (2021) in Table 3.1 explain the practice-led learning process.

Table 3.1. Learning steps according to practice-led research method, Tselepis (2021).

Practice-led Learning →	Teaching Through →	Design thinking Experiential learning Simulation

The term practice-led research and its related concepts (practice and research) are used to construct interrelated arguments about practice; the first is the process of practice in which creative work is itself a form of research, while the second is the accumulation of knowledge about creative practitioners past experiences and areas of expertise that can be written up as research (Smith, 2009).

Design-oriented studies using the practice-led research method encountered during the literature review are examined in this section. Terzi (2023) investigated the effects of machine learning algorithms on creativity in the early stages of design by developing a synthetic production tool based on machine learning principles. Terzi associated the practice-led research method with usability and discussed the tool's usability with user experiences (Table 3.2).

Table 3.2. The research method of "Terzi (2023), Synthetic Generation with The Architectural Section Tool: An Example of Auditorium

Implementation → method	Experimental → Method	Case Study →	Availability
The suggestion of a practice	Preliminary studies	Development and testing of the tool	User experiments and evaluation

Avinç (2022) used the ADDIE model in his doctoral dissertation, which included quantitative and qualitative evaluations and a course curriculum proposal using a mixed research model. The ADDIE instructional model proposes an organized process for

developing instructional materials, supported by continuous assessment and feedback (Shelton and Saltsman, 2006) (Figure 3.1). The ADDIE model consists of five steps: analysis, design, development, implementation, and evaluation (Davis, 2013).

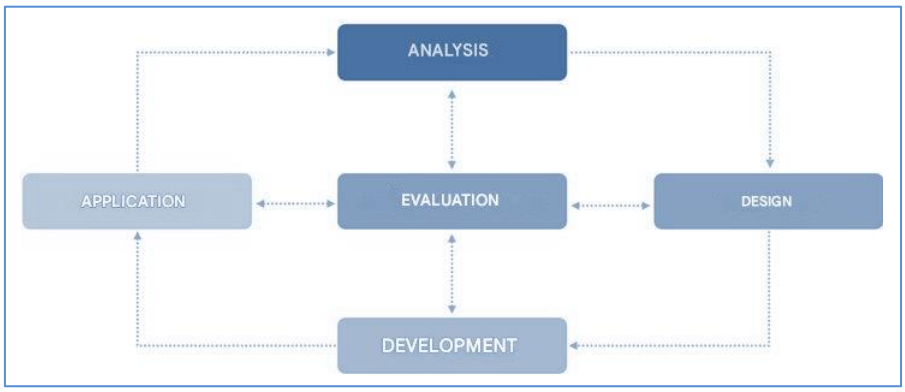


Figure 3.1. Steps of the ADDIE Model (Quigley, 2019)

Similar studies in the literature were examined, and a flowchart was developed to use the practice-led method in the thesis (Figure 3.2).

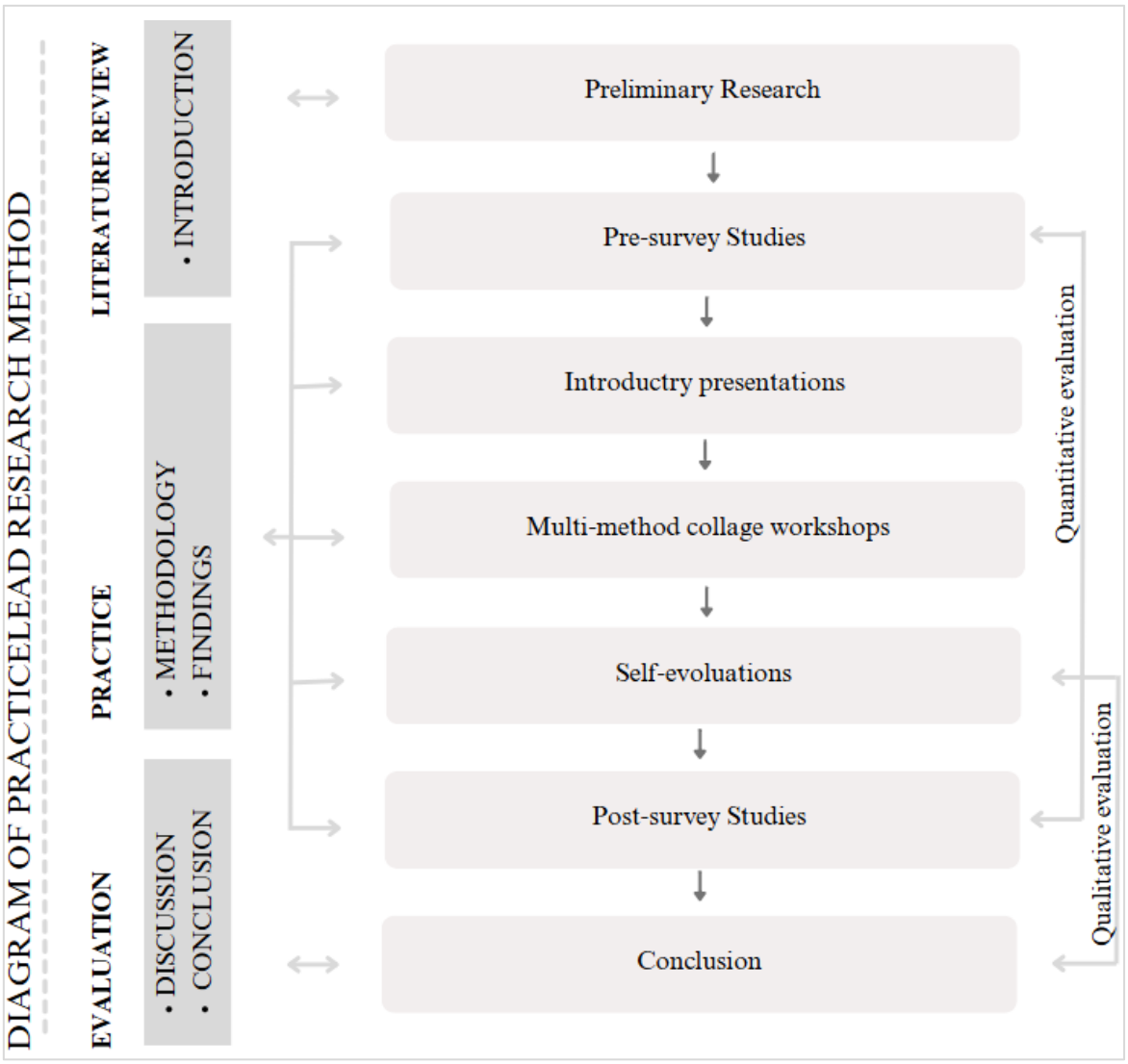


Figure 3.2. Workflow of the methodology of the thesis

The pre-and post-surveys applied before and after the workshops constituted the quantitative evaluations in the first two production steps. At the same time, the evaluation sections about the process asked from the students in all three steps constituted the qualitative evaluations.

This study is mixed-method research in which qualitative and quantitative methods are used together. The mixed method is defined as a research method that consists of a combination of quantitative and qualitative data. As a result of this combination, valuable results are obtained (Creswell, 2012:2). According to Cresswell (1999), the nature of quantitative methods is to focus an investigation on a cluster and to obtain variables that will serve the research question through this cluster, while qualitative research is about examining and presenting complex interconnected situations. The mixed-method research method is

divided into various categories by considering criteria such as which of the qualitative-quantitative methods is predominant in the study, the order in which these studies are conducted, and the method of data analysis (Şahin and Ozturk, 2019). Figure 3.3. shows the types of mixed methods.

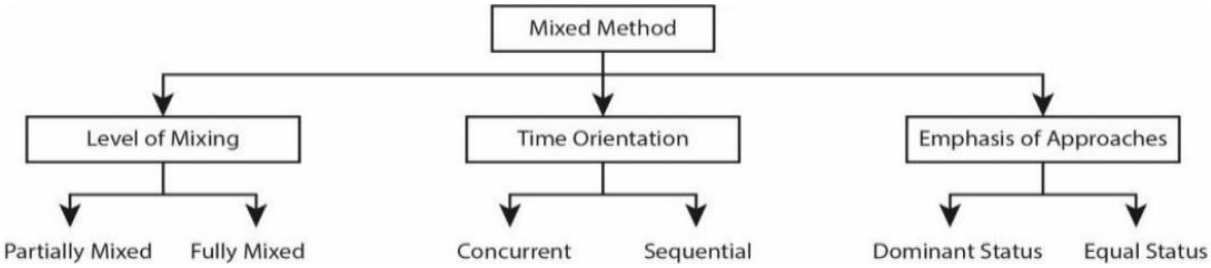


Figure 3.3. Classification of mixed methods studies (Leech and Onwuegbuzie, 2009)

Figure 3.4. shows the criteria according to which the types of mixed methods made by Creswell are classified.

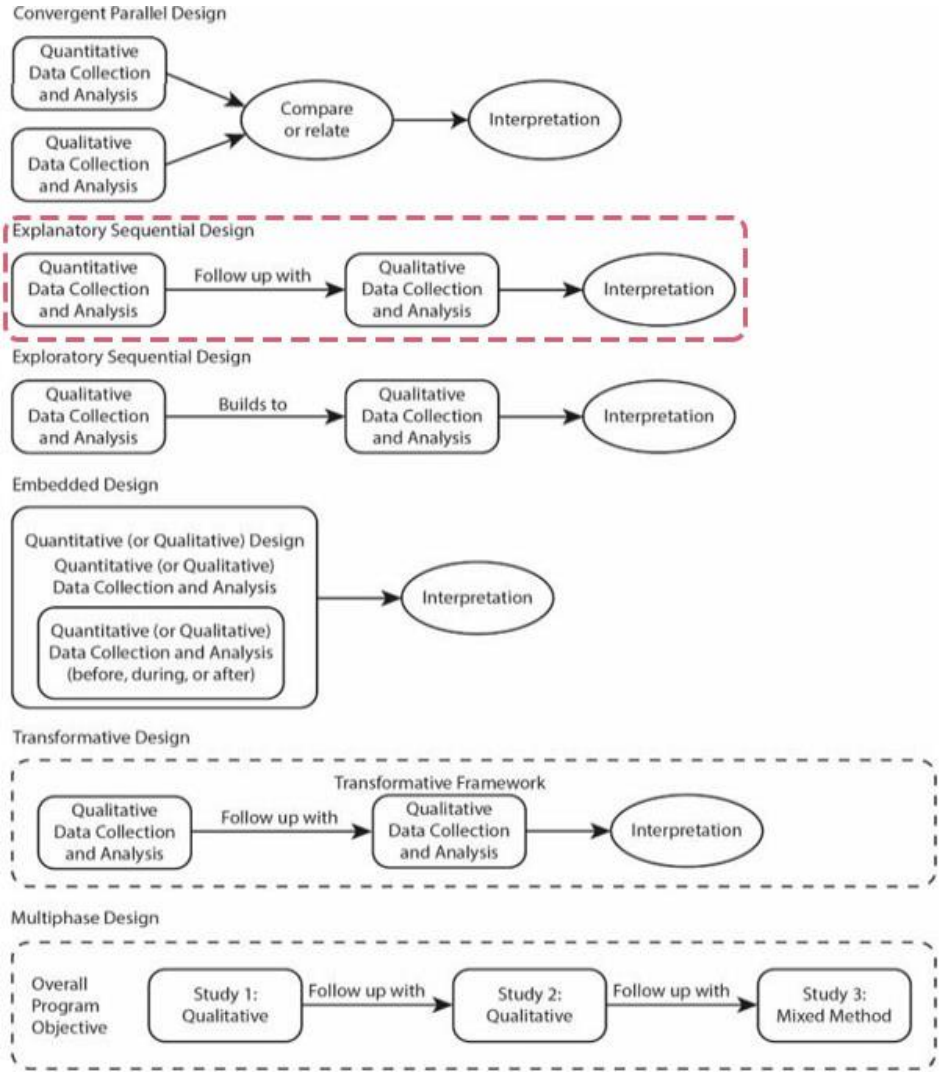


Figure 3.4. Types of mixed methods research according to Creswell (2012)

This thesis defines it as an explanatory sequential model, “a type of model that enriches, elaborates and supports the analysis results obtained from quantitative data with qualitative data” (Creswell and Clark, 2017:542). The explanatory sequential mixed model proposed by Creswell (2012) was adapted to the thesis study with a model in which the Quantitative Data Collection and Analysis step is divided into two sections: pre-survey questions and post-process survey Questions. Between these two sections is a Qualitative Data collection section consisting of the participants' self-evaluation sentences and the outputs of the collage studies (Figure 3.5).

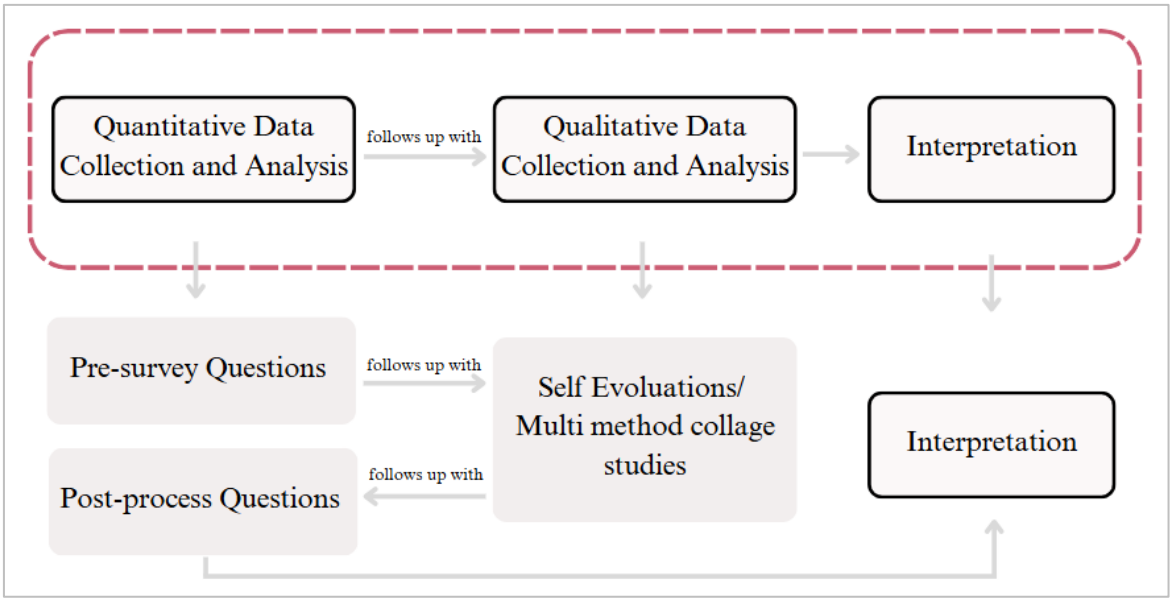


Figure 3.5. Adaptation of Creswell's explanatory sequential mixed model to thesis study

3.2. Data Collection

In this section, information about the content of the data regarding the three application steps carried out in the fall and spring semesters of the 2023-2024 semester within the scope of the "Principles of Digital Design and Fabrication" course, which is a course in Gazi University Architecture Graduate Program, and in the summer semester of 2024 within the scope of the "Visual Communication" undergraduate program course of Istanbul Technical University Department of Architecture.

The pre-and post-survey questions that constitute the qualitative evaluation part of the study were prepared online. The answers to these questions by 3 participant groups constituted the qualitative evaluation data.

The "self-evaluation" information constituting the quantitative evaluation part of the study constituted the quantitative evaluation data.

The steps of the analog, digital, and AI-supported collage works produced by the participants were recorded on Google Sheets through online tables. The research objectives are to determine the outputs that affect visual output quality in productions made with AI. Here, inputs and outputs constitute the data related to the applications.

Figure 3.6 shows a section from the Sheets file containing the data of the participant works from three different groups: analog collage, digital collage, and artificial intelligence-supported collage from the spring semester of the Principles of Digital Design and Fabrication course. The table belongs to the second production step; the very accumulation method used is valid for all three steps, and in all three steps, the participants were asked to record the inputs and visual outputs in the table. The table contains a data set of 69 rows and 57 columns covering images, phrases, input, output, advantages-disadvantages, strong words, ineffective words, style, and AI tools. Participants were asked to enter inputs and outputs according to their production processes in the relevant sections of the table. The relationship between inputs and outputs and comparing inputs and outputs at different steps provided data for the evaluation.

INPUT FOR ANALOGUE COLLAGE (your keywords)	Difficulties in the process	Positive aspects in collage process	Reflection/Discussion about your collage work	IMAGE OF A. COLLAGE WORK
duality of the city depressed people joyful people details everywhere clashing emotions envy and yearning wistful feelings	It was hard to find exact samples for Art Deco, and the lack of ability to adjust the sizes of found images made arranging them harder.	It was fun to "discover" images and put them together to create what written text had envisioned in our minds. Being able to physically hold and arrange the layers gave us opportunities we wouldn't be able to see in digital space.	Representing the duality of Phyllis by dividing the paper in two, I arranged a collage work of two perspectives. One from the visitors and other from the dwellers of the city. In one side all the people and elements that create the city are colorful, joyful ar full of life and opportunities. On the oth the expressions of the people and the atn phere of the city is dull and lifeless, con the feeling of nostalgia and depression th people who live in the city feels. Still, in sides, it is possible to see so many detail it is not the city that changes but the visi who experiences it.	

