

FROM PENCIL TO PIXEL

The Evolution of Design Ideation Tools

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Abstract. This study explores the integration of Artificial Intelligence-Generated Content (AIGC) in design processes, focusing on the ideation phase. Utilizing in-depth interviews with experienced designers and an experimental approach with novices, it compares AIGC tools like ChatGPT, Midjourney and Copilot with traditional sketching methods. The findings reveal two distinct operational patterns in AIGC utilization: a subtractive method of refining AI outputs and an additive method of evolving design through AI suggestions. Experienced designers view AIGC as a powerful aid for creative ideation, while novices prefer familiar hand-drawing methods. The study proposes a "Seeing-Instructing-Seeing" model, adapting Schön's reflective practice model, to incorporate the collaborative dynamic between designers and AI, marking a shift from manual to intellectual labor in design ideation. This represents a paradigm shift in design methodologies, suggesting a future of co-creative partnerships between designers and AI tools.

Keywords. AIGC, Ideation Design Process, Textual Thinking, Creativity.

1. Introduction

The rapid advancement of artificial intelligence (AI) has markedly influenced various domains, particularly in the field of design, revolutionizing traditional methodologies and introducing new paradigms (Javaid et al, 2023). One of the most notable applications in this evolution is AI-Generated Content (AIGC), which has significantly expanded its presence in the design domain since its emergence in 2022. This transformation in the design process reflects a shift from conventional, manual techniques towards more technologically advanced methods, bringing forth both challenges and opportunities.

Traditionally, design processes have emphasized the critical role of hand-drawn sketches, a practice rooted in the belief that manual drawing stimulates creative thinking. This perspective aligns with Donald A. Schon's "seeing-moving-seeing" model, which describes design as a reflective conversation. According to Schon (1992), this model involves a cyclical interaction between designers and their materials,

encompassing observation, action, and re-observation, thereby highlighting the subjectivity and inherent creativity within the design process. However, the rise of AIGC offers a contrasting approach by allowing designers to guide AI in generating designs through textual commands, as noted by Zhang et al. (2023). This novel method presents a paradigm shift from the tactile, manual process of sketching to an interaction that is predominantly digital and text-based.

The integration of AIGC into design systems has been a subject of increasing interest among researchers and practitioners. Yin, Zhang, and Liu (2023) have extensively discussed the incorporation of AIGC tools, such as ChatGPT, Midjourney, Copilot, into design systems. Their approach primarily focuses on enhancing collaboration and innovation in product design. The introduction of AMP-Cards, an innovative toolset designed by Yin et al. (2023), is a significant milestone in this regard. These cards facilitate the effective use of the Midjourney tool in product design and innovation, particularly in interdisciplinary collaboration environments. The AMP-Cards offer concise instructions for quick adaptation to Midjourney for visualization and graphic presentation, thereby streamlining the design research and practice. Educational experiments conducted with these tools revealed that AIGC significantly enhances efficiency in product development, especially in the exploratory product shape phase. The AMP-Cards design process, characterized by inputting style transition reference images, combining them with prompt formulas, and iterating on solutions, underscores the importance of precise command input in AIGC applications.

Beyond product design, the impact of AIGC is also evident in fields like architecture and gaming. A comprehensive survey by Workflos.ai highlights that AIGC tools are capable of creating not just 2D images but also 3D models, showcasing their efficiency and accuracy over traditional model creation methods. The 'Sketch-to-Architecture' initiative, utilizing generative AI to convert simple sketches into conceptual floorplans and 3D models, demonstrates the potential of these tools in architectural design. Researchers Li, et al. (2023) explored this new workflow, employing advanced methods like the Stable Diffusion model, the LoRA model, and ControlNet for precise generative condition control in architectural design.

Furthermore, the establishment of the AIGC Lab by Coohom marks another significant development in this arena. This lab focuses on 3D visualizations and AI design, exploring the application of AIGC in all-space design. Such initiatives underscore the growing recognition and application of AIGC tools in various design domains, from product design to architectural design, emphasizing their role in the early stages of the design process, especially in concept ideation.

