An attempt to integrate AI-based techniques into first year design representation course

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Abstract

This research aims to explore the potential application of AI-based techniques in the introduction of design representation during first-year education. Specifically, the study examines the integration of traditional representation techniques used in design education with AI algorithms through an assignment implemented in a course namely Visual Communication 1. This course is part of the Integrated Foundation Studio (IFC) model, which has been implemented at Istanbul Technical University, Faculty of Architecture for the past 8 years. The assignment was completed by 64 students from three different departments (architecture, interior architecture, industrial design) who were all freshmen with little prior knowledge and experience in design representation and digital tools. The assignment has three steps as: (i) creating a composition with basic solids and producing an isometric projection of the composition by hand drawing, (ii) generating a series of images by using an AI-based tool Midjourney by defining keywords, and (iii) combining the previous two productions using various techniques. As a result of this assignment, 50 out of 64 students produced and submitted their personalized and unique design representations. The outcomes of the assignment are qualitatively evaluated under two main categories as Combining Techniques and Atmospheric Elements. While the first main category Combining Techniques refers to types of used modification and visualization techniques, Atmospheric Elements deals with texture, color, and forms derived from AI-generated images. Initial findings indicate that text-to-image techniques of AI contribute to enhancing the interpretation and composition skills of freshmen while producing new visual representations by making use of source images and technical drawings.

Author keywords

Design Education; Design Representation; Visual Communication; Artificial Intelligence; Freshmen; Midjourney

Introduction

Advances in digital technologies continue to transform design processes with an increasing acceleration in the last two decades. Processes from a conceptual design to an end product have required a new mindset, toolset, and skillset with the rise of the computational design paradigm. In his paper, Schmitt (1997) conceptualizes the evolving impact of digital technologies on design under three phases: computers as tool, medium, and partner. In this consideration, the first encounter with designers and computers served to digitize traditional representations. The second wave mediated the utilization of computational approaches in design and production, while digital technologies provided more contribution than being a tool or a method. Partner refers to the active contribution of digital technologies to the design process as an actor.

Considering the constant pressure on the evolution of design processes, it has become crucial to reconsider integration of the emerging tools, techniques, and approaches into design education. On one hand integration of emerging technologies into existing design curricula is not a new topic (Duarte et al., 2012, Mark et al., 2001), the technologies that support design and representation continue to evolve on the other hand. Although the insertion of computation into design education has been approached by many scholars (Güzelci et al., 2021; Varinlioğlu et al., 2016), implementations and experiments on the integration of AI-based technologies into design education are limited (Akçay et al., 2022; Sciannamè, 2022; Sorguç et al., 2022).

The goal of this study is to explore the potential use of AI-based techniques in first-year design education, with a specific focus on the fusion of traditional representation methods with artificial intelligence (AI) algorithms. This examination is conducted through an assignment implemented in a design representation course, namely Visual Communication 1 (VC-1). VC-1 is a module of the Integrated Foundation Studio (IFS) model, which has been implemented at the Faculty of Architecture of Istanbul Technical University.

This teaching experiment seeks to answer the following questions:

- Does combining the current teaching methodology of the VC-1 with the possibilities of AI contribute to the students' skills such as establishing a part-whole relationship, thinking in three dimensions, expressing their design ideas, making collages, and forming compositions?
- How can students' creative thinking be supported while teaching operational knowledge and skills such as technical drawing and orthographic projection?

The assignment is carried out as part of the VC-1 course in which 64 students from 3 different departments (architecture, interior architecture, industrial design) are involved. The students enrolled in the course are all freshmen and have very limited knowledge and skills on design and representation. The assignment has three steps as: producing an isometric projection by hand drawing, generating a series of images by using an AI-based tool Midjourney, and fusing these two productions with various analog techniques. Following these steps, all students produced and submitted their personalized and unique design representations. The outcomes of the assignment are evaluated by the tutors according to 5 criteria (grouped under 2 main categories) extracted following an initial qualitative evaluation (Table 1).