INPUT FOR DIGITAL COLLAGE WORK	Difficulties in the process	Positive aspects in collage process	Reflection/Discussion about your collage work	IMAGE OF D. COLLAGE WORK
duality of the city roads filled with visiters of the city dwellers hiding behind buildings joy as light eyes envy and yearning reminiscing detailed wistful feelings clashing with joyous figures	With so many options for material use, it was hard to choose one and stay focused on the main idea or form of the collage. The want to use all the materials I had access to hindered the final product beacuse I couldn't find a place for all the images I liked but still wanted to use them nonetheless.	wanted gave me a freedom that wasn't there in the analogue collage work. It was also easier to find images that matched my architectural style and city. Digital work also enabled me to arrange all things as I wanted them, not being able to arrange them on top of each other or not being able to glue them properly were no longer a problem in digital space.	travellers are holding lights t somewhat showing them the They are also looking like st the roads. The eyes of the st the makeup mirror are lookir one in yearning for the peop the ability to leave this plave elsewhere in bliss and the ot the people that has to ability this colorful city. The problem about this colla my head and got outside of t and placing the figures. It ca looking and trying to underta	

FIRST INPUT FOR AI TOOLS (PROMPT)	OUTPUT OF THE FIRST PROMPT (IMAGE)	NAME OF AI TOOL	SUCCESFUL WORDS IN PROMPT	OBJECTS THAT ARE NOT IN THE PROMPT, BUT ARE IN THE IMAGE
A stunning cinematic image of two parallel cities, each showcasing the unique beauty of Art Deco architecture. The left city is a vibrant and colorful paradise, with intricate, sharp-edged buildings and statues amidst winding water canals. The sun illuminates the scene, casting a warm glow over the colorfully dressed inhabitants. In contrast, the right city is a monochromatic world of grey, with gloomy, cloudy skies and aging, damaged Art Deco structures. The few residents are huddled under umbrellas, dressed in somber grey attire. The dramatic juxtaposition of these two cities highlights the contrast between life and decay, happiness and melancholy., architecture, cinematic		Ideogram AI	Cinematic parallel cities	statues holding umbrellas
		STYLE	INEFFECTIVE WORDS IN PROMPT	STRONG WORDS (WORDS THAT AFFECT THE WHOLE PICTURE)
		Architecture Cinematic	vibrant	warm glow illuminating monochromatic somber atmosphere
		DISCUSSION		
		Because I liked the previous one, I tried to use it as a referance for a little bit different promp to see what would happen. Using the remix function of the Ideogram AI, this image was a one I also found very successful. I like the way that on the left, livlier side the city		

Figure 3.6. Sections of a database of practices

The definitions of the data in the table and their equivalents in practice are as follows.

-Input/ First Input for AI Tools (Prompt): The first group of texts entered for collage work and artificial intelligence tool, created by the participant.

-Difficulties in The Process: The text group in which the participants explain the difficulties they experienced during the production process in their own words.

-Positive Aspects in The Process: The text group in which the participants explain their positive ideas about the production process in their own words.

-Reflection/Discussion about Your Collage Work: A group of texts in which the participants explain in their own words the composition, method, main idea, etc., they have constructed in their collage work.

-OUTPUT/Image of Collage Work: Picture showing the final output of the analog and digital collage works.

-Name of AI tool: The name of the artificial intelligence tool preferred by the participant during visual production with AI.

-STYLE: The style option in the interface of the AI tool that adds a visual effect to the image.

-Successful Words in The Prompt: words that appear in the prompt and are equivalent in the image.

-Ineffective Words in The Prompt: words that appear in the prompt but do not appear in the image.

-Objects Not in The Prompt but Are in The Image: Objects in the prompt but not in the image.

-Strong Words (Words That Affect the Whole Picture): Words that affect the overall composition of the picture if added to the prompt.

3.3. Experimental Studies with AI and Collage

In the applied practices, workshops were planned to enable the GenAI tools to contribute to the designer as an auxiliary tool rather than a producer/designer.

The applied part of the study consists of 3 different production stages. AI tools are used in collaboration with analog and digital tools in these three stages. Collage is a visual production method that combines different pictorial elements to convey new ideas in a single work (Shields, 2014). AI models' “diffusion” process based on the “text-to-image” principle seems like the procedure outlined here. Collage is a suitable technique because it is based on basic cutting and gluing processes and allows for rapid visual production, transforming fictional text and existing images and preparing the ground for the manipulation of the visual by the participant. The thesis used the explanatory sequential model method, which includes analyzing the data in two steps: the application and the survey questions.

In two of these three stages, text-directed image generation was performed through text generation based on a fictional novel text. In contrast, text-directed image generation was performed in the other stage with images generated from the image. The productions performed with generative artificial intelligence tools were supported and compared with analog production methods in these three stages. These analog productions were carried out using the collage technique of the production principles of genAI tools. Collage is a two- and three-dimensional production technique based on gluing organic or inorganic, drawn, printed, photographic ready-made materials to a flat surface with the principle of coming together in a new whole independent of its existing composition; in this method, all kinds of materials, which we can call as a unit, serve a new whole in the collage in a new meaningful way (Ergün, 2012). For this reason, the logic of generating images with collage and generating images with diffusion of AI tools were considered close. For the three production steps, various visual materials were used as collage components, and various textual inputs were used as materials for production with AI (
Figure 3.7).

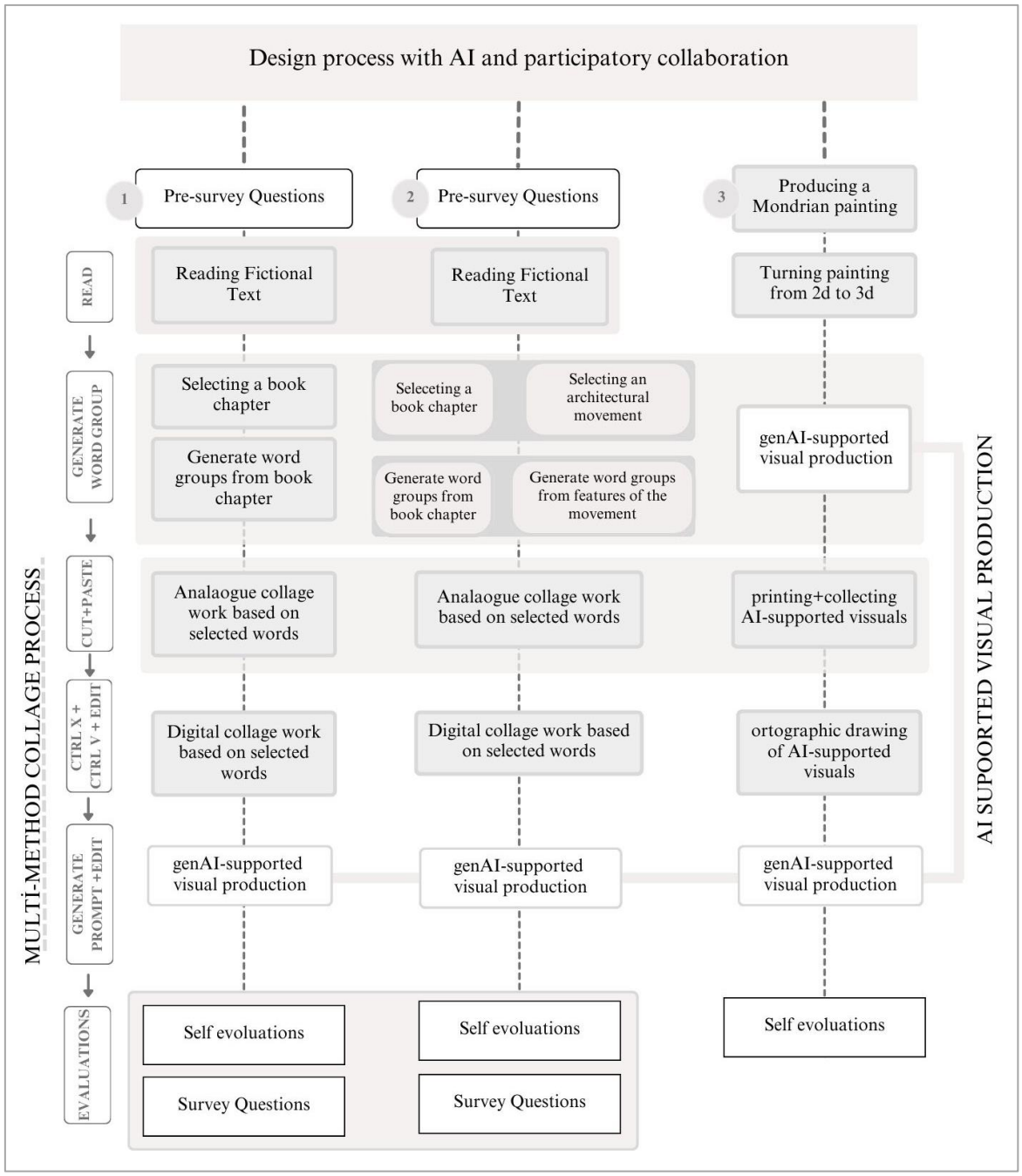


Figure 3.7. Flowchart of the three-step design process created with artificial intelligence and participatory collaboration

4. FINDINGS

This section includes detailed flow charts of the three production stages carried out within the scope of the thesis, workshop outputs obtained in the production stages related to this chart, as well as survey questions asked to students before and after the application and visual analysis of the answers given to these questions.

4.1. First Trial

In this step of the production, a 14-week course period was carried out in the fall semester of the 2023-2024 semester within the scope of the “Principles of Digital Design and Fabrication” course, which is a graduate course with the participation of 6 graduate students studying at Gazi University Architecture program. The children's book “Alice in Wonderland” was chosen as a fictional text because it combines abstract ideas such as chaos and serenity with concrete concepts such as scale and dimensional changes in space. After reading the book, students were asked to choose a passage and recreate a scene using their own words. After the text production was finished, three stages of the design process (analog collage, digital tool collage, and digital AI-assisted output) were planned. Figure 4.1 shows the flowchart of the process.

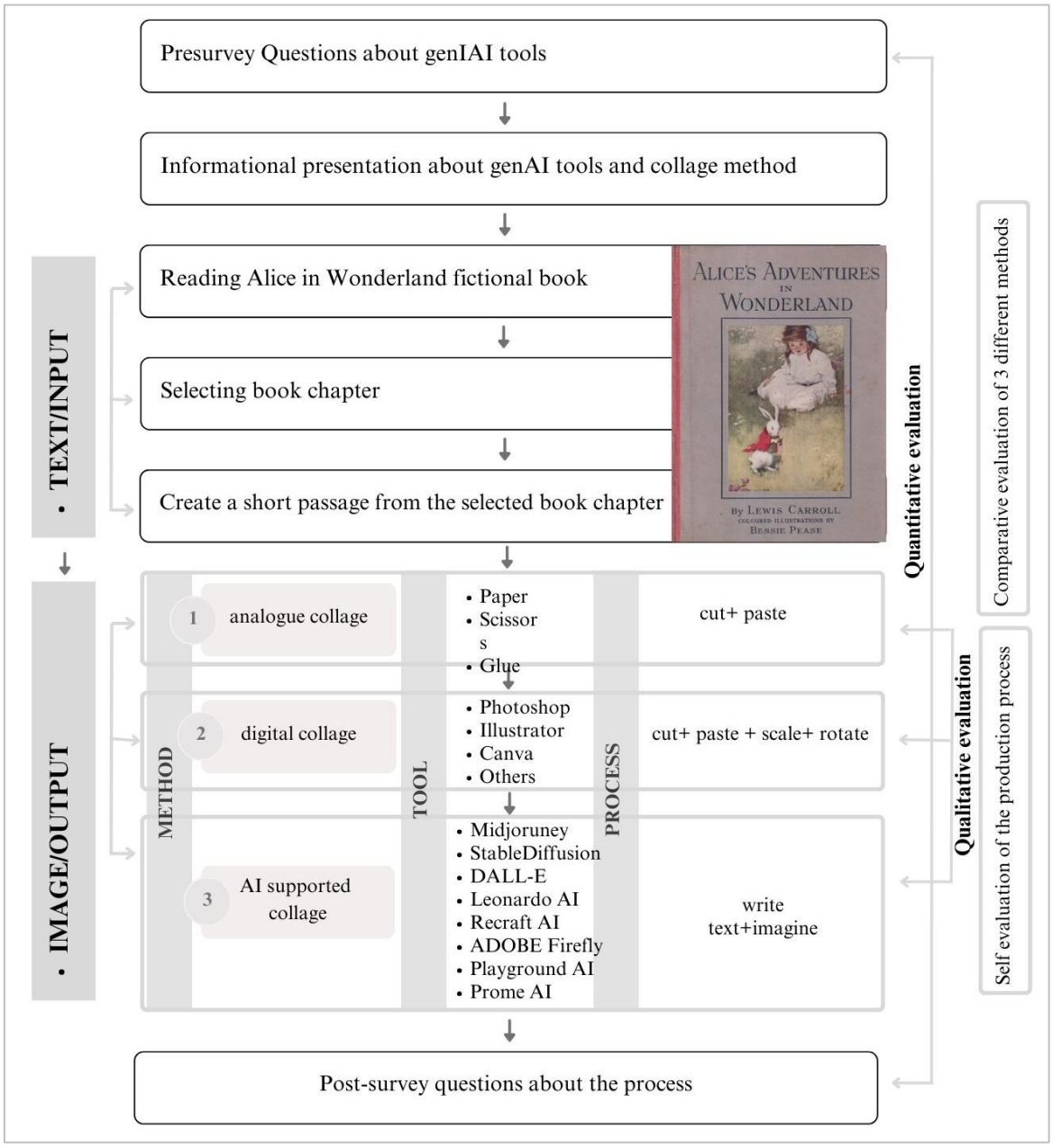


Figure 4.1. Workflow of the first trial

After the analog collage work in the workshop environment was completed, the students were asked to rethink the texts they created using selected passages from Alice in Wonderland, and digital collage work was done concerning the newly created texts. Students can choose from Canva, Illustrator, Photoshop, and other recommended programs for digital collage. After the production with analog and digital collage techniques, students were introduced to generative artificial intelligence tools' interfaces and asked to perform visual productions through prompts.

In production;

- Midjourney
- DALL-E
- Leonardo AI
- Stable Diffusion
- Playground AI
- Adobe Firefly
- Vizcom AI
- Prome AI
- Ideogram tools were used.

Table 4.1. The 14-week course curriculum of Principles of Digital Design and Fabrication shows the 14-week lesson flow.

Table 4.1. The 14-week course curriculum of Principles of Digital Design and Fabrication

Week	Content	Hour
1	General information about the lecture	3
2	Readings on collage works in architecture /Student representations and reflections	3
3	Student reproduction of passages from Alice's Adventures in Wonderland/ Collage workshop	3
4	Transformation of fictional texts /Digital collage workshop	3
5	Artificial Intelligence- Principles of generative AI tools- text-to-image concept	3
6	Information about artificial intelligence tools, student suggestions	3
7	Visual production experiments via generative artificial intelligence tools	3
8	Presentations/discussion of artificial intelligence-supported visual productions	3
9	Discussing visual designs produced by different artificial intelligence tools	3
10	Practices on plugins (editing/ out zoom/ zoom/ edit in canvas/ painting/ outpainting/ styles)	3
11	Student works on combining multiple genAI tools in one visual design	3
12	Student works on combining multiple genAI tools in one visual design	3
13	Editing selected images with the help of editing tools	3
14	Discussion on the evaluation criteria for the production process with artificial intelligence and the parameters affecting the quality of the final product	3

After the production, analog, digital, and AI-supported collage works and their methods and prompts were compared. Selected passages from the fictional text served as a reference for the text prompts prepared by the students. The collage works realized by each participant were analyzed in the tables comparing the three methods, and the students were asked to evaluate their production process in their own words in the “self-evaluation” box.

Table 4.3, and Table 4.4 contain the 3-method productions realized by the students.

Table 4.2. Comparison of collage, digital collage, and AI works processes of Student A

<table>
<tr><td rowspan="2">Analogue Collage
</td><td>Method</td><td>By cutting and pasting appropriate visuals
taken from some magazines, newspapers, etc.</td></tr>
<tr><td>Prompt</td><td>After falling into the rabbit hole and reaching a new universe, I designed a collage of "Alice," who evolved into different variations of herself through the changes she underwent during this long journey. I depicted the rabbit hole as black, symbolizing Alice's dynamic journey by using two hands holding this black hole, through which Alice thrust herself.</td></tr>
<tr><td colspan="3">Self Evaluation: I aimed to represent the infinite journey of our story's protagonist across two different periods and the transformations she underwent. I used various human visuals to symbolize our hero's differentiation. After this collage story, which I limited to a frame, I expressed the person Alice became in her real world after her journey and changes with different "Alice" images. The first of the difficulties I experienced was finding images suitable for the text I was preparing the story for from the magazines or newspapers I owned. Another challenge was to adapt the photos I found to each other dimensionally.</td></tr>
<tr><td rowspan="2">Digital Collage
</td><td>Method</td><td>By finding appropriate visuals on the Internet and combining them
using a tool named Photoshop</td></tr>
<tr><td>Prompt</td><td>I symbolized the transition to a long journey through falling down the rabbit hole and reaching a new universe with a particular frame. I used clock figures to show different temporal dimensions. I described the inside of the frame as a different universe and the outside as a different universe.</td></tr>
<tr><td colspan="3">Self Evaluation: Since we can access unlimited images online, finding images that fit my story and provide a balanced collage combination was challenging. Apart from this, in my opinion, it is a more accessible and more balanced collage work than handmade collage work. The first reason is that the internet is an unlimited resource, and the second reason is that it is straightforward to adjust the size of the relevant images and edit them using Photoshop.</td></tr>
<tr><td rowspan="2">Collage with AI
</td><td>Method</td><td>By using an artificial intelligence tool named Adobe Firefly</td></tr>
<tr><td>Prompt</td><td>Generate a wide-angle landscape scene of Alice in Wonderland. This detailed and intricate environment illustrates eternity, transformation, a new universe, colorful roses and books in the black hole, and global illumination. Alice is looking into the bright black hole. She has long blond hair.</td></tr>
<tr><td colspan="3">Self-evolution: The first of the positive aspects is that the resulting products can be edited with artificial intelligence tools, the second is the ability to produce unlimited products, and the other is to create visuals according to different styles. Besides this, I also experienced some difficulties. These are: When creating human or animal images, bodily parts such as hands, arms, legs, and eyes cannot be adequately designed; developing the appropriate prompt requires experience and practice, high quality in most artificial intelligence tools, and the application of all styles require premium membership or credit.</td></tr>
</table>

Table 4.3 Comparison of collage, digital collage, and AI works processes of Student E.

