

AI Chatbots in Architectural Design: Exploring the Potential and Limitations in Conceptual Image Development

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Abstract

In the schematic design phase of architectural practice, some designers find it challenging to develop conceptual images. The advent of AI chatbots has provided designers with a platform to generate architectural design images swiftly and effortlessly. However, questions remain about how much these images aid designers and whether they impede creativity. This research investigated the use of AI chatbots in generating conceptual images during the schematic design phase. Conducted as a case study in a first-year architectural design studio course at Hong Kong Chu Hai College, students were tasked with designing a single-family house, with some students using AI chatbots Stable Diffusion to create conceptual images. The study categorized the generated images into three distinct types: Type A, which produced realistic but superficial house design; Type B, which focused on creating picturesque atmospheres; and Type C, which generated abstract artistic images that significantly influenced the final design. The findings suggested that while AI-generated images could inspire designers, their impact varied depending on how they were generated. Type A images might limit deeper exploration, while Type B images helped to set an atmospheric tone but were less directly useful for designers' final housing design. In contrast, Type C images allowed for more creative and abstract exploration, with a notable impact on designers' final housing design. The study also addressed ethical considerations regarding the use of AI-generated images, particularly issues related to originality.

1. Introduction

Inspiration is essential for architectural designers as architecture is not just a functional craft but also a reflection of the culture and lifestyle of its time. Throughout history, architects have drawn inspiration

from art, as evidenced by architects such as Le Corbusier, who was influenced by Picasso's paintings, and Frank Lloyd Wright, who drew heavily from Japanese art. This tradition continues today with architects such as Ito [2] and MAD Architects [4] exhibiting their artwork to show the public where their inspirations originate.

For architects, conceptual images and early ideas are crucial in translating their responses to the site and program requirements. Artistic media and symbolic meanings often provide significant inspiration for architects at the initial stages of a project, helping them infuse their design with creativity and context in mind (see Figure 1).

The initial phase of the architectural practice is the Schematic Design phase. According to the Canadian Handbook of Practice for Architects [7], this phase allows for the synthesis of spatial planning, site analysis, and clients' functional requirements (see Figure 1). In spatial planning, conceptual images enable architects to visualize the building's sculptural quality and spatial relationships.

During this phase, architectural designers are expected to create conceptual images that reflect the inspiration behind their project. These concepts are typically presented to clients, and architectural schools follow a similar process (see Figure 2). However, some designers may find it challenging to develop these images, particularly young designers and students with limited design experience. They often bypass this step, develop their design, and then retrospectively create conceptual images or diagrams to illustrate the initial concept. According to Lee, Ostwald and Gu [3], AI generative design tools support design thinking by providing simulation and modeling of design options. They are regarded as enablers that enhance designers' cognitive strategies and skills, such as creativity, allowing space for greater creative potential in the design process.