In summary, the advent of AIGC has ushered in a new era in design methodologies, challenging traditional practices and offering innovative avenues for creative expression. As these tools continue to evolve and integrate into various design processes, they open up new possibilities for collaboration, innovation, and efficiency in design ideation and execution. This paradigm shift calls for a re-evaluation of conventional design models, encouraging a more collaborative and technologically inclined approach that leverages the strengths of both traditional and AI-driven design methods.

2. Research Problem and Objective

Reflecting on the existing literature, it is evident that the advent and application of Artificial Intelligence-Generated Content (AIGC) have introduced significant changes in the design process. This study aims to investigate how the application of AIGC, particularly during the sketching phase of the design process, may alter the thinking patterns and operational behaviours of designers in the conceptual ideation stage. It questions whether AIGC could lead to the emergence of new sketching processes in design. The research is grounded in Donald A. Schon's sketch theory model, which follows a "seeing-moving-seeing" behavioural pattern, and intends to develop and analyze a theoretical model for the sketching stage using AIGC.

The study focuses on comparing the influence of AIGC tools, such as ChatGPT, Midjourney or Copilot, with traditional sketching methods in the design ideation process, creativity, and efficiency among designers. The primary goal is to explore and evaluate the impact of AIGC tools on design ideation. This includes understanding how these tools affect creative thinking, the feasibility of designs, and the overall efficiency of both novice and experienced designers. The research also examines the variances in ideation methods when designers utilize AIGC tools as opposed to traditional sketching techniques.

Furthermore, the study delves into assessing the potential of AIGC tools in fostering innovative ideation processes and their influence on the roles, thinking patterns, and communication methods of designers. By conducting this research, we aim to provide empirical evidence and insights into the advantages and challenges associated with integrating AIGC tools into the design process. This, in turn, will inform current practices and guide future research in the intersecting fields of design and artificial intelligence.

3. Methodology and Steps

The methodology of this study comprised two approaches: conducting in-depth interviews with experienced designers and implementing a design experiment with novice designers.

3.1. SUBJECTS SELECTION

Experienced Designers: Five designers, each with over five years of experience and familiar with both hand-drawn sketches and AIGC tools, were selected for interviews. These participants all majored in Art and Design during their undergraduate studies, focusing on interdisciplinary art and design fields. After completing their bachelor's degrees, they pursued specialized studies in disciplines such as architecture, mechanical engineering, and interactive design.

Novice Designers: Seven designers, each with 2-3 years of experience, were chosen to participate in the sketch design experiment. These participants are undergraduate students majoring in Art and Design, currently in their second or third year of study.

3.2. INTERVIEWS WITH EXPERIENCED DESIGNERS

Activity: In-depth interviews and questionnaires were administered to five

experienced designers. These designers were proficient in using both traditional sketching methods and AIGC tools, such as Midjourney, ChatGPT or Copilot.

Objective: The goal was to gather insights into their experiences and perspectives regarding the utilization of both hand-drawn and AIGC mediums in the design process.

3.3. SKETCH DESIGN EXPERIMENT WITH NOVICE DESIGNERS

Participants: The experiment involved seven novice designers.

Task: The task was to ideate designs based on a specific theme, with the challenge of designing a chair that reflects personal creativity.

Tools: The tools provided included pen and paper for traditional sketching and AIGC tools (ChatGPT, Midjourney and Copilot) for digital design.

Objective: The aim was to engage participants in the ideation stage of design through sketching using both mediums.

Procedure: Each participant was allotted 30 minutes to ideate a design using one medium (pen and paper or an AIGC tool). Subsequently, they repeated the ideation process using the alternate medium.

Documentation: The entire process was meticulously documented through video recording. Additionally, photographs were taken, hand-drawn sketches were collected, and screen recordings were captured during operations with AIGC tools.

Following the experiment, the subjects were engaged in post-experiment interviews and questionnaire completion. This phase was aimed at assessing the operational differences and the support provided by each medium in the design ideation process. During these interviews, qualitative data were collected, focusing on the designers' thought processes, creative ideation methods, and the feasibility assessments of designs when utilizing both traditional and AIGC-based approaches. This comprehensive data collection was integral to understanding the impact of different mediums on design ideation, particularly in contrasting the approaches of novice and experienced designers.