Methodology

The education model and the course

The Integrated Foundation Studio (IFS) is an integrated education model that has been implemented at Istanbul Technical University, Faculty of Architecture for over eight years. The IFS model provides integrated and systematic course modules to students from five different departments, including architecture, urban planning, industrial design, interior architecture, and landscape architecture, to avoid repetition and convey that concepts and principles are part of the whole. The IFS program is composed of a total of five-course modules, distributed over two semesters. The first semester includes courses such as "Project 1", "Visual Communication 1: Visualization and Technical Drawing", and "Basic Design and Visual Arts". The second semester includes "Project 2" and "Visual Communication 2: Visualization and Perspective". The IFS model is supported by theoretical lectures and assignments, with a focus on creative thinking, the design process, and the final product. The syllabuses of the modules are prepared and presented concurrently to reflect the coordination between them. The emphasis on creativity, process, and final product, in addition to the cohesive nature of the program, allows students to develop a holistic understanding of design principles and practice.

The "Visual Communication 1: Visualization and Technical Drawing" (VC-1) is a 4 hours course that aims to enhance students' ability to externalize and develop design ideas through a variety of mediums, tools, techniques, and approaches. By taking this course, students will gain insight and knowledge on the basic design elements such as line, shape, form, and color, as well as graphical elements and techniques such as shade, shadow, texture, collage, and rendering. They will also learn about the representation and manipulation of complex geometries and the principles of projection, as well as how to sketch the orthographic views of structural and contextual elements (TES Foundation Studio, 2022).

In addition to traditional representation techniques such as freehand drawing, sketching, orthographic drawings, and axonometric drawings, the course also encourages students to explore experimental representation techniques that they develop themselves to express their design ideas and products. The course exposes students to digital tools and software for visual representation, providing them with the skills necessary to effectively utilize technology in the design process. Overall, the VC-1 course is an essential component of the Integrated Foundation Studio (IFS) program and aims to provide students with a comprehensive understanding of visual communication and technical drawing in the context of design education.

For the 2022-2023 fall semester, the weekly schedule of VC-1 is organized as given in Figure 1 and 64 students from 3 departments are enrolled in the course. The numbers of architecture, interior architecture, and industrial design students are 24, 22, and 18, respectively.

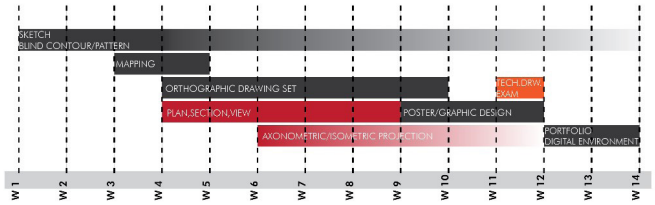

Figure 1. Weekly schedule of VC-1 (2022-2023 fall semester).

The assignment

As a module of IFC, the VC-1 course is selected to experiment the fusion of traditional representation techniques with AI-based algorithms. The assignment for this experimentation is designed to last for one week (Week 8) and is divided into three steps: in-class technical hand drawing by the students (2.5 hours), in-person tutorial by the tutors (1.5 hours), and work at home by the students to complete and submit their final productions.

In the first step of the assignment, each student created an isometric projection drawing relying on their previously generated composition of basic geometric forms, and traditional drawing equipment. The second step of the assignment involved a tutorial on the use of the Midjourney interface, which uses AI-based algorithms to generate images from text inputs. Tutors first prepared a tutorial video that described how to use the Midjourney interface through example image generations for text inputs. The content of the video tutorial was introduced to the students in the class and their questions (both contextual and technical) were answered.

DALL-E is another AI-algorithm that can be used for assignment and generates images from text. The DALL-E interface allows users to change the dimensions of the generated images, delete selected parts of the images, and replace them with new visual materials. Due to its limitations to interfere with the generated image, Midjourney was chosen to provide a common format that can be evaluated/compared in the works. In the Discord channel where Midjourney generations were made, students also saw text inputs defined by other users as well as visual outputs corresponding to these inputs.