Figure 1. Schematic Design Phase

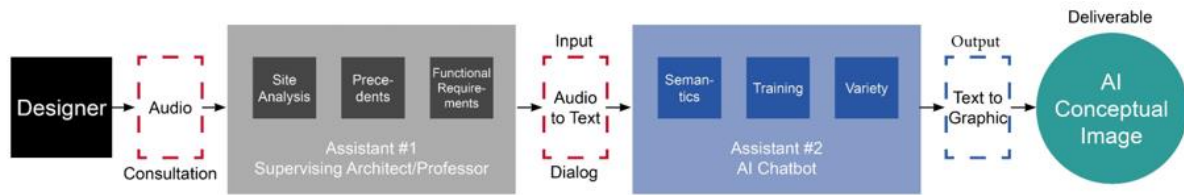


Figure 2. AI Chatbot as Assistant to Designers

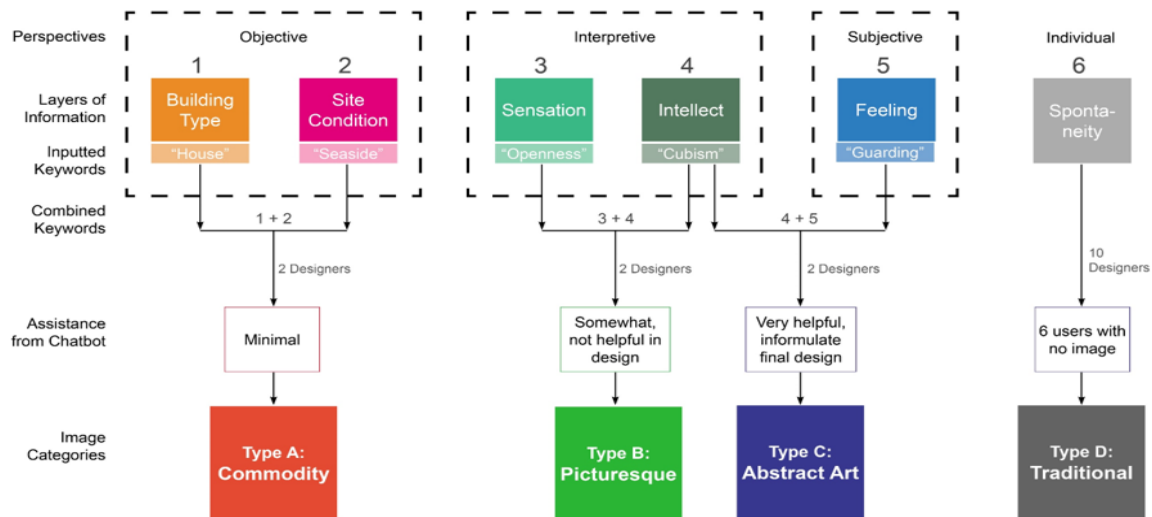


Figure 3. Designers' Perspectives and Image types

2. Literature Review

Pena, Rodríguez-Fernández, and Romero [5] stated that rather than seeking definitive solutions within a predefined search space, AI should be used to explore design requirements and potential solutions to meet those requirements. In this research, AI chatbots provided a valuable opportunity to assist designers in exploring concepts with conceptual images rather than creating fully-designed building images. Borglund [1] stated that AI provided designers with a variety of design options to use and explore.

A variety of AI chatbot techniques transformed concept image generation by offering designers new ways to explore creative ideas, such as Generative Adversarial Networks (GANs) and diffusion models. GANs generated concept images using two competing neural networks: the generator and the discriminator [9]. The generator created synthetic images by learning patterns from input data, while the discriminator evaluated if these images were real or fake. GANs were highly effective for creating realistic and diverse images, making them useful in design.

Stable Diffusion, a deep learning text-to-image model, was released in 2022 [10]. It generated images by referencing precedents through its training on large

datasets of images paired with textual descriptions. Human trainers curated these datasets to teach the AI to associate specific words and phrases with corresponding visual elements, patterns, and colors. By learning these associations, the model interpreted textual inputs and created new, coherent images that visually represented the described concepts.

Unlike GANs, which relied on two neural networks, Stable Diffusion refined random noise into coherent images based on a text prompt. Through multiple stages of denoising, it "diffused" patterns and structures into recognizable forms. This process allowed Stable Diffusion to produce high-quality images that aligned with the input text. In terms of their applications and results in image generation, Peng [6] stated that GANs performed well in generating realistic images but suffered from problems such as pattern collapse and unstable training, while the diffusion model had better stability and controllability. Therefore, Stable Diffusion was chosen to be employed by subjects in this research.

3. Objectives

This research aimed to examine whether AI chatbots could assist designers in creating conceptual images, which serve as a foundation for developing

schematic design. The study was conducted in a first-year design studio course in the Department of Architecture at Hong Kong Chu Hai College. Over an 11-week period, students were tasked with designing a single-family house, with the conceptual images generated within a span of 1 to 2 weeks.

The students were initially divided into two groups. Six students were assigned to the experimental group, where they were instructed to use the AI chatbot "Stable Diffusion" to generate their conceptual images (see Figure 2). The remaining ten students formed the control group (Group D), where no AI assistance was provided. Instead, they followed the traditional design approach, relying on their spontaneity and imagination to create conceptual images. By the conclusion of the schematic design phase, a significant disparity was observed between the two groups.