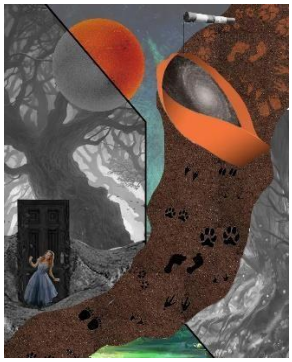
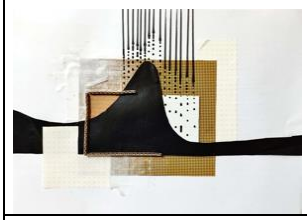
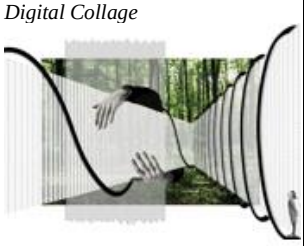
<table>
<tr><td rowspan="2">Analogue Collage
</td><td>Method</td><td>By cutting and pasting appropriate visuals taken from magazines, newspapers, etc.</td></tr>
<tr><td>Prompt</td><td>Freed from the pool of tears, Alice and the animals, large and small, ran to dry out in an endless cycle with no beginning and no end.</td></tr>
<tr><td colspan="3">Self-evolution: This study experienced a different experience with the cutting and pasting method. The most challenging part of the process was determining what would reflect and represent the things to be expressed and finding them in materials such as magazines and newspapers. For example, the most challenging thing in the final product was finding the textures to represent the animals. Another tricky thing was constructing the möbius strip to represent the cycle.</td></tr>
<tr><td rowspan="2">Digital Collage
</td><td>Method</td><td>By finding appropriate visuals on the Internet and combining them using a tool named Photoshop</td></tr>
<tr><td>Prompt</td><td>Wet in a pool of tears, Alice and the animals race with no winner to dry up.</td></tr>
<tr><td colspan="3">Self-evolution: Photoshop was used in digital production. Finding materials in this work was more accessible than the collage made by hand. For example, the Möbius strip itself could be used in the collage. This process made it easier to express oneself and show what one wants.</td></tr>
<tr><td rowspan="2">Collage with AI
</td><td>Method</td><td>By using an artificial intelligence tool named Leonardo, AI</td></tr>
<tr><td>Prompt</td><td>imagine a scene with Alice in Wonderland, Alice with wet and blonde hair, back turned, running various animals in front of Alice, Mobius strip, cut paper style</td></tr>
<tr><td colspan="3">Self Evaluation: Although image generation with artificial intelligence was fast, finding the right prompt was challenging. It took more work and trials to obtain the desired image than the other two methods. Although quite successful results were obtained, there are generally minor errors even in these successful images. For this reason, it was determined that using the photos without editing was impossible. It was tough to achieve good results, especially with animal and human limbs.</td></tr>
</table>

Table 4.4. Comparison of collage, digital collage, and AI works processes of Student F.

<table>
<tr><td rowspan="2">Analogue Collage
</td><td>Method</td><td>By cutting and pasting appropriate visuals taken from magazines, newspapers, etc.</td></tr>
<tr><td>Prompt</td><td>Alice suddenly begins to grow up after finding a drink in the rabbit's house and drinking it. She begins to push the boundaries of her space, and her body begins to spill out. As Alice grows, her house ceases to be the place itself, and the forest becomes the central place. The house starts to become an element of the place with Alice.</td></tr>
<tr><td colspan="3">Self Evaluation: The most significant advantage of this method, which is carried out using different materials and tools, is the ability to see and touch natural textures and materials—for instance, it is essential to be able to use the actual texture of the fabric in production instead of just its visual appearance or to visually attach a real tape for combining images. Despite the advantages of manual production, the limited and nonscalable nature of resources and materials, the difficulty of organization, and the time-consuming nature of the method have made it less preferred in today's context.</td></tr>
<tr><td rowspan="2">Digital Collage
</td><td>Method</td><td>By finding appropriate visuals on the Internet and combining them using a tool named Photoshop</td></tr>
<tr><td>Prompt</td><td>Meanwhile, the small animals outside are thrown into fear and chaos as Alice grows to gigantic sizes. They start throwing stones at Alice, but the rocks they throw turn into cake. As Alice eats the cakes, she begins to shrink and become afraid of the animals, which she initially feared, and runs away as soon as she leaves the house.</td></tr>
<tr><td colspan="3">Self Evaluation: This method produces visuals by combining materials and sources on the internet in the digital environment through human intelligence and perception. Having almost unlimited resources and the ability to edit materials much more quickly makes this method superior to manual production. In addition, the ability to make these edits according to the creator's desires and imagination is the most crucial feature that surpasses AI. While this method is currently the most preferred, it is believed that integrating it with AI will result in much faster and groundbreaking outcomes.</td></tr>
<tr><td rowspan="2">AI Art
</td><td>Method</td><td>By using an artificial intelligence tool named Prome AI</td></tr>
<tr><td>Prompt</td><td>A destroyed small village house, a scared girl running away, broken pieces of wood on the ground, glass in the air, dense forest background, big trees around, tiny cupcakes on the ground, pieces of rock flying in the air, an atmosphere dominated by feelings of fear, chaos, anxiety, and anger</td></tr>
<tr><td colspan="3">Self Evaluation: The graphic quality of AI, endless design options, and the ability to produce products in seconds are its most significant advantages, and they put it ahead of other methods. However, their perception, aesthetic understanding, and connection with reality are only as much as the combination of information and knowledge on the internet. The way it brings the components together and the visuals it creates sometimes differ from human perception regarding aesthetics, accuracy, scale, etc. It does not match the concepts. Therefore, although AI can produce images with high graphic quality, it is still thought to require human hands and minds.</td></tr>
</table>

Tables 4.5, Table 4.6, and Table 4.7 include the visuals and student evaluation obtained with three different AIs with the same concept but by transforming the prompts.

Table 4.5. Artificial intelligence experiences and prompt development of Student B

<table>
<tr><td rowspan="3">1</td><td></td><td colspan="2">Prompt: A whimsical scene of a giant Alice towering over a forest of tiny trees on the left, while on the right, a Miniature. Alice sits atop a mushroom with a curious caterpillar. A winding path leads through the middle, inviting you to explore this fantastical world.</td></tr>
<tr><td>AI Tool</td><td>Prome AI</td></tr>
<tr><td colspan="3">Self Evaluation: More clearly explaining both sides resulted in a closer result to the desired result. What was still wrong here was the presence of too many mushrooms.</td></tr>
<tr><td rowspan="3">2</td><td></td><td colspan="2">Prompt: In the world where the caterpillar sits on a mushroom, Alice sets foot in a world where there is no normal. She loses her identity, copes with change, and discovers the importance of adaptation as she reaches different dimensions.</td></tr>
<tr><td>AI Tool</td><td>Prome AI</td></tr>
<tr><td colspan="3">Self Evaluation: While I wanted a caterpillar sitting on a mushroom, Alice was drawn sitting on a mushroom. At the same time, many mushrooms were added as we tried to emphasize the differences in size. Therefore, it was aimed to eliminate situations that confuse.</td></tr>
<tr><td rowspan="3">3</td><td></td><td colspan="2">Prompt: Two sides of the mushroom, a growing and shrinking Alice and a wise caterpillar.</td></tr>
<tr><td>AI Tool</td><td>Prome AI</td></tr>
<tr><td colspan="3">Self Evaluation: When the two sides of the mushroom were mentioned, the page was divided into two, and a mushroom was drawn on each side. Since this is not a desired situation, it was intended to be explained more clearly.</td></tr>
</table>

Table 4.6. Artificial intelligence experiences and prompt development of Student E

<table>
<tr><td rowspan="3">1</td><td rowspan="2"></td><td colspan="2">Prompt: Beautiful Alice with wet and blonde hair, confused, running with many animals, a race, next to the forest, shining sun.</td></tr>
<tr><td>AI Tool</td><td>Leonardo AI</td></tr>
<tr><td colspan="3">Self Evaluation: It was found that by specifying the defining ‘characteristics of people’ (blond and wet hair, beautiful, etc.), more successful visuals were obtained in line with these characteristics. However, the following image has problems with the limbs without descriptive features. In addition, the artificial intelligence that emphasized the word race reflected this in Alice's outfit.</td></tr>
<tr><td rowspan="3">2</td><td rowspan="2"></td><td colspan="2">Prompt: Imagine a scene with Alice in Wonderland, Alice with wet and blonde hair, back turned, running various animals in front of Alice, Mobius strip, collage style.</td></tr>
<tr><td>AI Tool</td><td>Leonardo AI</td></tr>
<tr><td colspan="3">Self Evaluation: It was found that more effective visual production was achieved with commands such as ‘imagine.’ In addition, more visual results were obtained with ’ keywords’ such as ‘Mobius strip.’ In order to hide the errors in the human faces and limbs, the ‘back turned’ command was used. However, it was not determined how to correct the mistakes in animals.</td></tr>
<tr><td rowspan="3">3</td><td rowspan="2"></td><td colspan="2">Imagine a scene with Alice in Wonderland, Alice with wet and blonde hair, back turned, running various animals in front of Alice, Mobius strip, cut paper style.</td></tr>
<tr><td>AI Tool</td><td>Leonardo AI</td></tr>
<tr><td colspan="3">Self Evaluation: Adding ‘style’ to the prompts increased the effect of the visual. However, no solution was found for the problems related to animals. It is thought that this problem will be solved in the editing phase.</td></tr>
</table>

Table 4.7. Artificial intelligence experiences and prompt development of Student F

<table>
<tr><td rowspan="3">1</td><td rowspan="2"></td><td colspan="2">Prompt: Alice pushes the boundaries of the space she is in, and her body begins to spill out; the small animals outside are thrown into fear and chaos as Alice grows to a gigantic size; they start throwing stones at Alice, and the rocks turn to cake, forest background.</td></tr>
<tr><td>AI Tool</td><td>Leonardo AI</td></tr>
<tr><td colspan="3">Self Evaluation: The expression "a house, a girl in front of the house" provided more precise, realistic, and successful visuals than "the girl is leaving the house." The visuals found no response for expressions such as "Push the limit, spill, reach gigantic sizes, start throwing." Nouns such as "Alice, stones, forest" were removed from the text to create the image.</td></tr>
<tr><td rowspan="3">2</td><td rowspan="2"></td><td colspan="2">Prompt: A worried little girl, jamming, distorted body scale, a house, small forest animals, abstract style, forest background</td></tr>
<tr><td>AI Tool</td><td>Leonardo AI</td></tr>
<tr><td colspan="3">Self Evaluation: Commas separate the adjectives used. Subjective adjectives and the absence of a specific object render the request insufficient. Objective statements such as "blonde, flying, standing on the ground" generally gave positive results. Relative expressions such as "big, small, too much" and "small as a matchstick girl" did not produce satisfactory results with the AI.</td></tr>
<tr><td rowspan="3">3</td><td rowspan="2"></td><td colspan="2">Prompt: A destroyed small village house, a scared girl running away, dense forest background, big trees around, tiny cupcakes on the ground, pieces of rock flying in the air, a crowd of animals, an atmosphere dominated by feelings of fear, chaos, anxiety, and anger.</td></tr>
<tr><td>AI Tool</td><td>Prome AI</td></tr>
<tr><td colspan="3">Self Evaluation: It has been found that the characteristics of some words in the prompt affect the reflection of other words in the result. Negative connotations such as "chaos, anxiety, anger" prevented positive expressions such as "cupcake" from being included in the visual. However, when models and effects that create a more positive perception are selected in production, both expressions find visual equivalents.</td></tr>
</table>

The comparison table has one analog collage, one digital collage, and 1 AI-assisted visual work. Compared to analog collage and digital collage works, AI-assisted productions were produced much shorter, so it was possible to obtain multiple visual outputs with a single prompt and make rapid changes in the prompt and, therefore, in the visual production quickly. For this reason, the AI-assisted collage works were analyzed separately on a secondary table, using their production processes and techniques. Tables 4.8, Table 4.9, and Table 4.10 show the production stages of AI-supported collage work selected by students and the variables affecting the production quality. The table first includes the name of the genAI tool used, then the AI model option within this tool, which affects criteria such as light, linear characters, and realism regarding the visual output. The “Guidience” value in Box 6 of the table contains the numerical value that determines how much of the prompt data entered by the participant will be used by the AI. The resolution value is the numerical value expressing the visual quality. The “editing process” section in the second half of the table shows the first editing steps of the images produced with genAI.

Table 4.8. AI work process of Student E

<table>
<tr><td rowspan="2">Final Output</td><td colspan="3"></td><td colspan="3">AI Tool: Prome AI
A.I. Model: Artistic photography
Effect 1: -
Effect 2: -
Effect 3: -
Guidance: -
Resolution: 512 x 512 px</td></tr>
<tr><td colspan="6">Prompt: Imagine a scene with Alice in Wonderland, Alice with wet and blonde hair, back turned, running various animals in front of Alice, Mobius strip, cut paper style.</td></tr>
<tr><td rowspan="5">Editing Process</td><td colspan="6">Steps, Tools, and Prompts for Editing</td></tr>
<tr><td>1</td><td>erase</td><td>2</td><td>mask (rabbit)</td><td>3</td><td>mask (cat)</td></tr>
<tr><td>Recraft AI</td><td></td><td>Prome AI</td><td></td><td>Prome A1</td><td></td></tr>
<tr><td>4</td><td>mask</td><td>5</td><td>erase</td><td></td><td></td></tr>
<tr><td>Leonardo AI</td><td></td><td>Recraft AI</td><td></td><td></td><td></td></tr>
</table>

Table 4.9. AI work process of Student A

<table>
<tr><td rowspan="2">Final Product</td><td colspan="4"></td><td>AI Tool: Leonardo.Ai</td></tr>
<tr><td colspan="4"></td><td>AI Model: Leonardo Diffusion XL</td></tr>
<tr><td rowspan="6">Editing Process and Tools</td><td colspan="5">Prompt: Generate an angle landscape scene of Alice in Wonderland, a detailed and intricate environment, illustrating eternity, transformation, a new universe, colorful roses and books in the black hole, and global illumination. Alice is looking into the bright black hole and has long blond hair.</td><td>Effect 1: -</td></tr>
<tr><td colspan="5">Steps, Tools, and Prompts for Editing</td><td>Effect 2: -</td></tr>
<tr><td>1</td><td>erase</td><td>2</td><td>mask (rabbit)</td><td>3</td><td>mask (cat)</td><td>Effect 3: -</td></tr>
<tr><td>Photoshop</td><td></td><td>Photoshop</td><td></td><td>Photoshop</td><td></td><td>Guidance: -</td></tr>
<tr><td>4</td><td>mask</td><td>5</td><td>erase</td><td></td><td></td><td>Resolution: 512 x 512 px</td></tr>
<tr><td>Photoshop</td><td></td><td>Photoshop</td><td></td><td>Photoshop</td><td></td><td></td></tr>
</table>

Table 4.10. AI work process of Student C

<table>
<tr><td rowspan="2">Final Product</td><td colspan="4"></td><td>AI Tool: Prome AI</td></tr>
<tr><td colspan="4"></td><td>AI Model: Leonardo AI</td></tr>
<tr><td rowspan="7">Editing Process and Tools</td><td colspan="5"></td><td>Effect 1: Paper Cut-01</td></tr>
<tr><td colspan="5"></td><td>Effect 2: -</td></tr>
<tr><td colspan="5"></td><td>Effect 3: -</td></tr>
<tr><td colspan="5"></td><td>Guidance: 35</td></tr>
<tr><td colspan="5"></td><td>Resolution: 512 x 512 px</td></tr>
<tr><td colspan="6">Prompt: Alice in Wonderland, looking at the distant shore, Pool of Tears, water collecting, abstract visualization, border, despair, offshore, animals in the water.</td></tr>
<tr><td colspan="6">Steps, Tools, and Prompts for Editing</td></tr>
<tr><td>1</td><td>Draw skyline.</td><td>2</td><td>Futuristic mountain.</td><td>3</td><td>Mountain from tears.</td></tr>
<tr><td>Leonardo AI</td><td></td><td>Leonardo AI</td><td></td><td>Leonardo AI</td><td></td></tr>
<tr><td>4</td><td>Snowy Mountain.</td><td>5</td><td>black hole picture</td><td></td><td></td></tr>
<tr><td>Leonardo AI</td><td></td><td>Leonardo AI</td><td></td><td>Leonardo AI</td><td></td></tr>
</table>

4.2. Second Trial

In this step of the production, a 14-week course period was carried out in the spring semester of the 2023-2024 semester within the scope of the “Principles of Digital Design and Fabrication” course, which is a graduate course with the participation of 11 graduate students studying in Gazi University Architecture program. A 14-week curriculum was prepared for the course semester. The transformation process of the Invisible Cities book from text to visual was realized in three steps. The visual production process consisted of three stages: analog collage, digital collage, and artificial intelligence-assisted design. The collage technique was proposed in the first step of visual production.