Following the in-person tutorial, tutors shared the assignment brief, a public link to the tutorial video, and a flowchart describing the steps for image generation. To ensure that the generated images are relevant to the assignment, "isometric projection", "detailed", "shade and shadow", and "8K rendering" were defined as compulsory keywords and phrases for the image

generation. Apart from these compulsory keywords, students are asked to select their keywords or phrases considering the predefined categories. The predefined categories are as follows; "style" (like cinematic, cartoon, realistic, futuristic, "color" (such as soft, dark, neon, pastel, black and white), "story" (one or more sentences from a movie, series, book, poem or imagination of the participants), "material" (like metal, concrete, steel, timber), and "people" (such as woman, man, elder, teenage, robot, alien, groups of people). Last, students were requested to upload their isometric projection drawing, AI-generated image, and fusion of drawing and image to separate cloud-based folders created by the tutors.

In the final step of the assignment, students were asked to complete their work at home by utilizing the AI-based algorithms they learned about in the tutorial. Following logging into the Discord application where they can interact with Midjourney interface, students decided on the keywords or phrases as input and ran the algorithm to generate 4 AI-generated images. The Midjourney allows the students to run the algorithm multiple times (up to 25 for the free version) and produce alternative images. The final step required students to augment their previous isometric drawings by incorporating information captured from the AI-generated images. This reflection from AI-generated images into new productions by using previously obtained isometric drawings covers the decomposition and interpretation of the source domain, as well as the use of free techniques such as collage, watercolor, and redrawing.

Table 1. Evaluation of students' work based on defined categories and criteria.

	COMBINING TECHNIQUES					ATMOSPHERIC ELEMENTS				
	MODIFICATION		VISUALIZATION TECHNIQUE			TEXTURE OF AI		COLOR OF AI		FORM OF ISO
	DIRECT USE OF ISO	DIRECT USE OF AI	DRAWING	PAINTING	CUT & PASTE	BACKGROUND	FACES	BACKGROUND	FACES	ADAPTED
1	●	●		●	●	▲	▲	▲	▲	▲
2			●	●		▲	▲	▲	▲	▲
3				●		▲		▲	▲	
4		●		●	●	▲		▲	▲	▲
5			●		●	▲	▲	▲	▲	▲
6	●				●	▲	▲	▲	▲	
7	●			●			▲	▲	▲	
8			●	●		▲	▲	▲	▲	▲
9			●	●		▲	▲	▲	▲	▲
10	●		●	●	●	▲	▲	▲	▲	▲
11	●	●	●	●	●	▲	▲	▲	▲	▲
12			●	●	●	▲	▲	▲	▲	▲
13	●			●	●	▲	▲	▲	▲	
14	●	●		●	●	▲		▲		
15	●			●			▲	▲	▲	▲
16	●		●	●	●	▲		▲	▲	
17	●	●			●	▲		▲	▲	
18	●	●			●	▲		▲		
19	●		●	●	●	▲	▲	▲	▲	
20					●	▲	▲	▲	▲	
21	●	●			●	▲	▲	▲	▲	
22	●				●		▲	▲	▲	▲
23			●	●		▲	▲		▲	
24	●	●	●	●	●	▲		▲	▲	▲
25			●	●		▲	▲	▲		▲
26			●	●			▲	▲	▲	▲
27	●				●	▲	▲	▲	▲	
28	●			●	●	▲		▲	▲	
29			●	●			▲	▲	▲	▲
30	●	●			●		▲		▲	
31			●	●		▲	▲	▲	▲	▲
32	●		●	●	●	▲		▲	▲	
33	●			●		▲			▲	
34			●	●		▲	▲	▲	▲	▲
35						▲	▲			▲
36	●				●		▲	▲	▲	
37			●	●	●	▲	▲	▲	▲	▲
38			●	●	●	▲	▲	▲	▲	▲
39	●			●	●	▲	▲	▲	▲	
40			●		●	▲	▲	▲		▲
41	●			●			▲		▲	
42	●		●	●		▲		▲	▲	
43			●			▲	▲	▲		▲
44	●	●		●	●	▲	▲	▲	▲	
45			●	●	●	▲	▲		▲	
46	●		●	●		▲		▲	▲	
47	●	●			●	▲	▲	▲	▲	▲
48			●	●		▲	▲	▲	▲	
49			●	●		▲				▲
50	●		●	●		▲		▲	▲	

Results

The productions obtained by blending the AI-generated image and the isometric projection drawings are grouped into two basic categories according to their characteristics. The first category, "combining techniques", involves the evaluation of the modification type and visualization techniques used while creating the final product. The second category, "atmospheric elements", comprises the usage of texture, color, and form derived from AI-generated images. All final productions were evaluated under these two main categories and their subcategories, which are summarized in Table 1.