Only 10% of the control group produced conceptual images, highlighting the challenges faced by students who were not aided by AI chatbot in visualizing their initial design concepts. Most students chose not to create conceptual images. For example, one student presented only massing models without a clear visual concept, while another included an unreferenced image but did not explain its origin or influence on the design.

The subject group demonstrated a more conscious effort by creating conceptual images through AI chatbot. The conceptual images provided more narrative and imagination to their projects, fostering artistic inspiration and exploration. This approach resulted in stronger foundations and clearer direction for their design compared to those without conceptual images. All six students in the subject group were free to input any keywords they deemed important for generating their conceptual images of the single-family house. To gain insights into their experiences, the students were surveyed with the following five questions:

1. Which AI chatbot did you use?
2. What keywords did you input into the chatbots to generate the AI images?
3. Did you change your keywords many times before getting the images you liked?
4. Did you use these images as your conceptual concepts to develop your final project?
5. Did you find the chatbot helpful and user-friendly?

4. Assist Designers In Generating Conceptual Images

Sonderegger and Seufert [8] suggested that chatbots had the potential to assume roles such as teachers and supervisors, enhancing designers' learning experience by meeting various learning

requirements and achieving targeted outcomes. This research explored the potential for AI chatbots to assist designers in generating conceptual images (see Figure 2). Ideally, the design process typically began with the designer consulting with a primary assistant, such as supervising architect or professor. They would advise them on site analysis, precedents and client's functional requirements. The designer then engaged with a secondary assistant, an AI chatbot, by inputting keywords via text or voice commands. The chatbot, utilizing semantics and its training dataset, transformed these inputs into graphic outputs, offering a range of conceptual image options. This assistant role of AI had the potential to significantly improve the efficiency and creativity involved in architectural design.

5. Comparative Analysis

Consequently, all six students used Stable Diffusion in various ways. The images generated could be categorized as three distinct image types (see Figure 3):

Type A Images: Commodity

Type B Images: Picturesque

Type C Images: Abstract Art

6. Type A Images: Commodity

Two students, designer A1 and A2, used objective keywords related to building type and site context, such as "house" and "seaside," when inputting their prompts into Stable Diffusion (see Figure 4). The AI-generated images were highly realistic, resembling fully designed houses. However, instead of creating unique, custom-tailored homes, this approach led to arbitrary images, treating architecture as generic, mass-produced commodity.

Both students reported that the AI-generated images were not helpful in developing their architectural concepts. In fact, they stated that continued use of these images could have confused them and hindered their creativity. As a result, they chose to proceed with their design without relying on the AI-generated images. Ultimately, their final house design bore no resemblance to the AI images.

In professional architectural practice, the schematic design phase for a house typically spans 1 to 2 months. During this time, designers conducted many design studies and developed schematic design (see Figure 1). The absence of a comprehensive design process rendered the AI-generated images superficial, as the design were not tailored to the specific requirements of clients. Therefore, the assistance provided by the chatbot in this approach was very limited.

In the right context, these images can be



Figure 4. Type A - Generic Commodity

beneficial, especially for non-designers such as real estate agents or public housing officials. AI chatbots enable these personnels to explore a wide range of design styles and alternatives early in the process [3]. By generating multiple housing images almost instantly, they could quickly gauge client preferences, enhancing the efficiency of their sales presentations. Borglund [1] further notes that individuals can use these AI-generated design to show that the options are grounded in evidence, enabling them to make informed decisions based on research and proven experience. The buildings shown in Figure 4 could be built easily and quickly indeed.

7. Type B Images: Picturesque

Two students, designers B1 and B2, inputted interpretive sensation and intellect keywords into the AI chatbot, seeking to generate conceptual images that would reflect the picturesque atmospheres they intended to convey in their design. Rather than focusing on fully designed architectural forms, the chatbot produced picturesque and imaginative images. Both designers refined their input multiple times, experimenting with various word combinations until they arrived at images that aligned with their thought.