In the analog collage stage, students try to depict their cities using the architectural elements of their chosen architectural movement by using ready-made materials from various sources together and in layers. This process takes place in collaboration in a workshop environment.

In the digital collage stage, students are asked to realize their collage works digitally through a computer program in which they are proficient. Photoshop is used because it is the program most students prefer. At this stage, any visual accessed over the internet is accepted as collage material.

In AI-supported visual production, students are first asked to explore the working principles and interfaces of AI models they will use as a production tool. In productions with AI, the words students use as a means of expression serve as a direct input for visual production. Students create their prompts and can transform them until they reach the desired result (Figure 4.2).

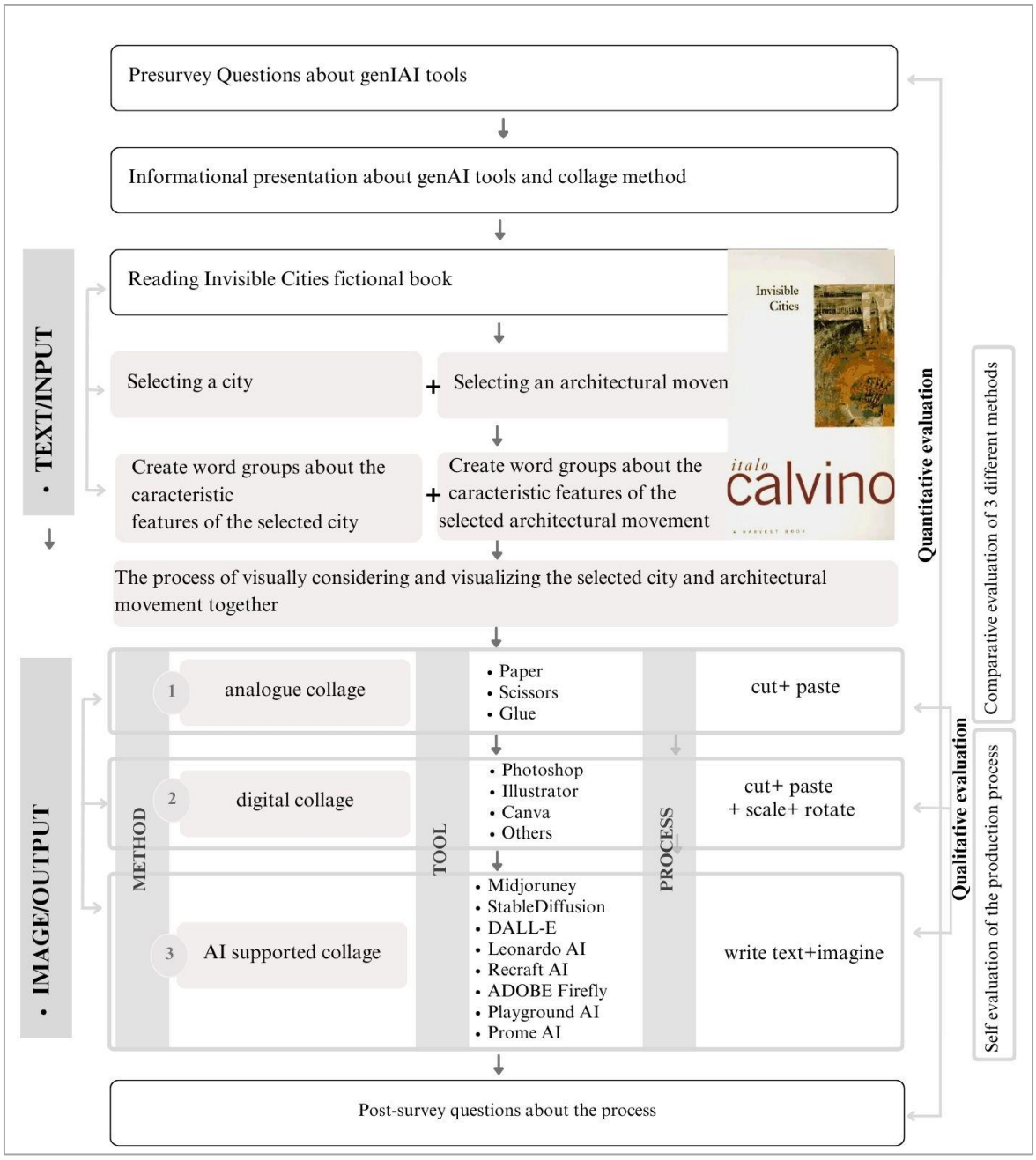


Figure 4.2. Workflow of the second trial

Table 4.11. 14-week course curriculum of Principles of Digital Design and Fabrication course

Week	Content	Hour
1	General information about the lecture	3
2	Readings on collage works in architecture /Student representations and reflections	3
3	Student reproduction of passages from Invisible Cities with selected architectural movements / Collage workshop	3
4	Transformation of fictional texts /Digital collage workshop	3
5	Artificial Intelligence- Principles of generative AI tools- text-to-image concept	3
6	Information about artificial intelligence tools, student suggestions	3
7	Visual production experiments via generative artificial intelligence tools	3
8	Presentations/discussion of artificial intelligence-supported visual productions	3
9	Discussing visual designs produced by different artificial intelligence tools	3
10	Practices on plugins (editing/ out zoom/ zoom/ edit in canvas/ painting/ outpainting/ styles)	3
11	Student works on combining multiple genAI tools in one visual design	3
12	Student works on combining multiple genAI tools in one visual design	3
13	Editing selected images with the help of editing tools	3
14	Discussion on the evaluation criteria for the production process with artificial intelligence and the parameters affecting the quality of the final product	3

Participant A chose the city of Leonia from the book Invisible Cities. Leonia is a city where the inhabitants wake up each new day with clean clothes and belongings, and the garbage and used items from the previous day are collected outside the city to form the walls surrounding the city. Scavengers regularly transport all the garbage produced in the town, and this circulation maintains the municipality's order (Calvino, 1972). As a participatory architectural movement, he chose Archigram, a paper architecture based on the manifesto that cities and buildings can be transported. The scavengers carrying garbage to Leonia (Table 4.12) are identified with the zeppelins carrying the towns and buildings proposed by Archigram.

Participant B chose the city of Bauci from the book Invisible Cities (Table 4.13). Bauci is located on a platform raised above the ground on flamingo legs, and people stand in this city with binoculars and telescopes, looking at the Earth from a distance (Calvino, 1972). Participant B chose High-tech architecture as the architectural trend. He aimed to depict the city of Bauci as a city built with high technology.

Participant C chose the city of Armilla from the book Invisible Cities (Table 4.14). Armilla is an unfinished city with no walls, floors, or roofs, with steep and long water pipes rising into the sky. The connection points of the pipes consist of siphons, bathtubs, and plumbing details. The city's only inhabitants are women bathing in these tubs and water nymphs (Calvino, 1972). The participant chose the International Style (Algan, 2022), an architectural movement that combines simple, minimalist, and orthogonal forms with glass and metal materials. The plumbing pipes of Armilla were used to produce orthogonal forms, and the bright and unfinished state of the town was represented using glass dividers.

Table 4.12. Characteristic features of the selected city and architectural movements

<table>
<tr><td>Participant A</td><td>Selected Architectural Movement:</td><td>Archigram</td><td>Selected City:</td><td>Leonia</td></tr>
<tr><td>Keywords:</td><td colspan="2">visionary, futuristic, playful, imaginative, pop culture, comic style</td><td rowspan="4">FEATURES OF THE CITY</td><td rowspan="4">● There is no material reference in the text.
● There is no color reference in the text.
● Surrounded by garbage mountains. Garbage quality evolves with the development of the city.</td></tr>
<tr><td>Characteristic features:</td><td colspan="2">Modular, flexible, mobile, temporary</td></tr>
<tr><td>Form/ Material:</td><td colspan="2">High technology and materials challenge traditional, flexible structures.</td></tr>
<tr><td>Color:</td><td colspan="2">Colorful and playful</td></tr>
</table>

Table 4.13. Characteristic features of the selected city and architectural movements

Participant B	Selected Architectural Movement:	High Tech	Selected City:	Bauchi
Keywords:	Technology, Geometry, Demonstration		*FEATURES OF THE CITY*	● There are no walls, ceilings, or floors; there is just a forest of pipes, and the bathtubs, sinks, or toilets are bonded to pipes. ● The city may have been corroded or unfinished. ● There are nymphes everywhere, believed to bring water to the city. ● There are only women living here.
Characteristic features:	Expression of volume, not mass, open floor plan, functionality, clean lines, sharp and light geometric forms			
Form/ Material:	Steel, glass, concrete minimalist, sleek, and industrial surface			
Color:	Natural color: white, grey			

Table 4.14. Characteristic features of the selected city and architectural movements

Participant C	Selected Architectural Movement:	International Style	Selected City:	Armilla
Keywords:	no ornament, natural light, balance, simplicity		*FEATURES OF THE CITY*	● just a forest of pipes and the bathtubs, sinks, or toilets bonded to pipes. ● the city may have been corroded or unfinished. ● there are nymphes everywhere, believed to bring water to the city. ● There are only women living here.
Characteristic features:	Open floor plan, functionality, clean lines, sharp and light geometric forms			
Form/ Material:	Steel, glass, concrete minimalist, sleek, and industrial surface			
Color:	Natural color: white, grey			

Table 4.15. Characteristic features of the selected city and architectural movements

<table>
<tr><td>Participant D</td><td>Selected Architectural Movement:</td><td>De Stijl</td><td colspan="2">Selected City:</td><td>Eudoxia</td></tr>
<tr><td>Keywords:</td><td colspan="2">Geometric Abstraction, Balance, Minimalism</td><td rowspan="4">FEATURES OF THE CITY</td><td colspan="2" rowspan="4">● design of carpet, carpet's harmonious pattern
● symmetrical motives whose patterns are repeated along straight and circular lines, reached by climbing ladders
● the crowded, narrow streets</td></tr>
<tr><td>Characteristic features:</td><td colspan="2">Clean Straight Lines</td></tr>
<tr><td>Form/ Material:</td><td colspan="2">Right Angles, Clean Straight Lines, Horizontal and Vertical Emphasis, Horizontal and Vertical Emphasis, Modularity, Grids and asymmetry</td></tr>
<tr><td>Color:</td><td colspan="2">Red, yellow, blue, white, black</td></tr>
</table>

Participant D chose the city of Eudoxia from the book Invisible Cities (Table 8). Eudoxia resembles a carpet woven with colored threads, with dead-end streets and colored blocks on different levels connected by stairs (Calvino, 1972:96). The participant chose De Stijl, a modernist movement in which the primary colors, black and white, are in the foreground, as the architectural trend. The fact that the city of Eudoxia is a city of colorful and geometric movements is likened to Mondrian paintings, a product of the De Stijl movement.

Table 4.16, Table 4.17, Table 4.18, Table 4.19 include the relationship level of the word groups (input) and images (output) created by the students in the analog collage, digital easy and AI-supported design processes, the positive and negative situations encountered in the process, and the evaluations of the final images.

Table 4.16. Methodical analysis and evaluation table on analog collage, digital collage, and AI-supported design processes of city Leonia.

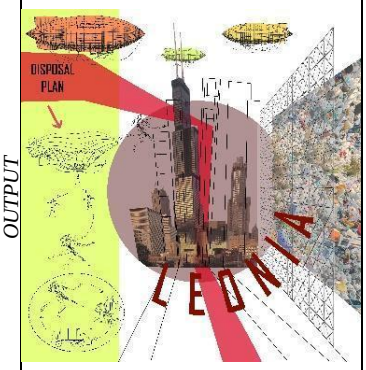
ANALOGUE COLLAGE		*DIGITAL COLLAGE*		*AI SUPPORTED DESIGN*	
INPUT	garbage mountains, consumption objects, texts, high-tech buildings or assemblies, old magazines, hygiene, and garbage removal concept	*INPUT*	garbage piles, modern high-rise building's view, objects/drawings for garbage disposal plan, zeppelins text styles for slogans, layers of boundaries as structure	*INPUT*	On the horizon, garbage piles like mountains. On the sidewalk of the road to the city center, there are spotless plastic bags full of garbage. On the road are futuristic garbage trucks. The people are cleanly dressed. Borders overflowed with plastic bags. An avant-garde archigram architecture style from the 1960s is high-rise buildings and zeppelins with the text "Instant Disposal Plan." The text" LEONIA" is on the top of the paper
OUTPUT		*OUTPUT*		*OUTPUT*	
Difficulties	Finding the right images related to my early sketch concept, both with different photos and collage composition	*Difficulties*	"garbage," "tall building," etc. Having endless resources for a simple keyword has made it difficult to choose the right image. For this reason, I spent more time selecting images than composing them.	*Difficulties*	Characteristic structures of zeppelin and arthrogram were not found in the visual.
Positive aspects	Even though it was difficult to access the image in my mind with the limited materials, the process allowed me to use creativity to get what I planned in the early sketch.	*Positive aspects*	It was easy to scale the materials I chose in Photoshop. It was a good experience to evaluate many materials I chose by turning the layer off and on and finding the best one to improve the composition.	*Positive aspects*	The visual image did not match the poster I had aimed for in other works, but the pastel colors and atmosphere succeeded.
Self Evolution: I used images from old magazines. I tried to create a poster-like image of the city with texts and slogans. Garbage trucks and garbage collectors were seen as savior angels for this city, which was clean and new every morning.		*Self Evolution: I planned to create a layered city that* included a garbage pile by positioning the city in the center, with a perspective of town. Inspired by the archigram movement, I added the "Instant Disposal Plan" event as a futuristic reflection of a garbage disposal project.		*Self Evaluation:* The imagined illustration was like a poster. Previously, trials were also not successful in this area.	

Table 4.17. Methodical analysis and evaluation table on analog collage, digital collage, and AI-supported design processes of city Bauci

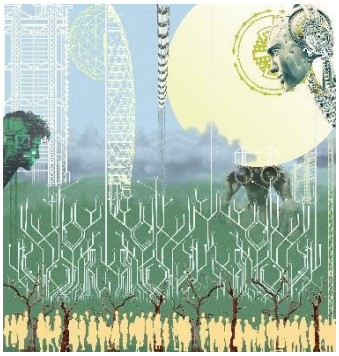
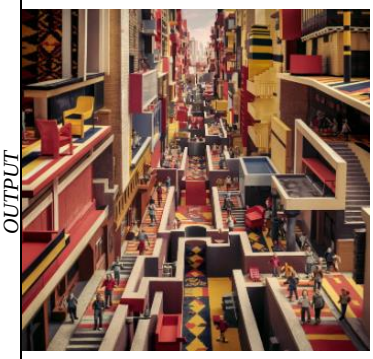
ANALOGUE COLLAGE		*DIGITAL COLLAGE*		*AI SUPPORTED DESIGN*	
INPUT	carpet's harmonious pattern, various types of street order de stijl colors vertical and horizontal lines crowded streets	*INPUT*	The duality of a high-tech city high above the ground, clouds, and an undeveloped town underground, people above the ground are becoming robots. People in these two worlds watch each other through binoculars. Due to high technology, people above the clouds are like robots, while those below are standard and monotonous.	*INPUT*	A high-tech city floating on flamingo foot-like pillars above a sea of fog, and a futuristic community peering through technologically advanced fog with binoculars. The town is made of glass, steel, and plastic in bright yellow, red, and blue colors, a world of rotten trees and ruin. The two worlds are separated by a thin fog, symbolizing the stark contrast between futuristic and primitive.
OUTPUT		*OUTPUT*		*OUTPUT*	
Difficulties	Create a standard composition with all images; the scale incompatibility of the found images caused difficulties.	*Difficulties*	Making a 3-dimensional design in a 2-dimensional worksheet was a challenge. I had difficulty expressing people and their actions due to the scale of the collage work, where I had to deal with combining structures in a composition.	*Difficulties*	There are more city depictions than the desired city; the results not included in the input appear in the image and require editing.
Positive aspects	I developed my creativity by combining physical objects from various sources and deriving new meanings from different objects.	*Positive aspects*	Digital collage work has enabled me to be free in my design by minimizing the limitations thanks to the numerous drawing and visual possibilities available on the internet, or I can draw myself through Photoshop.	*Positive aspects*	Bauhaus colors were reflected very well; I had the opportunity to quickly change the visual by changing the prompts.
Self Evolution: I expressed the view of this city with a person who jumps to completely different universes with VR glasses and experiences that high technology. The collage contrasts the high-tech Bauchi city with the world's surface, whose green areas have decreased.		*Self Evolution: The high-tech architectural movement expresses that while there is life in a place where trees are destroyed,* and people are impoverished, there is a high-tech city above the ground and the clouds connected with digital network connections.		*Self Evolution: This image is produced straightforwardly,* and the details are not readable.	