4. Results and Analysis

The study conducted a detailed analysis based on the interviews, experiments, and the resulting sketches, questionnaires, and interview responses. Two distinct types of sketches were examined: Figure 1, representing hand-drawn sketches using pen and paper as the medium, and the results produced using AIGC tools.



Figure 1. Left: Hand-drawn sketches; Right: AIGC images

Analysing the experimental results from the provided sketches, we can systematically organize the observed phenomena into the following.

4.1. DESIGN ELEMENTS IN SKETCHES

1. Hand-Drawn Sketches:

- Perspective drawings are a common feature, offering a three-dimensional representation of the design concept.
- Explanatory text accompanies the visuals, providing insights into the design intentions.
- Human figures are often included, giving scale and context to the design.
- Almost all design elements are represented within the sketches, from initial concepts to detailed breakdowns.

2. AIGC-Generated Images:

- Perspective views are detailed, with shadows enhancing the three-dimensionality, presenting a near-final product appearance.
- Due to the features of the tool, AIGC images generally lack textual descriptions and rely heavily on visual representation.

4.2. DESIGN FACTORS CONSIDERING DURING SKETCHING

1. Hand-Drawn Sketches:

- Design ideas or concepts are evident through the text annotations within the sketches.
- Material choices are indicated through both text and visual cues.
- Aesthetic form and styling are discernible from the perspective drawings.
- Proportional relationships are gauged through the inclusion of human figures.
- Construction methods are revealed through exploded or deconstructed views.
- Usage scenarios are implied by the positioning and interaction of human figures with the design.

2. AIGC-Generated Images:

- Design concepts are primarily conveyed through complete perspective visuals.
- The aesthetic appearance and form are depicted in full perspective.
- Material textures are indicated by the rendered quality of the perspectives.
- Composition and construction are portrayed through the comprehensive perspectives provided by the AI.

This structured analysis highlights the distinctive approaches and outputs

associated with hand-drawn sketches and AIGC-generated images within the design process. Hand-drawn sketches offer a rich tapestry of design information, incorporating annotations and human elements that provide scale and context. In contrast, AIGC-generated images, while more polished and visually complete, tend to focus on the visual representation of the concept, often omitting the textual explanations and human elements that provide context and scale. This comparison underscores the complementary roles that hand-drawn and AIGC methods can play in the design ideation process, each with its strengths in conveying different aspects of design thinking.

4.3. ANALYSIS OF INTERVIEWS AND QUESTIONNAIRES

Based on the analysis of interviews and questionnaires, the study derived the following comparative results, evaluating various aspects of design ideation through traditional sketching and the use of Artificial Intelligence-Generated Content (AIGC) tools. Table 1 shows the comparative aspects. The following describe the analyse results.

1. Designer's Role

- Traditional Sketching: Designers perceive themselves as the sole creators with direct and personal input.
- AIGC Tools: Designers assume the roles of directors or instructors, commanding the AI rather than creating visuals themselves, leading to a co-creative partnership with the AI.

2. Concept Translation

- Traditional Sketching: Novice designers believe that hand-drawing more closely aligns with their conceptual vision, resonating with Schön's "See-Move-See" model of reflection in action.
- AIGC Tools: While simpler and quicker, visuals generated by AI tools require familiarization for accuracy. Novice designers find that hand-drawing offers a more tangible representation of their conceptual translation process.

3. Intuitiveness

- Traditional Sketching: Generally tends to be more intuitive.
- AIGC Tools: Initially less intuitive, but they offer a faster materialization of concepts.

4. Design Iteration

- Traditional Sketching: This method typically leads to fewer iterations during the concept ideation phase.
- AIGC Tools: These tools result in a greater number of design iterations, enabling quicker entry into the iteration phase with more concrete representations.

5. Design Options

- Traditional Sketching: Provides a limited number of design options within a given

timeframe.

- AIGC Tools: Capable of rapidly producing a wider array of design options.