To emphasize, the presented assignment was completed by a group of students from architecture, interior design, and industrial design. However, since the students had only been at the faculty for seven weeks and had not enrolled in any field-specific courses, the assignment results were not discussed according to the departments in which the students were enrolled.

Combining techniques

Modification

The analysis of the final results showed that different combining techniques were preferred by the students while creating the final images by blending the isometric drawing and the AI-generated image. 44% of the students revised their isometric drawings, while 56% kept their drawings as they were. On the other hand, 78% of the students modified their AI-generated images and transferred them to their final work. Only 20% of the participants adapted both the isometric drawing and the AI data. It is observed that 32% of the participants did not modify either the AI image or the isometric drawing. This could indicate that the students had difficulties in adapting the AI image and isometric drawing, which could be due to the fact that they have not completed even half of the first semester of the first year of design education. This highlights the need for further education and training in the use of AI-based algorithms in design education, to improve students' ability to effectively incorporate these techniques into their design process.

Visualization technique

Although the participants were not limited to any particular method, the visualization techniques used by students while creating the final product can be grouped under three basic categories: drawing, painting, and cut-and-paste methods. It should be noted that, as the students were in the early stages of their design education, no digital compositing and editing programs were taught before this assignment. Students were

mainly expected to create a poster using traditional methods, but the use of digital methods was also accepted.

The most common method used by students was painting, with 37 participants using this technique. The second most common method was the cut-and-paste, used by 28 participants, followed by drawing, used by 27 participants. Some students preferred to use more than one of these visualization techniques. 20% of the participants used all three visualization techniques together. There was one participant who did not use any of these techniques. The most preferred combination was the use of both drawing and painting techniques, which made up 28% of the participants. Additionally, 14% of the participants used painting and cut-and-paste techniques together.

Atmospheric elements

Texture of AI

In the scope of the given assignment, it was examined whether the image produced with the Midjourney interface was used while creating a texture in the final data. 42 students used the texture of the image that emerged in Midjourney as the background of the newly created data. A total of 36 students used the AI-generated texture on the surfaces of their isometric drawings. The work of student 30 (STU.30), shown in Figure 2, is a clear example of this. This result suggests that students were able to effectively incorporate the textures generated by the Midjourney into their final work, highlighting the potential of AI-based algorithms in enhancing the visual qualities of traditional representation techniques.

All of the participants used the AI-generated texture in their final work, either in the background or on the surfaces of their isometric drawing. A total of 56% of the participants utilized the texture in both the background and the isometric drawing, indicating the flexibility and versatility of the AI-generated textures in changing the visual qualities of their work.

Color of AI

The usage of the colors of the image created with AI in new production is frequently preferred by the students. In this context, 86% of the students used these colors in the background of their new work and 86% used them on the surfaces of the geometries represented in the isometric drawing. Since most of the students completed the work by hand, the exact match of the color codes in the digital data and the colors in the final work was not expected. The use of colors from available materials was also accepted as long as they represented the digital color code. Only 4% of the participants did not transfer the AI-generated color to their new production, and 76% of them used both for the background and the isometric drawing surface.

This result highlights the importance of color in enhancing the visual qualities of the final work and the ability of students to effectively incorporate AI-generated colors into their traditional representation techniques. It also suggests that providing students with a wide range of colors and color palettes generated by AI-based algorithms can support their design work.

Form in AI

48% of the students used the form, which they created as an isometric drawing, by reshaping and adapting it according to the AI image. In this interpretation, minimal changes were generally preferred, and the main block of the isometric drawing was not far away. The form in the isometric drawing of student number 34 (STU.34) is a typical example of reshaping according to AI data. In the isometric form, several openings were created to strengthen its spatial characteristics, and the similarities to the mass offered by AI were revealed (Figure 2). This result suggests that students were able to effectively incorporate the forms generated by AI-based algorithms into their traditional representation techniques.