Table 4.18. Methodical analysis and evaluation table on analog collage, digital collage, and AI-supported design processes of city Armilla.

ANALOGUE COLLAGE		*DIGITAL COLLAGE*		*AI SUPPORTED DESIGN*	
INPUT	forest of pipes, nymphes, women, bathtubs, sinks, green, glass walls, international style, natural colors, integration of human and nature	*INPUT*	pipes in a forest, women, nymphes, showers, glass walls, plants, international style, natural colors, human and natural integration, and a deep scene	*INPUT*	Image of the mystical city of Armilla with additional forest elements, where rectangular glass walls and modern-style rooms are constructed on pipes that rise towards the sky. Between the pipes, glass rooms serve as baths for women bathing in tubs. It is unfinished but is in perfect harmony in the forest, as water fairies provide water and play around a pond on the ground. Soft lights and sharp lines
OUTPUT		*OUTPUT*		*OUTPUT*	
Difficulties	It was hard to create a perspective from the pipes. It was challenging to mix human and nature and an architectural style.	*Difficulties*	I tried to transfer the effects of the international style to the city without disturbing Armilla's mystical world. Finding textures and materials that would show the characteristics of the style and bringing the ingredients together was challenging.	*Difficulties*	The words woman and nymphs did not find enough responses in the prompt, and I had difficulty adjusting the relationship between city and human scale.
Positive aspects	The lack of things that can be done in the digital environment, such as being unable to change the scale of the materials at hand or changing their opacity, has made it challenging to create a composition.	*Positive aspects*	It was easier to combine city details digitally. The many possibilities of changing the images through the program helped convey the forest image I created.	*Positive aspects*	The city atmosphere and lights are depicted very successfully.
Self-Evolution: While creating the analog collage, I tried to make a composition close to the exact image of Armilla that came to my mind when I read the book. The city is described as a mystical forest world full of water fairies and women. There was a city rising from pipes on the banks of a pond. In analog collage, I tried to get to know this world as well as possible and create the most realistic atmosphere.		*Self Evolution:* It was enjoyable to make digital collages in a virtual environment with endless possibilities. Working in a virtual environment is a good exercise to push the limits of imagination. As the options increase, it becomes more challenging to achieve what you want, so extra brainstorming is needed.		*Self Evolution:* In this image, I observed that the artificial intelligence tool could not visualize the woman and nymph figures on the prompt. The artificial intelligence tool understands all the words in the prompt, but the forest element is minimal in the image, and the woman bathing is not visible.	

Table 4.19. Methodical analysis and evaluation table on analog collage, digital collage, and AI-supported design processes of city Eudoxia.

ANALOGUE COLLAGE		*DIGITAL COLLAGE*		*AI SUPPORTED DESIGN*	
INPUT	The transition between universes, the Industrial Revolution, technological transformation, the age of artificial intelligence	*INPUT*	Keep the line order and colors of de stijl down and juxtapose them with the city's complicated structure. Create a crowded and complex street design, mixing the de stijl line features and the city's narrow, dead-end, and broad street order. I preferred the top view to understanding the harmony between them. Red, yellow, and blue are the primary colors. Each part connects streets that have different sizes and quality. The city resembles the carpet motives. The whole appearance of the collage gives a feeling of complexity within order and harmony.	INPUT	The De Stijl architectural movement inspires the 3D realistic rendering of the cityscape. The streets are filled with narrow paths, stairways, and dead ends. At first sight, nothing seems to resemble less than the design of that carpet, which is laid out in symmetrical motives whose patterns are repeated along straight and circular lines. Red, yellow, and blue. The city has geometric forms and structures, reflecting the principles of the De Stijl architectural movement. The urban landscape is depicted with a diverse crowd of happy people walking the streets in the style of realistic architectural photography.
OUTPUT		*OUTPUT*		*OUTPUT*	
Difficulties	The De Stijl has primary colors and orders, and my city especially resembles carpet motifs. Therefore, it was not easy to find suitable motifs, patterns, or images and combine them with the order and colors of the De Stijl architectural movement.	*Difficulties*	the city resembles the carpet motives, so it is hard to provide harmony between this complicated city and de Stijl's more minimalist position	*Difficulties*	Not being able to see all the elements mentioned in the prompt in the visual results.
Positive aspects	similarities between the city and architectural terms in terms of colors and straight lines	*Positive aspects*	De Stijl's features and the city of Eudoxia have similar features. Both have various colors and a balance. Horizontal and vertical features are also standard.	*Positive aspects*	To produce works in a very short time and the desired colors. Being able to produce three-dimensional forms more quickly than collage work
Self Evolution: I expressed the view of this city with a person who jumps to completely different universes with VR glasses and experiences that high technology. The collage work contrasts the suddenly changing surface of the high-tech Bauchi city with the world's surface, whose green areas have decreased significantly over time.		*Self-evolution:* The city, a blend of urban environment and architectural style, embodies a mix of chaos, vibrancy, and order. This city, reminiscent of a carpet, has gained structure through the De Stijl architectural movement. Horizontal and vertical lines have divided the city into regions, aiming to provide people with various experiences through different types of streets.		*Self Evolution:* In this image, I changed the text a bit. Unlike the other visuals, the city has gained a different perspective. While it usually offers a top view, I removed the 'top view' expression, resulting in a closer look at the city. The expression "several people on the street" worked well in this visual. I want more diverse streets that combine the city and architectural style.	

After the analog collage, digital collage, and AI-assisted collage steps, a detailed examination of the inputs of the production step with AI was made. This step measures the relationship between the AI tool and the change observed in the resulting quality when used with the same prompt.

Table 4.20 shows the visual outputs obtained by giving the prompt written by the participant as input to 3 different AI tools, Ideogram AI, CoPilot AI, and Leonardo AI, during the visualization of the city of Bersabea, a city of shiny jewels, richness and meticulousness below the ground, and a dark city full of garbage and filth built by master architects below the ground, by adapting it to the Bauhaus movement.

Table 4.20. Visual productions of the city of Bersabea produced with three different genAI.

<table>
<tr><td colspan="2">City: Bersabea</td><td>Architectural movement:
Bauhaus</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>Ideogram AI</td><td>CoPilot AI</td><td>Leonardo AI</td></tr>
<tr><td>PROMPT</td><td colspan="2">There is a place called Bersabea where two different cities are on top of each other. The upper town's buildings are jeweled, sharp-edged, Bauhaus-style red, blue, and yellow. People uptown are happy. The doors of the buildings are gold, and the locks are silver, creating a jewel city. In the lower city, the buildings are made of garbage, fish bones, dishwater, and dirty paper, but they are still in the sharp-edged Bauhaus style. The upper city has a planet of broken eggs, broken umbrellas, filthy rags, potato peelings, and glass shards, all blowing in the wind.</td></tr>
</table>

Table 4.21. Shows the visual outputs obtained by giving the prompt written by the participant as input to 3 different AI tools, Adobe Firefly, Ideogram AI, and Leonardo AI, during the visualization of the city of Eudossia, which resembles a carpet where stairs connect dead-end streets and colored blocks at different levels, adapted to the De Stijl movement.

Table 4.21. Visual productions of the city of Eudossia produced with three different genAI.

<table>
<tr><td colspan="2">City: Eudossia</td><td>Architectural movement: De Stijl</td></tr>
<tr><td colspan="2"></td><td></td><td></td></tr>
<tr><td colspan="2">Adobe Firefly</td><td>Ideogram AI</td><td>Leonardo AI</td></tr>
<tr><td>PROMPT</td><td colspan="3">The city has narrow streets, stairs, dead-end streets, and poor neighborhoods stretching up and down. The cityscape has a variety of colors and urban textures that resemble motifs in a carpet pattern. There are red, yellow, and blue colors of the De Stijl architectural movement on the streets. De Stijl's iconic chair is also on the streets as urban furniture. The streets of the city were designed vertically and horizontally with the geometric forms of the De Stijl architectural movement. The “De Stijl” architectural movement influences the cityscape, and the city has a realistic 3D appearance. Many happy people are on the streets, making this a crowded and lively city. Architectural. 3D reality.</td></tr>
</table>

After the same prompt was tested with three different AI tools, the improvement of the prompt created with an AI tool found to be more successful was studied. Table 4.22 and Table 4.23 show the images of the cities of Eudossia and Bersabea produced by the participants, together with the tool, style, prompt, and prompt analysis.

Table 4.22. Evaluations of the visual production produced by Ideogram AI of the city of Eudossia

OUTPUT OF EUDOSSIA	AI Tool	Effective words	Objects Not Included In The Prompt
	Ideogram AI	- red and yellow - pattern -3D realistic rendering	- bird's eye view
	Architectural movement	Ineffective words	Strong Words
	De Stijl	Crowd of people -people walking or sitting - circular pattern -red and blue chair -Gerrit Rietveld	- red and yellow - pattern - 3d rendering
	Discussion: I rewrote the text and transformed more essential sentences. I highlighted the names of the colors, but the blue color is not dominant in the photo. I wanted the building structures in the city to resemble the structures designed by Genry, but I did not find this successful. However, the characteristics of the style are reflected more clearly. In the general atmosphere, the visual does not give the feeling I want. I think this text is too long for the AI tool.		

Table 4.23. Evaluations of the visual production produced by Ideogram AI of the city of Bersabea

OUTPUT OF BERSABEA	AI Tool	Effective words	Objects Not Included In The Prompt
	Ideogram AI	-Bauhaus style -yellow, blue, red -rubbish -broken egg -dirty rag	-four sections, a ladder, a line of garbage
	Architectural movement	Ineffective words	Strong Words
	Bauhaus	-a connected city	-two different above and below City
	Discussion: Divided the image into four parts in Bauhaus style created correctly. It made the stairs even harder. The prompt added a staircase even though I did not ask for it.		

4.3. Third Trial

In this step of the production, city images were produced through a Mondrian painting with the participation of 27 undergraduate students within the scope of the “Visual Communication” course of Istanbul Technical University Department of Architecture (Figure 4.3).

Mondrian paintings were considered suitable bases for 2D and 3D visualization due to their simple forms and colors. While the black contour lines act as separators in the composition and act as lines in the 2D drawing step, they turn into structural and different scaled elements, such as stairs and corridors connecting the volumes in the 3D drawing step and the visualization step with AI. After these tables are produced digitally, they are drawn in two dimensions on Autocad in an 8x8 cm square. After the 2D drawing, the 8x8 cm 2D drawings of yellow, blue, red, white, and black quadrilaterals were elevated on an 8x8 cm ground with 3D modeling tools and made three-dimensional. Scaled orthographic images of the obtained models were recorded. These images were given as input to the GenAI tools and developed to form a city parcel according to the criteria determined by the participants. City images were generated using these orthographic images as a base, and the participants entered text prompts.

A city produced by each participant constitutes the units of a whole in the next stage. The parcels come together on a floor in the workshop environment, and the participants were asked to form groups consisting of 3 to 5 parcels in line with the criteria they set themselves and to form groups consisting of the number of members in the number of parcels. A collage work was realized by cutting and pasting on isometric paper. The parcels were asked to be brought together to form a narrative, and this narrative was asked to create reference prompts for secondary artificial intelligence generation. The parcels that come together form a neighborhood consisting of multiples of 8 cm. An abstract orthographic drawing of this neighborhood is created. With this drawing, a new city is generated with new text prompts.

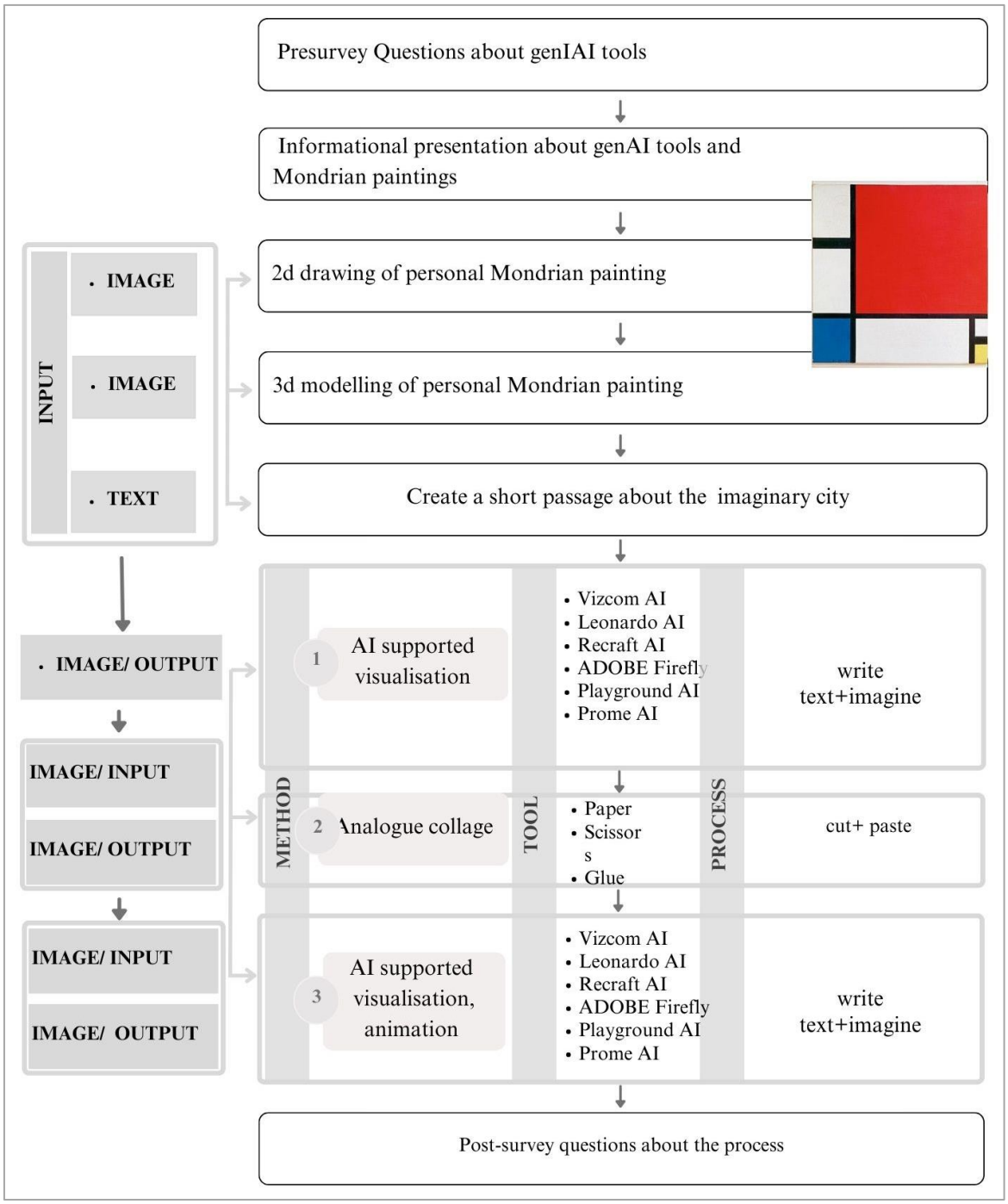


Figure 4.3. Workflow of the third trial

Mondrian's paintings include compositions on a white background, created with the principle of using red, yellow, and blue colors with straight lines and geometric shapes in a particular rhythmic order. With the use of essential forms and colors, the effects of abstraction art and modernism are evident in the paintings (Azer, 2023) (Figure 4.4).

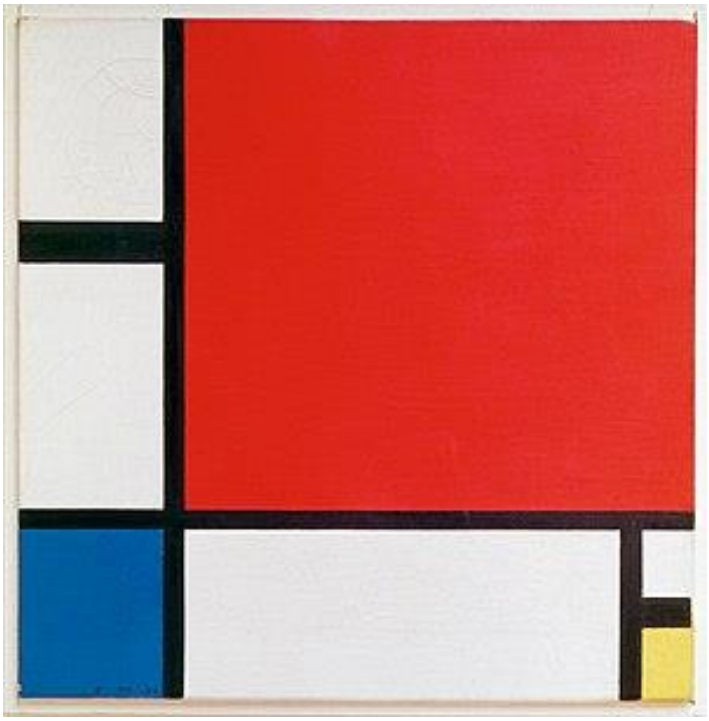


Figure 4.4. Piet Mondrian, “Composition II in Red, Blue, and Yellow” 1930 Wikipedia, 2024.

Mondrian's paintings were chosen as a base for the students' two-dimensional and three-dimensional drawings, as they contain line and quadrilateral areas of different sizes and simple primary colors. Using primary colors increases the three-dimensional model's visual legibility of mass movements. Linear movements are envisioned to transform into urban elements such as streets, buildings, stairs, and avenues for the urban parcels, which are the target visuals of the workshop.