6. Unexpected Discoveries

- Traditional Sketching: This method offers limited opportunities for unexpected discoveries.
- AIGC Tools: These tools encourage a higher occurrence of unexpected discoveries, which can be beneficial for creativity, creative ideation and advancement.

7. Suitability for Novices

- Traditional Sketching: Its usefulness may be limited by a novice designer's drawing skill level.
- AIGC Tools: Found to be more supportive for novices, as they stimulate creative thought without the limitations of drawing skills.

These findings highlight the distinct roles and capabilities of traditional sketching and AIGC tools in the design ideation process. While traditional methods offer intuitive and direct engagement with the design concept, AIGC tools facilitate a broader exploration of ideas with less reliance on manual skills. The integration of both methods can potentially enrich the design process, catering to diverse needs and skill levels of designers.

Table 1. Comparative aspects between traditional sketching and AIGC tools

Aspect	Traditional Sketching	AIGC Tools
Designer's Role	Creator	Director/Instructor
Concept Translation	Direct; Reflective	Indirect; Requires Adjustment
Intuitiveness	Higher	Variable; Requires Familiarity
Design Iteration	Limited	Enhanced
Design Options	Fewer	More; Rapid Generation
Unexpected Discoveries	Fewer	More; Stimulates Creativity
Suitability for Novices	Skill-Dependent	More Supportive

4.4. OPERATIONAL PATTERNS IN AIGC UTILIZATION

The analysis of textual records from subjects' interactions with Artificial Intelligence-Generated Content (AIGC) tools during the concept ideation sketching phase revealed two distinct operational patterns manipulated by the subjects:

1. Pattern A: Subtractive Method

- **Direction Without Personal Ideas:** Subjects presented the AI with the general direction of the topic without disclosing their personal design ideas. This approach allowed the AI to generate initial creative concepts.
- **Selective Elimination:** Upon reviewing the AI-generated concepts, subjects identified elements that did not align with their intended design and eliminated them.

- **Iterative Customization:** Subjects gradually introduced their personal design elements or details, directing the AI to make specific revisions.

This pattern is defined by a subtractive process, wherein the broad initial output provided by the AI is refined through the removal of undesired elements.

2. Pattern B: Additive Method

- **Direction and Abstraction:** Subjects communicated the overall direction of the topic and described their abstract design thoughts to the AI.
- **Keyword-Prompted Generation:** The AI-provided keywords related to the abstract ideas were used as the main prompts for generating visuals.
- **Progressive Enhancement:** From the AI-generated visuals, participants selected those that resonated with them and added additional desired design elements, requesting the AI to produce more variations or refine the output.

This approach is characterized by an additive method, beginning with general concepts and systematically incorporating specific elements to evolve the design. This process is more similar to hand sketching thinking process.

These operational patterns illustrate the diverse methodologies subjects employ when using AIGC tools for conceptual sketching. Pattern A's subtractive method focuses on refining AI-generated outputs by removing mismatched elements, whereas Pattern B's additive method emphasizes building upon the AI-generated base with incremental additions and refinements. These findings not only demonstrate the flexibility and adaptability of AIGC tools in the design process but also reveal the varying strategies designers might employ to harness the full potential of AI in creative ideation.

4.5. PERSPECTIVES OF EXPERIENCED AND NOVICE DESIGNERS ON AIGC

The analysis of questionnaire results reveals that both experienced designers and design novices hold similar views regarding the characteristics and comparison of Artificial Intelligence-Generated Content (AIGC) with the traditional sketching process. However, a notable difference emerges in their approach and preference towards these tools.

1. Views of Experienced Designers

Experienced designers, with their rich design background in the field (include Art and Design, Architectural Design, Interactive Design), perceive AIGC as a powerful design assistant. They recognize its potential to significantly aid the ideation phase by providing a broader range of creative ideas. This group demonstrates a strong inclination to integrate AIGC tools directly into their ideation process. Their familiarity and comfort with various design mediums enable them to see AIGC as an effective extension of their creative toolkit, appreciating its capacity to enhance and diversify their design concepts.