Designer B1, for instance, inputted keywords such as “plants” and “green park,” generating AI images that evoked the sensation of a peaceful, untouched natural landscape as a wild park (see Figure 5). This image resonated with his sensation to incorporate a sense of harmony with nature into his conceptual design. Additionally, designer B1 experimented further by inputting “tree in empty background,”

which produced a minimalist image of a single tree standing alone in a vast, barren landscape. The contrast between the solitary tree and the emptiness of its surroundings conveys a sense of quiet contemplation and isolation. Designer B1 noted that this image accurately reflected his sensation of simplicity and solitude, fitting well with the atmosphere he intended to evoke in his architectural design.



Figure 5. Type B1 - Mystical Landscape Picturesque

Designer B2 inputted intellectual keywords such as “one single white cube” and “simplicity style house.” The AI-generated images conveyed a sensation of openness, embracing simplicity through the cube (see Figure 6). These minimalist visuals encapsulated B2’s design vision of clean lines, pure shapes, and simplicity. The images express a visually and spatially open environment, free from distractions, and evoking calmness and clarity.



Figure 6. Type B2: Simplistic Building Picturesque

While both designers acknowledged that the AI-generated images were somewhat helpful in illustrating a picturesque atmosphere, they ultimately did not use these images in the development of their final housing design. Although the images bore minimal resemblance to the students’ final design, they served as valuable visualization tools during the early stages of conceptualization. The designers appreciated how the AI offered immediate visual feedback, but also noted significant limitations. Specifically, they stated that the images lacked any clear implications about potential building forms or spatial arrangements, which were crucial in the housing design.

Furthermore, both designers admitted they were unwilling to invest the time needed to interact with the chatbot and refine the output images. They expressed doubts about the chatbot's ability to assist them further, feeling that additional time spent with the AI would not be worthwhile. As a result, the generated images captured the general atmosphere the designers were seeking but enabled to provide impactful inspiration.

8. Type C: Abstract Art

Two students, C1 and C2, inputted subjective keywords that expressed their intellectual preferences for geometric forms (see Figure 2).

Initially, designer C1 generated realistic, fully designed house images similar to Type A images. However, he continued refining the AI chatbot's outputs by experimenting with more subjective, abstract keywords. Eventually, he inputted keywords such as "suprematism," "guarding," and "self-defending," which led the AI to generate abstract artistic images (see Figure 7). These images suggested a concentric geometric form, with layers radiating from a central point, evoking a protective and introverted design. The layered geometry created a sense of enclosure and security, as if shielding the core from the outside world, symbolizing a space that prioritized privacy and internal focus over external connections. This shift from Type A realistic image types to abstract concepts marked a turning point in C1's process, allowing him to explore deeper architectural ideas. The chatbot's ability to interpret intellectual and philosophical terms enabled C1 to explore beyond conventional constraints, ultimately shaping the core principles of his final housing design.

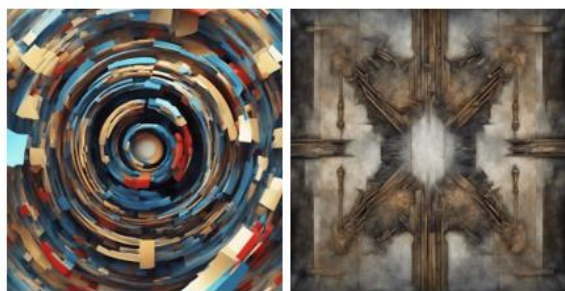


Figure 7. Subject C1: Abstract Form

Designer C1 stated that the AI-generated images directly inspired his final housing design. The concentric form was maintained in his house, with all rooms oriented around a central courtyard (Figure 8). Similar to the abstract image (see Figure 7), the courtyard became the focal point, around which all elements and activities were organized. This inward-facing design ensured privacy and protection, as the family's activities were visible only from the

courtyard and not from the street.