Table 4.24., Table 4.25. and Table 4.26 show the 2D and orthographic drawings produced by Participant 1, Participant 2, Participant 3, and Participant 4 and the city parcels produced by AI tools with references from these drawings.

Participant 1 produced a Mondrian painting that causes intense linear movements and, therefore, intense mass movements in the three-dimensional model. He describes this model as “Make a realistic city view from that 3D model. I imagine a city with lights, streets, buildings, rooftops, green environment, transportation solutions, etc. Make it more detailed, make it more interesting, make the buildings more realistic” prompt. It is seen that the concepts in the prompt, such as rooftops, transportation solutions, and green environment, are not included in the visual.

Table 4.24. 2d, 3d, and AI visualization steps of Participant 1

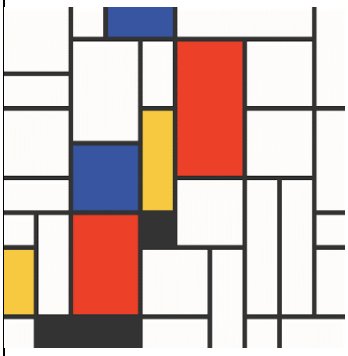
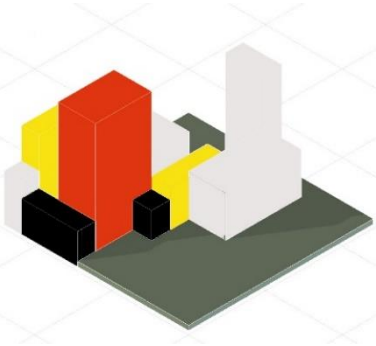
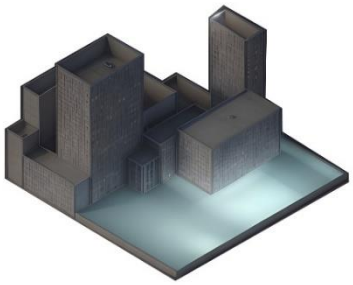
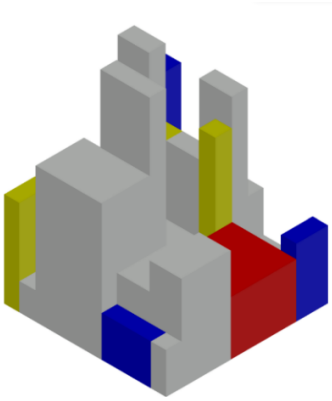
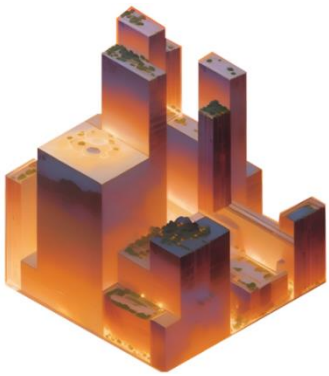
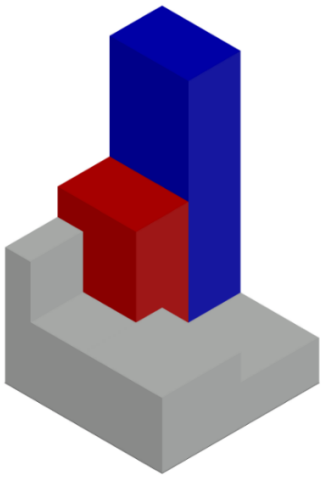
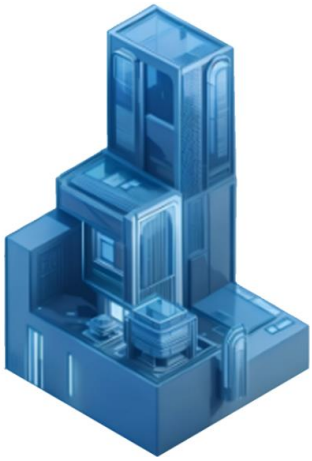
PARTICIPANT 1	*2D drawing*	*3D model*	*AI sup-design*
			
			AI tool | Vizcom AI
	Prompt	Make a realistic city view from that 3D model. I imagine a city with some lights, streets, buildings, rooftops, green environment, and transportation solutions vs. making it more detailed, make it more interesting, make the buildings more realistic.	

Table 4.25. 2d, 3d, and AI visualization steps of Participant 2

PARTICIPANT 2	*2D drawing*	*3D model*	*AI sup-design*
			
			AI tool | Vizcom AI
	Prompt	A bright, colorful, authentic, and high-tech city.	

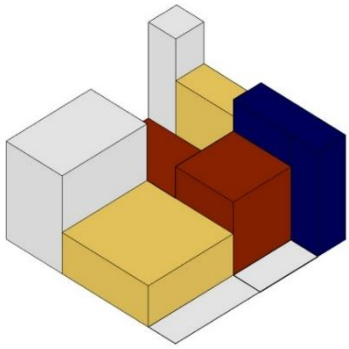
Participant 3 produced a Mondrian painting with less linear movement and color than the other participants. The axonometric view produced by modeling the painting was visualized with the Prompt, “It is a city where homes and workplaces have high-tech windows and doors.” It was visualized with the Prompt. It was observed that the term *high-tech windows* in the Prompt corresponded with the visual, while concepts such as *homes and workspaces* did not.

Table 4.26. 2d, 3d, and AI visualization steps of Participant 3

PARTICIPANT 3	*2D drawing*	*3D model*	*AI sup-design*	
				
			AI tool	Vizcom AI
	Prompt	It is a city where homes and workplaces have high-tech windows and doors.		

Participant 4 produced a Mondrian painting with intense color but not intense linear movement. Three-dimensional image of the painting: “Let the flat areas be streets, and the prisms be buildings. Glass style should be used. Let it be a city with people and trees.” prompt. The concepts of *people and trees* in the prompt and the definition of *letting the flat areas be streets and the prisms be buildings* are included in the visual.

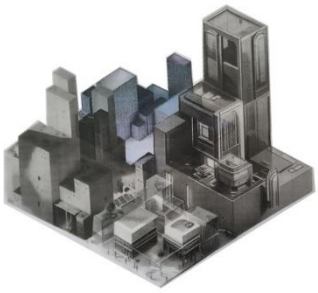
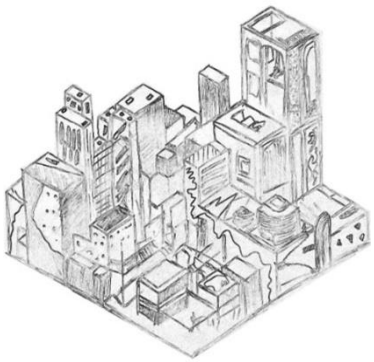
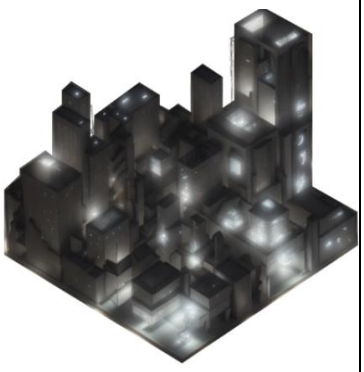
Table 4.27. 2d, 3d, and AI visualization steps of Participant 4

	2D drawing	*3D model*	*AI sup-design*	
PARTICIPANT 4				
			AI tool	Adobe Firefly
	Prompt	Let the flat areas be streets, and the prisms be buildings. Glass style should be used. Let it be a city with people and trees.		

The four cities produced by these 4 participants form a collage on isometric paper. Produced by four students, these four cities with different concepts and volumetric movements constitute Collage City 1 in Table 4.28. A re-orthographic drawing of this city was made with simple lines. This drawing was again given as a reference to AI tools to create a new narrative independent of the characteristics of the four parcel cities, and a new visual production was provided.

Collage City in the table is a city image where the city parcels produced by Participant 1, Participant 2, Participant 3, and Participant 4 come together to create a concept on isometric paper. Participants can combine the cities they choose on this isometric paper without gluing, using the relationships and narrative they want. In this way, producing and changing various variations will be possible. The selected collage city was photographed, and then an orthographic drawing of this collage city was asked to be made. Unlike the technical drawing made in the first stage, this is an orthographic drawing that includes freehand sketches and details about the narrative attributed to the city by the participant. The photograph of this orthographic drawing was given as a reference to the GenAI tool, and the collage city was re-visualized with a written text as a prompt.

Table 4.28. Collage of city, axonometric perspective drawing, and secondary AI image

COLLAGE CITY 1	*Collage City*	*Orthographic Drawing*	*AI sup-design*
			
	AI Tool: Vizcom AI	*Prompt*: dystopic city with lights, people, animals, streets, dark weather, and chaos scared people, screams, artistic	

5. DISCUSSION

This part of the thesis includes the outputs of the three production steps described in the field study. The first part of the outputs of the field study consists of the questionnaire questions asked to the students before the application and the analysis of their answers, and the second, third, and fourth parts are the evaluations of the three application steps.

5.1. Analysis of Survey Questions

In all three steps, pre-survey questions were asked to the students before the workshop to measure their ideas about AI, familiarity with AI tools, concerns, and expectations, and post-survey questions were asked to learn about their experiences and opinions after the workshop. The answers to these questions are discussed in this section.

5.1.1. Analyses of survey responses/ first trial

When the students were asked whether they had any information about using artificial intelligence in the design field before the application studies started, 5 out of 6 students answered yes. One answered no (Figure 5.1).

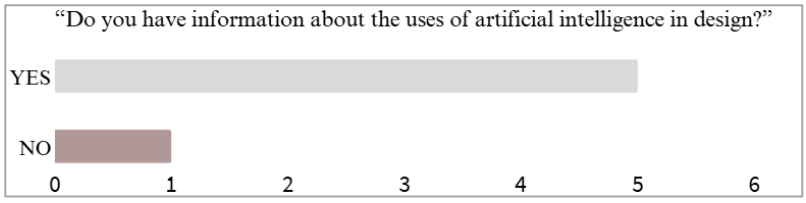


Figure 5.1. Students answer the question: "Do you have information about the uses of artificial intelligence in design?"

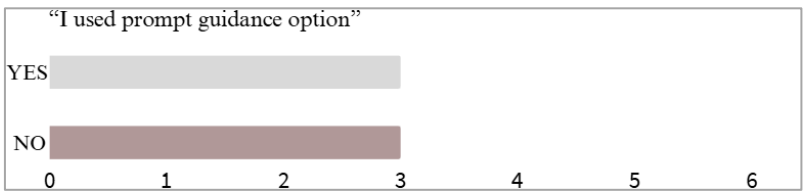


Figure 5.2. Students answer the questions: "Have you used the prompt guidance option?"

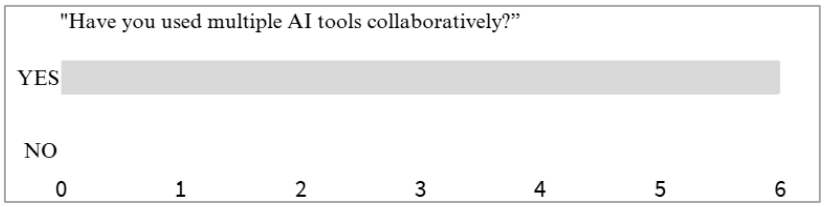


Figure 5.3. Students answer: "Have you used multiple AI tools collaboratively?"

After completing the workshops and collage productions, the students were asked to answer measurement questions about the process. These questions aim to measure the variables on which the qualities of the collage outputs realized with AI depend. Some AI models, such as Leonardo AI and Prome AI, have the option of "prompt guidance," which allows the command typed by the user to be improved with AI support. Students were asked whether they used the quick guidance option in their completed artificial intelligence studies. Of 6 students, three answered yes, and three answered no (Figure 5.2). These AI tools use not only text but also existing images as input. In this way, it is possible to edit an image produced in one AI tool with another AI tool. When students were asked whether they used these tools together, they answered that they used more than one AI tool collaboratively (Figure 5.3). Based on these responses, it is possible to say that a single AI tool is not enough to achieve the desired outcome.

When examining artificial intelligence applications, it is seen that the qualities and order of the words that make up the prompt directly affect the quality of the final product. Students were asked to write down "the words they should change the most in the prompts." Table 5.1 lists the concepts that do not appear in the output when typed in the prompts. The words used frequently in the prompts are listed in Table 5.2.

Table 5.1. Table of the words that cannot be answered adequately in prompts.

STUDENT	Words that cannot be answered adequately in prompts
A	Colorful roses and books in the black hole
B	Alice
C	-
D	Duchess, baby, cat, colorful, Alice, cook.
E	Animals, pool of tears
F	House, tiny, extra, rabbit, animal, giant cupcakes

Table 5.2. The words most frequently used in prompts by six students.

STUDENT	Words with the most successful results
A	Black Hole
B	Generate wide-angle landscape scene.
C	Keyhole, abstract, Alice style.
D	Mystical forest, kitchen, looking at the door, chaos
E	Möbius strip, backturned, running
F	House, little girl, trees, forest background

The answers given by the students to the question, “Did you have difficulty representing spaces while producing with artificial intelligence?” can be seen in (Figure 5.4).

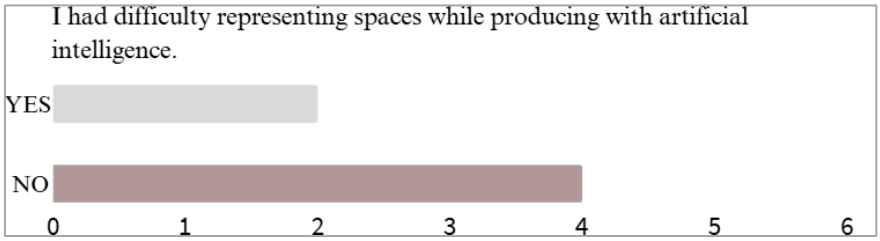


Figure 5.4. Students answer: "Did you have difficulty representing spaces while producing with artificial intelligence?"

When the students were asked about the AI program with the most successful results at the end of the semester, four answered Prome AI, one answered Leonardo AI, and one answered Recraft AI. The outputs obtained in the first phase were edited in the second phase by using them as input for another AI tool. Students were asked with which AI programs they achieved the most successful results in the editing phase; 3 students answered Leonardo AI, two students answered Prome AI, and one student answered Adobe Firefly.

As a general result of these responses, it was observed that Prome AI was the most successful text retrieval AI program used during the course, and Leonardo AI was the most successful in the editing process.

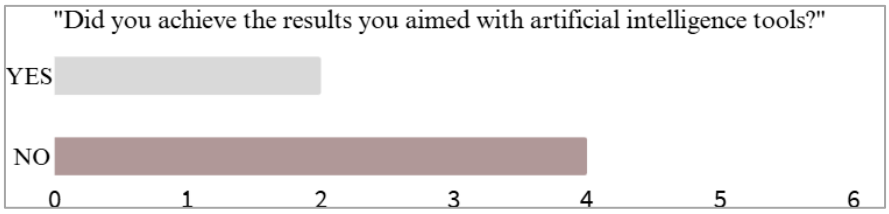


Figure 5.5. Students answer the question: "Were you able to achieve the results you aimed for with artificial intelligence tools?"

Students were asked: "Did you achieve the results you aimed with artificial intelligence tools?" The question was asked, and it was seen that most students answered "no" (Figure 5.5.).

5.1.2. Analyses of survey responses/ second trial

When the students were asked, "Do you have information about the uses of artificial intelligence in design?" Three students answered "no," and eight students answered "yes" (Figure 5.6). "Are you concerned about integrating AI tools into design processes?" Four students answered 'yes,' and seven answered 'no' (Figure 5.7).

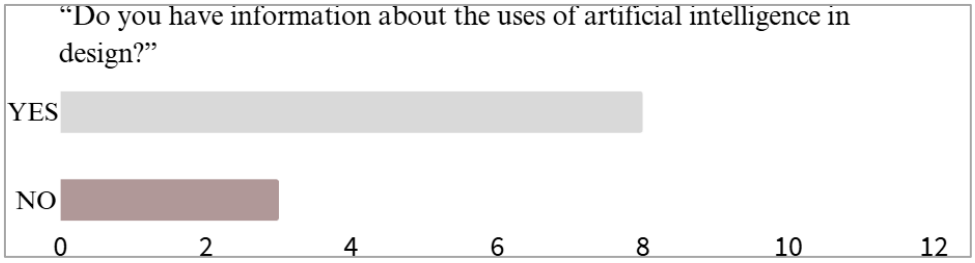


Figure 5.6. Students answer the "Do you have information about the uses of artificial intelligence in design?" question.

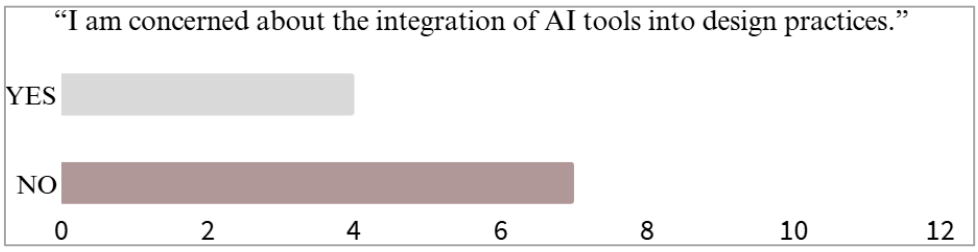


Figure 5.7. Students answer the "Are you concerned about integrating AI tools into design practices?" question.