Conclusion

This study aimed to explore the potential use of AI-based techniques in first-year design education, with a specific focus on the fusion of traditional representation techniques used in design education with AI algorithms. Through an assignment implemented in a design representation course, the study sought to investigate whether combining the current teaching methodology with the possibilities of artificial intelligence technology would contribute to the students'

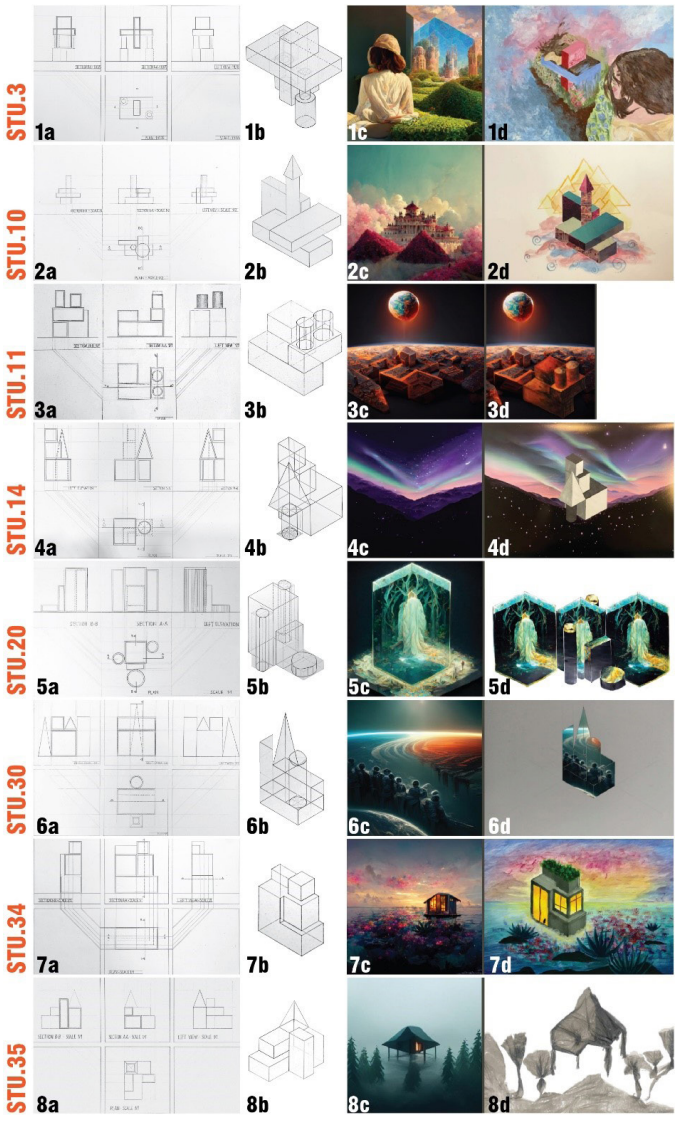

Figure 2. Examples from students' work: plans, sections, and views (column a); isometric projections (column b); AI-generated images (column c); fuse of isometric projections with AI-generated images (column d).

skills such as establishing a part-whole relationship, thinking in three dimensions, expressing what they think, making collages and forming compositions. This study allows for a clear comparison and analysis of the different techniques and elements used by students in the final products and provides insight into the potential of combining traditional representation techniques with AI-based algorithms in design education.

In previous years it was observed that technical orthographic drawings mostly remain as a separate skill and it cannot meet design thinking processes. Students tend to generate technical drawings and other conventional representations after their design ideas become concrete, instead of integrating these drawings into visual and spatial reasoning. In this context, the findings of the study showed that the integration of AI-based techniques in the design representation course improved the students' skills and supported their creative thinking, highlighting the potential of AI-based techniques in design education. The AI-generated images provided contextual qualities such as composition, temporality, sense of scene with environmental elements, scale, etc. The decomposition of these elements and making collages supported the reflective thinking process, while augmenting the previously generated technical drawings. The assignment, in particular, encouraged students to use traditional representation methods combined with AI-based algorithms to create an innovative and unique representation of their design ideas.

It should be noted that the results of this study should be interpreted within the context of the study's limitations. The number of students enrolled, the complexity of the design task, and the specific encounter between AI and students could all affect the results. To draw more concrete conclusions, further research with larger sample size, more complex design tasks, and different AI-student interactions would be necessary.

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