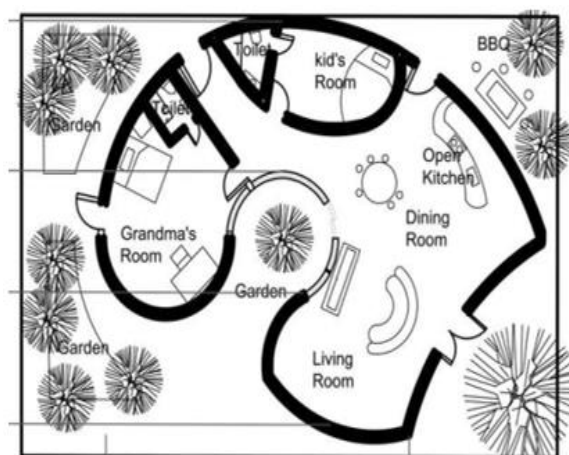


Figure 8. C1 Designer's Housing Floor Plan

The floor plan revealed that key living spaces—such as the dining room, living room, and grandma's room—all overlooked the courtyard (Figure see 8). This layout reinforced the protective nature of the house, allowing family members to observe the communal areas while maintaining privacy. Designer C1 emphasized the home as a protective environment for the family. The concept of self-guarding seen in the AI-generated image, was reflected in the three dimensional physical model and virtual model of the house (Figure see 9).

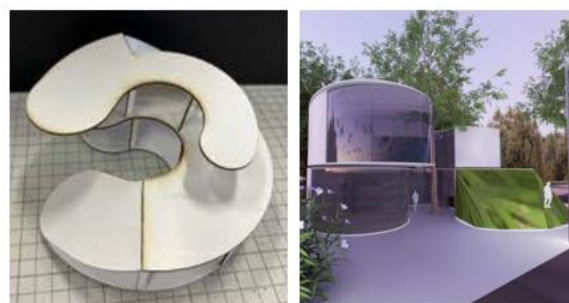


Figure 9. C1 Final Housing Design

The AI chatbot provided valuable assistance to Designer C1, it might have also limited his creative process. C1 spent an excessive amount of time attempting to connect AI-generated images to other aspects to his house design: site conditions, precedent studies, and client's functional requirements (see Figure 10).

Since these elements were largely irrelevant to the AI's conceptual image, there was no need to create arbitrary symbolic correlations. For spatial planning, C1 appeared to settle on the initial AI-generated concentric form without fully exploring or transforming it to meet client's functional requirements.

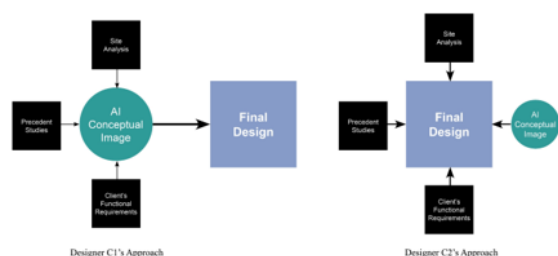


Figure 10. Designers' Approaches to AI images in Final design

While the concentric form was intriguing, designer C1 might have prematurely adopted it without ensuring it accommodated essential spaces like the living room and kitchen. Alternative forms, such as a concentric rectangular layout or a three-dimensional spiral, might be better suited, while still preserving his concepts of concentricity and protection. Furthermore, C1 did not fully consider key site conditions, such as the beach location or sun orientation. By focusing too heavily on the AI-generated image, he missed opportunities to better integrate these factors into his design. Despite these limitations, C1's work was still evaluated positively in the design studio course, receiving a "Good" grade from the professors.

Designer C2 was eager to explore the light and shadow design in a house. After refining his keywords, he inputted intellectual keywords such as "abstract," "concept," and "cubism" into the chatbot. The resulting AI-generated images appeared to conceptualize light and its reflection (see Figure 11). The abstract image depicted light (represented by white) and shadow (represented by black) in a fragmented, mirror-like composition. This abstraction gave the impression of a real object broken into smaller parts, with each fragment revealing a piece of the whole. While this image doesn't directly suggest a specific architectural form, the dynamic interplay of light and shadow across various dimensions offered a unique perspective, serving as visual inspiration for exploring how light interacts with space in architectural design.