Six students answered “yes,” and six students answered “no” to the question, “Do you know about artificial intelligence tools that enable image generation from text?”. When asked whether they knew the concept of “Prompt,” seven students answered “no,” and five students answered “yes” (Figure 5.8).

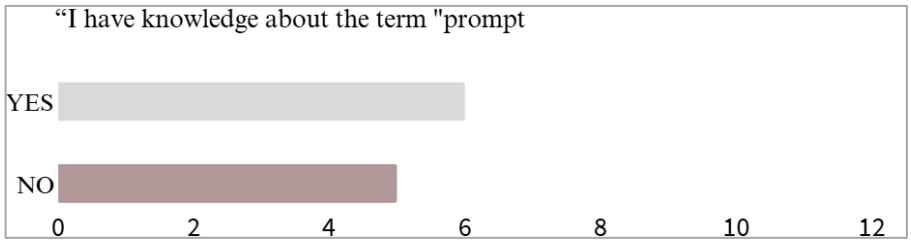


Figure 5.8. Students answer the “Do you know the term ‘prompt’?” question.



Figure 5.9. Students answer the “Have you had the opportunity to produce with artificial intelligence tools that provide text-to-image production?” question

Eight students answered 'no,' and four students answered 'yes' to the questions “Have you had the opportunity to produce with artificial intelligence tools that provide text-image generation?” and “Do you have any knowledge about the working principles of artificial intelligence tools that provide text-image generation?”

When the answers to the survey questions are analyzed as a whole, it is seen that the number of students who do not know the working principles of text-based image-generating artificial intelligence tools and the concept of the prompt is the majority. The number of students with and without knowledge about text-based AI tools and the number of students with and without concerns about integrating these tools into their design processes is equal. One of the PDDFA course outcomes is to enable students to experience more than one text-driven AI tool in the design process.

Post-Process Survey Responses

When the students were asked, “Did you learn about the working principles of artificial intelligence tools?” at the end of the production, all 11 students answered “Yes.” At the beginning of the semester, nine students answered “no,” and two answered “yes” to the same question. This situation was seen to be positive in terms of application outputs.

When the students were asked which textual/visually oriented thinking styles they used in the production process with artificial intelligence, one student said they were visually oriented, and one student was text-oriented; the remaining nine said they thought both textually and visually (Figure 5.10). This majority reveals the positive effect of textual and visual-oriented thinking on the final product during production with AI tools that produce visuals with text prompts.

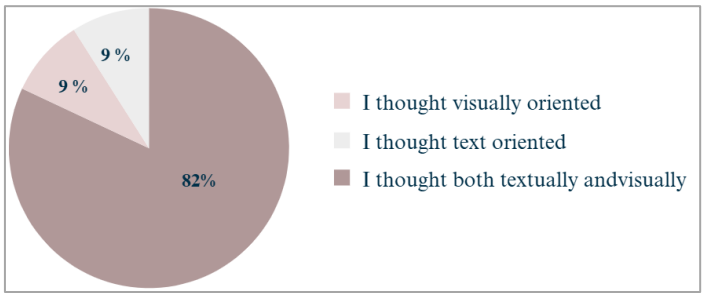


Figure 5.10. Graphic showing the way students think in the production process with artificial intelligence

During the production with artificial intelligence, it was observed that the genAI tool gave visual responses by differentiating the prompt according to the available data. To measure the effect of this situation on creativity in the design process, students were asked the question, “Did artificial intelligence transform the design decisions you made at the beginning of the study? Did it shape your way of thinking?” and it was observed that 10 of the 11 participants answered ‘yes’ and 1 of them answered ‘no.’

Many criteria affect the quality of visual products made with GenAI tools. However, prompt quality is the most important of these criteria. When the students were asked which criteria

affecting the prompt successfully affected their work, most answered: “concrete concepts, short texts, detailed sentences” (Figure 5.11).

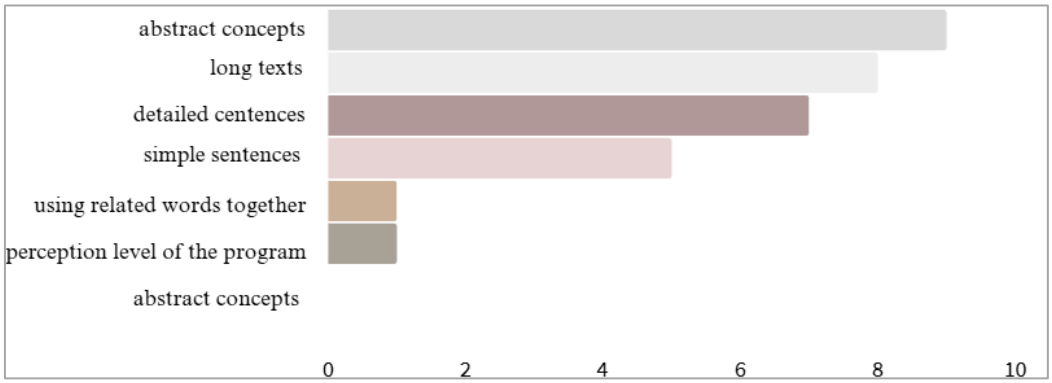


Figure 5.11. Students answer the following question: “In your opinion, what criteria make a prompt successful?”

5.1.3. Analyses of survey responses/ third trial

The third step, the last step of the applications, took place chronologically later than the other two steps, and the number of participants was higher. Participants were asked, "Do you know the uses of artificial intelligence in design?” “Do you know the term prompt?” and “Have you had the opportunity to produce with artificial intelligence tools that provide text-to-image production?” before the practices. The answers are seen in Figure 5.12, Figure 5.13, and Figure 5.14.

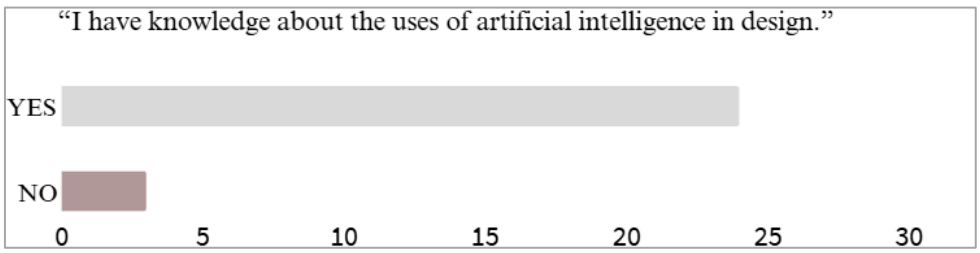


Figure 5.12. Students answer the following question: “Do you know the uses of artificial intelligence in design?”

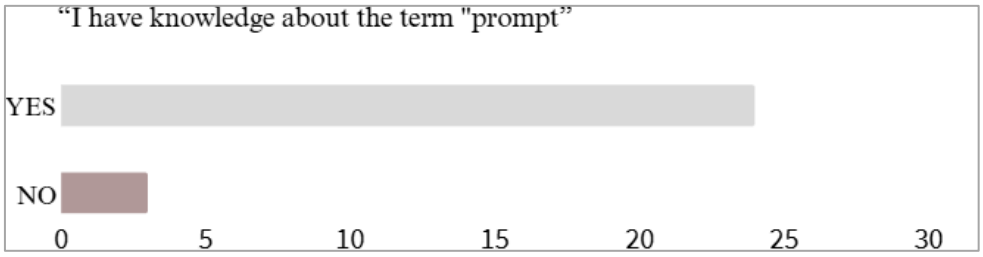


Figure 5.13. Students answer the following question: "Do you know the term prompt?"

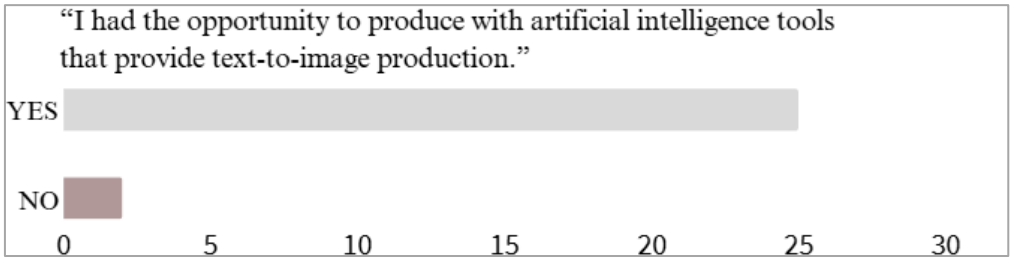


Figure 5.14. Students answer the following question: "Have you had the opportunity to produce with artificial intelligence tools that provide text-to-image production?"

Post-process survey questions

After the implementation phase, students were asked post-process questions about the positive and negative situations they encountered during the implementation process and the parameters affecting the final product when asked which textual/visually oriented thinking styles they used in the production process with artificial intelligence. It was observed that the number of students who stated that they think both textually and visually was the majority (Figure 5.15).

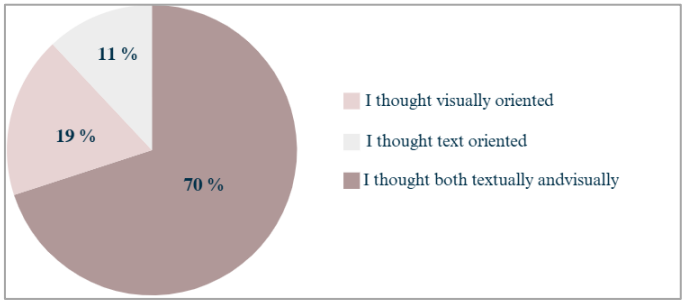


Figure 5.15. Students answer the following question: "Which of the textual, visual, textual, and visual thinking options did you use in your visual productions with artificial intelligence?"

The answers to the question “Were you able to show the colors and textures you wanted in the image you produced with artificial intelligence?” are shown in (Figure 5.16).

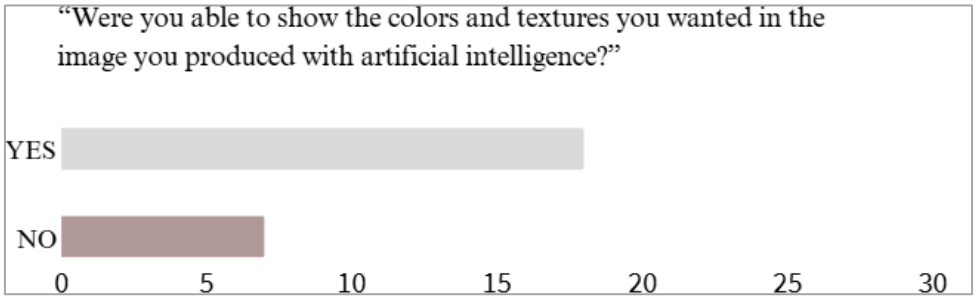


Figure 5.16. Students answer the following question: “Were you able to show the colours and textures you wanted in the image you produced with artificial intelligence?”

The answers to the question “Have there been any cases where objects not included in the text were included in the images you produced with artificial intelligence?” are shown in (Figure 5.17).

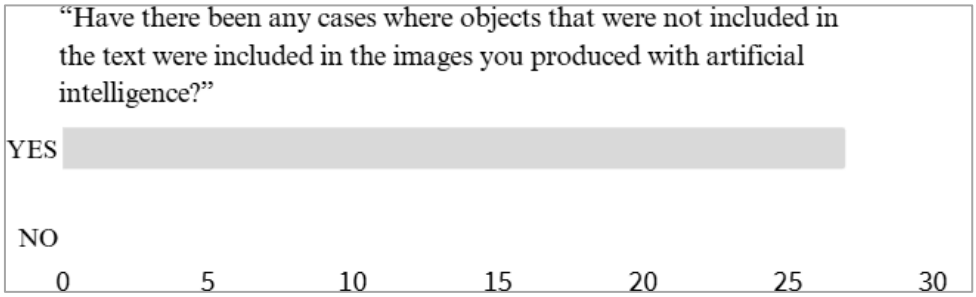


Figure 5.17. Students answer the following question: “Have there been any cases where objects not included in the text were included in the images you produced with artificial intelligence?”

The answers to the question “Were you able to show the architectural features you wanted in the image you produced with artificial intelligence?” are shown in (Figure 5.18).

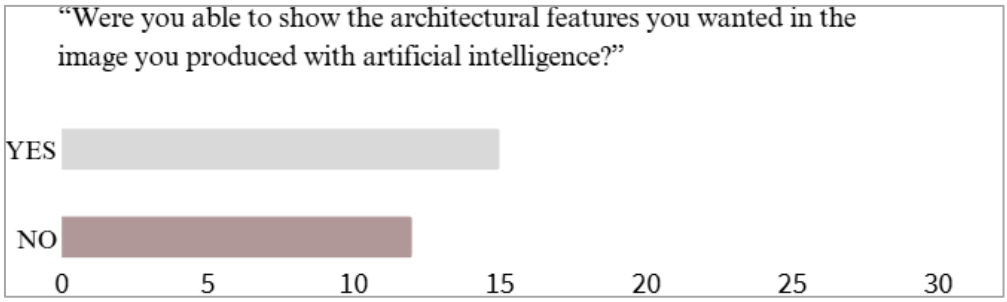


Figure 5.18. Students answer the following question: "Were you able to show the architectural features you wanted in the image you produced with artificial intelligence?"

When the answers to the question "Has AI transformed the design decisions you made at the beginning of the study, did it shape the way you think?" are examined, it is seen that the students who say that AI has affected the way of thinking in design are in the majority (Figure 5.19.).

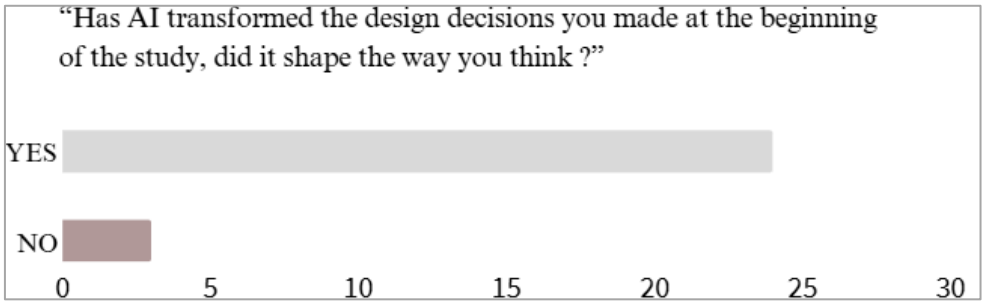


Figure 5.19. Students answer the question: "Has AI transformed the design decisions you made at the beginning of the study? Did it shape the way you think?"

When the students were asked, "Did creating a collage with axonometric urban parcels prompt you to think creatively?" the majority responded in the affirmative (Figure 5.20).

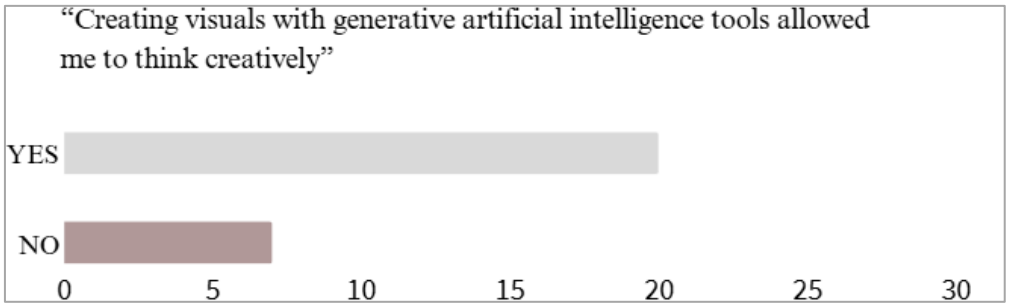


Figure 5.20. Students answer the following question: "Did creating a collage with axonometric urban parcels make you think creatively?"

5.2. First Trial

In evaluating the productions made with analog collage, digital collage, and artificial intelligence-supported tools, students were asked to express their experiences in all three stages with method explanations and visuals.

In the production phase with the analog collage method, students were asked to bring ready-made visuals to the workshop. Students were not asked to present the text they read visually but to create and express their compositions. Problems such as the images cut from magazines and newspapers not being suitable for scaling and limited resources are the difficulties encountered during the study. In addition to these negatives, unlike digital methods, the ability to feel the textures of the materials and experience the assembly of concrete pieces with the collage principle in the workshop environment are among the positive results.

In the digital collage method, students can add all the images they can access from the internet to their work. While this was an opportunity for some students, it was a limiting factor in the decision-making process for others. Unlike the artificial intelligence studies, the open-access images used here were selected through the designer's filter.

Six students produced many images in the AI studies using different AI tools. While the fact that these images did not have the desired quality in the first place was evaluated as a negative situation by the students, the fact that the images could be edited with artificial intelligence tools was assessed as a favorable situation. While obtaining many outputs with a single text input was considered positive regarding fast production, it was considered a

disadvantage at the decision stage. While these images obtained quickly gave quality results with some guidance, images containing human bodies, faces, and animal species were found to be inadequate and needed to be edited. In cases where the visual quality was insufficient, students searched for ways to improve the cues. At this point, many factors, such as the words used, the language used, and the level of detail of the descriptive words, directly affected the visual quality. This situation suggests that the designer's visual design skills and the relationship they establish with the text/word/concept should be sufficient in the text-guided visual production phase with artificial intelligence. Although it offers the opportunity to produce many images in seconds, the fact that these images cannot be accepted by the artist and require various arrangements has been a common feature of the productions made with this method.