2. Preferences of Novice Designers

On the other hand, novice designers (Art and Design background), who are relatively less acquainted with diverse media, tend to prefer more traditional and intuitive methods such as hand-drawn sketches for their design ideation. Their preference stems from a lack of familiarity with AIGC tools, leading them to rely on more conventional techniques that they are skilled in. Despite recognizing the potential benefits of AIGC, their comfort with hand-drawn sketches prevails in the initial stages of their design careers.

This comparative analysis underscores a pivotal trend in the design community's reception of AIGC tools. While experienced designers are quick to adopt and integrate new technologies like AIGC into their workflow, novices tend to adhere to traditional methods until they develop a more profound understanding and skill set in using advanced tools. This insight into the varying levels of acceptance and integration of AIGC in the design process offers a valuable perspective on the evolving landscape of design methodologies, particularly in the context of emerging technologies.

5. Discussion and Conclusion

Adapting Design Models with AIGC Utilization in Sketching

Based on the results of the experiments and questionnaire analyses, particularly drawing insights from the findings in "Operational Patterns in AIGC Utilization," this study synthesizes a new design model for the sketching stage using Artificial Intelligence-Generated Content (AIGC).

Our research culminates in a refined sketch theory model, reimagining the application of AIGC within the design process. This model is an evolution of Schön's reflective practice model, traditionally conceptualized as a "Seeing-Moving-Seeing" cycle. The study proposes an adapted model that transitions this cycle into "Seeing-Instructing-Seeing," integrating the unique dynamics of AIGC tools.

In the traditional Schön model, the emphasis is placed on manual creation, such as drawing or writing, where the designer is actively involved in translating ideas into physical representations. This process typically involves solitary creative engagement, with the designer's hand guiding the transition from concept to creation.

The model introduced in this study contrasts this approach by incorporating AIGC, suggesting a dual active role involving both the designer and the AI. The action, primarily focused on typing or text input, becomes an intellectual task. The designer's role evolves from a creator to a director or instructor, formulating prompts that steer the AI to generate desired visual outputs. In this interaction, the AI emerges as an active participant, interpreting instructions and materializing concepts, thereby marking a significant shift from manual to intellectual labor in the ideation phase.

This novel approach necessitates a different skill set, primarily emphasizing the designer's ability to articulate ideas through text prompts. The AI, acting as a responsive agent, introduces a collaborative dynamic to the design process. The "Seeing-Instructing-Seeing" cycle fosters a partnership in creativity, where the designer's

creative intellect and the AI's generative capabilities work in tandem.

Figure 2 visually represents this theoretical shift. The Left cycle illustrates Schön's original model, while the Right cycle depicts the new model integrating AIGC. This comparison highlights a paradigm shift in the design ideation process and introduces a symbiotic relationship between the designer's creativity and AI's generative power.

The implications of this shift extend beyond methodology, suggesting a redefinition of the designer's role and the creative process in the age of AI. This study provides a foundation for further exploration into the collaborative dynamics between designers and AI tools, proposing a future where this partnership could redefine the landscape of design ideation.

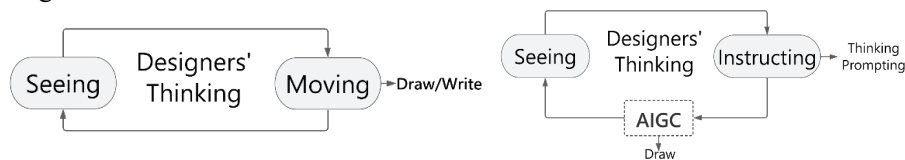


Figure 2. Left: Schön's "Seeing-Moving Seeing" model; Right: "Seeing-Instructing-Seeing" model

6. Limitations and Future Study

This study is confined by its focus on specific AIGC tools and a select group of experienced and novice designers. The reliance on current AI capabilities might not reflect future technological progress, and the emphasis on AIGC tools may understate the importance of designers' inherent creativity.

Future research should explore a broader range of AIGC tools and include a more diverse group of designers to capture a wider spectrum of experiences and perspectives. Investigations into how evolving AI technologies impact the balance between manual creativity and AI assistance in design will also be valuable.

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