Figure 11. Designer C2: Abstract Lighting

Designer C2 was inspired by an AI-generated

image featuring long, white rectangular strips, which he interpreted as representations of light. Intrigued by this visual element, he envisioned these strips as windows or light wells for his house, positioning them as key sources of sunlight. Consequently, his house design revolved around these "pockets of light," with surrounding rooms arranged to encircle these areas, emphasizing the importance of natural light in the architecture (Figure 12).



Figure 12. Final Housing Design of Abstract Lighting

Designer C2's approach to using the AI-generated image was regarded as interesting and effective (Figure 10). He successfully drew inspiration from the AI image's focus on lighting, incorporating it into his design through the use of windows and light wells. By contextualizing the AI image, he translated its abstract concept into an architectural element. However, he chose not to relate AI image to other aspects, such as site conditions and the client's functional requirements. This approach allowed designer C2 to balance the use of AI while maintaining creative freedom in other areas. Nevertheless, designer C2 did not thoroughly explore the spatial form for his final design. As a result, his project received an "Average" grade, indicating room for improvement.

Consequently, both designers C1 and C2 had their house design influenced by the AI-generated conceptual images (see Figure 13). Unlike Type A

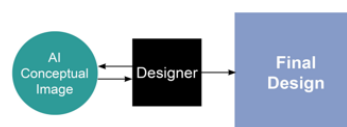


Figure 13. Designers Generated and Were Inspired by AI Images

images, which offered quick views of fully designed commodity houses, and Type B images, which focused on creating picturesque atmospheres only to evoke sensations, Type C images explored abstract art more deeply, allowing them to inspire and influence designers' final housing design. This is achieved by continuous interaction between the C1 and C2 designers and the chatbot.

9. Drawback of AI Conceptual Images

The use of AI-generated images in the design process could have raised potential ethical concerns, particularly regarding intellectual property. Generally, architects and designers highly valued originality and aimed to avoid copying or imitating existing works. However, there was a lack of transparency in how AI chatbots like Stable Diffusion and ChatGPT were trained, and how they transform original data or copyrighted material. Designers had to ensure their work was ethically sound. Currently there were no clear guidelines or legislation governing the licensing rights of AI-generated images, making it crucial for designers to take precautions.

Running AI-generated images through plagiarism detection platforms helped assess their originality. In this research, all the conceptual images produced in this research were examined in a plagiarism detection platform Pixsy. No identical or similar images were found. This suggested that the conceptual images were original to a certain degree. There is a need for designers to examine how the AI-generated images could comply with ethical standards, protecting their work from potential copyright challenges.

10. Conclusion

Some designers might find it challenging to develop conceptual images during the schematic design phase. This research explored the impact of AI chatbots in assisting designers in generating conceptual images during the schematic design phase. By categorizing the approaches into three image types—Type A (Commodity), Type B (Picturesque), and Type C (Abstract Art)—the study demonstrated how AI-generated images influenced different design strategies.

Type A images, which showed realistic but simplistic house design, provided little depth for creative exploration. Type B images helped evoke a sense of atmosphere, but they were only moderately useful in influencing designers' final design. Meanwhile, Type C images, which were abstract and more intellectually stimulating, had a significant impact on the designers' processes, guiding them to create final housing design.

The research also highlighted the potential benefits and limitations of AI chatbots in architectural design. While AI could serve as an effective tool for generating visual ideas and overcoming creative blocks, designers need to be mindful of how much they rely on these images. Balancing AI-generated images with consideration of other site aspects is crucial for maintaining originality and meeting functional requirements. Additionally, the research raised ethical considerations around the use of AI-generated images, particularly in terms of copyright and originality.

Ultimately, the research emphasized the importance of thoughtful use of AI in design. As AI chatbots continued to evolve, they could become significant secondary assistants to designers, as illustrated in Figure 2, potentially involving themselves in more aspects of the design process in the future.

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12. Acknowledgements

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