5.3. Second Trial

This production process was analyzed at the end of the workshop in terms of various criteria. Each seminar stage was recorded in an online spreadsheet, and participants were asked to record their methods, inputs, outputs, and self-evaluation. All the work was evaluated at the end of the production process. A preliminary survey at the beginning of the workshop aimed to gauge the participant's knowledge and experience with generative AI tools. According to the answers to the survey questions, most students were familiar with AI tools. However, the number of students who knew the application areas of AI tools in design and the working principles of these tools was in the minority. The workshop aimed to familiarize the participants with the working principles of generative AI tools and effective ways to use them. Three stages of visual production followed the survey—all three stages aimed to visually reflect the selected city to reflect the chosen architectural trend. Participants listed the challenges and positive aspects of these phases.

In line with the design decisions of the participants, analog collage works were completed by combining ready-made materials with the cut-and-paste method. The fact that the visual materials that could be used in the analog collage phase were limited to resources such as magazines, newspapers, and brochures limited the desired visuals. Processes such as cutting, folding, and crumpling during collage provided the opportunity to create a more layered visual, and students saw these possibilities as elements that supported creativity. Since finding images in the desired color and scale was impossible, there was a limitation during

collage. In the digital collage phase, computer-aided expression programs such as Photoshop were used to edit and prepare digital images. All kinds of open-access visual materials were used as resources at this stage. Since it was possible to scale and edit the photos quickly, creating compositions in the digital environment was more straightforward than analog collage. While unlimited visual resources were seen as positive, some participants stated that these limitations experienced during analog collage fostered creativity during production but created disadvantages during digital collage. After these two collage phases, the participants explored the interfaces of the artificial intelligence tools and experimented with many visual production experiments. The working principles of synthetic intelligence tools based on fast production made producing images faster than other tools possible. However, it was impossible to process visual elements such as texts and people, which can be processed in detail in collage works with artificial intelligence. The first commands written did not give the desired results, but in the following trials, the commands were transformed to improve the visual results. It was observed that the words used in the selected command directly affect the quality of the final product. The fact that the command consisted of very detailed and long texts and that abstract concepts were included in the command hurt the result.

It was observed that some of the genAI tools used produced better-quality visuals than others. Participants preferred AI tools such as Ideogram, Adobe AI, and Midjourney because they made more successful products.

In this study, visual productions were realized using the commands prepared by the participants using generative AI tools that provide visual production with text commands. The book “Invisible Cities” was chosen as the subject of the study because it contains concepts involving city scale and architectural elements.

The tools used in the study provided fast and realistic visual productions, but these visuals were insufficient to give spatial images detailed structural features. In other words, while these tools created a fast visual whole, they did not offer spatial outputs that could be defined as architectural design.

5.4. Third Trial

In the Third Trial, when the images of the two-dimensional Mondrian Paintings asked from students were compared, it was seen that some paintings contained intense lines and colors. In contrast, in others, these movements were less intense. These linear movements constitute a reference for the three-dimensional model. Therefore, Mondrian paintings with intense linear details have created 3D models with more volumetric effects. Three-dimensional models of these models were produced using various three-dimensional modeling programs such as Sketchup and Autocad, and scaled images were obtained from these programs with the axonometric view option. Each student gave a reference image in this production step and received some outputs from AI. Therefore, AI tools such as Leonardo AI and Vizcom AI that accept reference image input were preferred. These images were given to the AI tools as reference images and re-visualized using prompts containing the students' desired city features. When these city images were compared, it was seen that the visual harmony with the prompt varied according to the style and AI tool used. It was observed that linear and color densities did not directly affect the quality of the visual results.

There was no relationship between the more detailed city image and the mass and linear movement of the image. There was no direct relationship between the more detailed city image and the length of the prompt, but the quality of the words in the prompt was more effective. Digital and analog tools were used sequentially in this step, which included the process of producing a 2d Mondrian painting in the digital environment, making a 3d model of the painting in the digital environment, converting the 3d model into a city image with AI, combining the outputs of the city images on the axonometric ground with the collage technique, and re-visualizing this whole with AI by adding a new narrative withdrawing. Participants' collaboration with AI, collaboration between AI tools and other representation tools, and listing the factors affecting creative thinking in these steps with survey questions constituted the production outputs.

5.5. Outcomes

With the literature review and the examination of the theoretical background, it was seen that the emergence of the concept of artificial intelligence and the studies that formed its foundation date back to the 16th century, but the studies on the use of text-based GenAI tools

used as tools in the study gained momentum after 2020. The total number of GenAI tools used in these studies and their add-ons increased with each new tool. The methodological review section of the literature studies examined applied studies with student participation. GenAI tools were used as auxiliary tools, and their integration into design processes was investigated. Moreover, it was seen that different applications such as “sketch, mock-up, model, text production” were used together with AI tools. Within the scope of this thesis, three different AI-supported collage applications were carried out, in which analog and digital methods supported the reproduction of existing textual and visual elements by students.

These three studies are detailed in the thesis structure as Step 1, Step 2, and Step 3. The first step was carried out in the 2023-2023 academic year/fall semester, the second step was carried out in the 2023-2024 spring semester, and the third step was carried out in the summer semester of 2024. The number of participants in all three steps was different. The common feature of the participation groups was that they were students receiving undergraduate and graduate education in architecture. The survey responses constitute the data of the qualitative evaluation phase of the study. When the survey responses are examined, it is seen that the experiences of Step 1, Step 2, and Step 3 participants related to AI increase chronologically. As the number and accessibility of GenAI tools increased, the knowledge and familiarity of design students with these tools increased. In all three application steps, the working principles and sample interfaces of GenAI tools that provide visual production with text prompts were introduced to the participants, and it was possible to use any AI tool that provides visual output with text prompts without any restrictions on the AI tool used.

6. CONCLUSIONS AND FUTURE REMARKS

In this part of the thesis, the answers to the research question are given in light of the results obtained from the study's findings, and the hypothesis is discussed. In addition, the questions that support the results of the leading research question are answered and evaluated. Finally, recommendations for future research on integrating generative AI tools into design domains are presented.

6.1. Conclusions

Within the scope of this thesis, which aims to examine the role of generative artificial intelligence tools in current design practices and their relationship with the designer, the answers to the research questions were investigated by proposing different application programs that explore the effective use of GenAI tools in design education and design processes, measuring their advantages and disadvantages, and using GenAI tools in collaboration with existing analog and digital tools. In this section of the thesis, the general conclusions reached as a result of the discussion of the application outputs realized in line with the research question and the consistency of the application studies with the hypothesis of the thesis are explained.

Based on the hypothesis"It is possible to use generative artificial intelligence tools creatively as an auxiliary representation by students trained in architecture and design and to improve students' visual expression skills," the thesis consists of survey studies in which students' AI experiences, knowledge, and application experiences are measured with pre- and post-survey questions and a repeatable application consisting of three different application steps covering analog-digital-AI supported visual production processes. With the AI-infused applications, the research question "What are the potentials of artificial intelligence tools that enable visual generation from text as an auxiliary tool in the early stages of design?" was sought to be answered.

"What are the positive and negative aspects of generative AI models as a representation tool in the design process?" and 'To what extent is it possible to improve the quality of the final product with the given text prompt and editing tools, and can these tools that produce

singular images support three-dimensional thinking and design?' are sub-research questions that supported the research of outputs to support the main research question and shaped the method of the application steps.

The practice-led research method was used in the thesis study, and applied studies followed the literature review. Applied studies were examined using the "explanatory sequential mixed method" method, in which qualitative and quantitative data were examined together, and qualitative data were analyzed after the analysis.

The design process is transferring and representing all kinds of mental and physical experiences of the person, from abstract thoughts to concrete thoughts, with all sorts of tools. Representation uses sketches, models, photographs, texts, and other methods and tools. Representation tools are constantly evolving with the development of physical conditions and technological possibilities. Developing these representation tools also improves creative thinking, expression, and the development of thought in design. The discipline of architecture is constantly changing in parallel with these developments, and the architectural design process is directly related to other art branches such as graphic design, cinema, and painting. While many factors affect creativity and representation in architectural design processes, learning and designing experiences in design education are also changing. Architectural education is an environment where students learn to design "by doing." In traditional design studios, design teaching is based on "learning by doing," students are intended to learn from the design process. However, as conventional design tools change, so do the design environment and education.

AI tools, the subject of the thesis, are algorithms that can perform cognitive human actions such as thinking, writing, and calculating, which can be performed naturally. Developments related to generative AI tools, which are artificial intelligence models that process all kinds of data given to them according to the way they are trained and produce new results, are increasing daily, and the use of GenAI tools in daily life and professional disciplines is becoming widespread. Like many other disciplines, using GenAI in design and education has brought various advantages and concerns. Within the scope of this thesis, studies based on the use of GenAI tools in three different application steps covering the realization of collage, a visual design technique, analog and digital means, and artificial intelligence tools were carried out. The general methodology of each step was to produce images with text

prompts, to produce analog and digital collages with visual outputs, and to record students' evaluations of these productions in their own words. In this way, while the qualitative data group mentioned in the data collection phase is provided, the pre-and post-test questions asked to the students before and after the workshops constitute the quantitative data group of the study. However, these three implementation steps differ from each other in various ways.

The first and second application groups consisted of 6 and 11 students studying in the Gazi University Architecture program and taking the “Principles of Digital Design and Fabrication” course, which is a graduate course in the related program, and the third application group consisted of 27 students at the undergraduate level within the scope of the “Visual Communication” course in the Department of Architecture. The applications were carried out within the scope of the relevant courses in the fall, and summer semesters of the 2023-2024 semester.

At the beginning of the semester, students were asked preliminary survey questions to measure their relationship and experience with GenAI tools. The aim here is to record the student's relationship with the AI before the implementation and to make it possible to measure what positive/negative contributions and experiences the implementation process offers to the student. The responses to the pre-test questions are analyzed in detail in the Discussion section. When the questionnaire responses are examined, it is seen that most students know the use of AI tools in design. Still, the number of students who know the working principles and the concept of prompts is relatively low. After the working principles of AI tools were explained to the participants, it was stated that they could choose the GenAI tool they wanted. When the applications were examined chronologically, it was seen that the variety of AI tools selected and the majority of students who responded positively when asked about their experience and knowledge about AI were increasing. From this point of view, it is possible to say that the use of AI tools in design disciplines and educational environments has become widespread quite rapidly, even in the 9 months covering the duration of the thesis study.

After the preliminary survey, the participants were given production topics that included fictional texts and visual underlays. Each step has a production topic. In the first step, the book “Alice in Wonderland”; in the second step, the book “Invisible Cities”; and in the third

step, Mondrian paintings were chosen as production topics. The students were asked to reproduce the visual and textual inputs of the selected design subject differently from the original object and with their methods. The productions consisted of an analog collage, a digital collage, and visual production steps using AI. The textual productions formed the word groups that provided input for the AI tools. The first inputs given to the AI tools did not provide the desired result at once, and it was aimed to obtain the desired result by changing and transforming criteria such as prompt text, abstract/concrete concepts in the text, text length, visual effect used, and AI tool selected. Students tried to improve their work in digital and analog steps. After completing the productions, they were asked to compare the analog, digital, and AI-enhanced visualization steps. The aim here is to compare the processes in the students' own words to determine the factors affecting the level of creativity of the participants in analog tools, digital tools, and AI-enhanced design processes, the negativities they encounter in the process, and the criteria that ensure the effective use of these tools.

The final questionnaire studies are a group of questions aimed at determining the student's way of thinking in the application process, the criteria such as word, style, prompt length, abstract/concrete thinking, and preferred AI tool that contribute positively and negatively to the visual output, and to investigate ways to improve the final product by changing these criteria.

As a result of all these applications and evaluations,

- The analog collage method, which involves cutting and pasting in a workshop environment and physically, has disadvantages, such as lack of visual resources and difficulty in scaling visual objects, as well as advantages, such as working with a group in a workshop environment, feeling the textures of visual materials and transferring them to collage work,

-In the digital collage step, where computerized visual design tools such as Photoshop and Illustrator are used, unlimited access to resources and easy reproduction and transformation of these resources provide advantages in terms of production, while this fast access opportunity dulls creative thinking due to the easy solution of problems encountered during collage,

-The choice of AI tool used during visual production and collage applications with AI tools is directly related to the visual quality of the final product and prompt-visual compatibility,

-Abstract concepts such as emotional states, ideas, and some concrete concepts are not included in the visual output even if they are included in the prompt; however, some words (power words) shape the composition of the picture in a way that affects the whole picture when added to the prompt,

-The rapid visual output features of AI tools have positive contributions, but the visual output obtained with a single prompt and in a short time does not provide sufficient results for students coming from the discipline of architecture based on trial and error and learning by doing, and there is a need to edit these outputs with various editing tools or by changing the prompt and other options,

-When the visual output of three different AI tools using the same prompt as input is examined, the visuals obtained differ in terms of prompt-visual relationship and visual quality, and this may be due to the different visual database and language model used in the selected AI tools,

-That quality visual production with AI tools can be achieved by modifying and improving the initial prompt,

-In these processes, where qualified visual production is aimed with AI tools, the changes made in the prompt and the trial visuals produced by AI in a short time during these changes transform the students' initial design idea through the prompt,

-Repetition of the stages of text to visual in processes that start with textual thinking and visual + text to visual in processes that begin with visual thinking gives students the ability to think textually and visually simultaneously at the end of the process.

-The implementation steps described in the method section are repeatable methods that can be repeated with many different participant profiles and different production objects and are expected to yield different results in relation to the current characteristics and interfaces of the AI tools.

-It is possible to research and develop the effective use of AI tools in design processes where visual production and collage processes, where textual thinking is also included in the design process, are supported by the integration of AI tools.

These results show that effective ways of using AI tools in design processes are possible in line with the mentioned criteria, thus supporting the thesis hypothesis. In addition, as determined during the study period, rapidly developing AI tools do not have a stable interface and capacity. For this reason, to use these rapidly evolving tools effectively in design processes, it is essential to know the working principles of the tools used and to explore their interfaces.

6.2. Limitations

Generative AI tools are accessible tools that have entered our lives due to the intense technological developments of the last decade. These tools are developing rapidly, creating different opportunities and threats daily. Generative artificial intelligence tools produce new products by processing existing data. These data are all kinds of accessible visual, audio, and textual data on the internet. Although this data is generally open access, software companies impose restrictions on some tools today, where many ethical questions have not yet been answered. These tools are not accessible to all participants, students, and designers. For this reason, AI tools with more advanced features, such as Midjourney and Adobe Firefly, are among the tools that are not accessible to every designer/user due to usage fees. AI tools such as Leonardo AI and DALL-E are open-access and free. These tools include interfaces where the productions made by users can be seen and copied by other users to contribute to the production community. This causes some disadvantages for designers in terms of originality.

Another limitation is that depending on the current features of the rapidly developing generative artificial intelligence tools, the visual product qualities vary depending on the time the tool is used. The first workshop within the scope of the thesis was conducted in the fall semester of 2023-2024 as part of a graduate course. The artificial intelligence tools that could be used during this time were Midjourney, DALL-E, Stabble Diffusion, Leonardo AI, and Playground AI. Many new features were added to these tools in the spring semester of the next workshop, and new tools with similar or more advanced features were made

available to users. The third workshop occurred during the summer school semester of 2024, and most participants had already experienced AI tools. This situation is related to the speed of development of AI tools and their gradual diffusion among designers, and the outputs of the three-step workshop were evaluated in relation to the current situation of AI tools and designers at the time of the workshop.

6.3. Future Work

In this thesis, undergraduate and graduate students initially used GenAI tools that were openly available in the market and released during the study period. These tools are artificial intelligence tools that generate images from text prompts. Each prompt gives 1-8 image results; these images are unrelated, even if they relate to the prompt. Although it is possible to edit and upscale the visual outputs and existing images obtained with prompted-generating artificial intelligence tools, it is impossible to diversify these images into the same concepts and sizes. This situation is unsuitable for architectural design processes based on the principle of gradual development and transformation of design. However, in cases where a fast visual product, a spatial rendering of a sketch, or a concept image is needed, it is possible to provide visual output quickly. For this reason, three workshops were conducted on using GenAI tools in design workshops and collage works. However, given the current possibilities of GenAI tools, producing an image that provides depth information about a space makes it impossible to obtain a scaled drawing or perspective image. Future studies are envisaged in which GenAI tools can contribute more effectively to spatial design processes and architectural design workshops by using plugins and developer tools that provide spatial depth information on an image, giving depth maps, and using auxiliary tools to scale the obtained fast perspective images.

In addition to the AI tools that produce images with text prompts used as tools in the thesis study, there are also AI tools that produce images with visual and text prompts. Based on the thesis study for future studies, it is possible to say that addressing the rapidly developing AI tools with their current qualities and benefits and applied studies in which auxiliary digital and analog design-representation tools to be identified about the current benefits and advantages of the AI tool will increase the effective use of AI tools. During the planning and execution of these applications, it is possible to say that recording unsuccessful outputs and successful productions realized with these tools, whose integration into design fields is still

new, is an essential factor in the exploration of the role of AI in design. Recording the negative aspects and failures and the benefits of GenAI tools was seen as necessary for improving the integration of AI tools into design processes and design studios and conducting studies on their practical use.

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Gazili olmak ayrıcalıktır