

The Role of Creativity in Integrating Artificial Intelligence within Conceptual Architectural Design

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Abstract: Advancement of AI (Artificial Intelligence) technologies has a strong impact on evolving role of creativity in architectural design. Advancement and rapid adoption of Artificial Intelligence technologies brought new challenges to the philosophical debates on creativity, further expanding the ambiguity resulting in lack of adequate education and professional improvement. This review paper argues that the integration of generative AI technology in architectural design fundamentally transforms the nature of exercised creativity to shift the focus from idea generation to problem framing and critical curation. In this paper new essential skills such as semantic articulation (prompt crafting) and iterative visual refinement are identified based on the synthesis of foundational theories on creativity and the operational reality of modern AI generators. Findings of this paper suggest that AI externalizes ideation process demanding enhanced capacity for strategic unpredictability, conceptualization and aesthetical evaluations. Advancing integration of AI within conceptual architectural design demands further development of creative intelligence that will facilitate requirements and limitations of collaborative human-AI ecosystem.

Keywords: artificial intelligence, creativity, architectural design, design, education

1. Introduction

During the present rapid growth of use of different generative AI tools, models, agents in architectural design (Midjourney, ChatGPT, Google Gemini, Sora 2, WAN, Tencent Hunyuan), it remains unclear how the creative process and exercise of creativity is being affected and what cognitive capacities of architects are being challenged by the AI interface. Intense development of generative AI tools is already allowing everyone to create highly professional architectural visualizations, videos and animations, 3D models, simulations. Architectural renders and animations which required knowledge in specialized software and highly expensive equipment, can now be created and run on smart phone devices. The aim of this paper is to examine how creativity fits in the AI assisted architectural design process.

The concept of architectural thought or creative thinking is crucial for modern architectural science and creativity is fundamental to design problem-solving. (Kokorina 2022) (Casakin & Wodehouse 2021) Architectural industry is classified as one of the creative industries and architectural design process is based on a highly valued creative phase (Kowaltowski et al. 2010) (Othman & Khalil 2018) Creativity and innovation are important throughout the life span of the projects. (Idi & Khaidzir 2015) Creativity is the main propulsion mechanism for a design cycle since design cycle consists of activities which have no equivocal starting point, neither the end result is known beforehand and is reached by a trajectory that is capricious. (Lutters et al. 2014) The core of architectural education is the design activity, making creativity a key element in design education and yet there is a relatively limited amount of literature concerned with the role of creativity in architectural studio. (Mahmoud 2020) (Casakin & Wodehouse 2021) (Kahvecioğlu 2007)

2. Definitions of creativity

Concept of creativity appears to be particularly multi-faceted and complex to define, and decades of debates have first focused on delineating it from closely related concepts such as originality, genius, imagination and talent. (Esling & Devis 2020) Creativity may be no more than new combinations of previous ideas and one person's creativity may be another's banality (Hakak et al. 2014) (Cropley & Cropley 2010) (Lutters et al. 2014) Creativity occurs through a process of generating ideas, solutions or products that are novel and valuable. (Lutters et al. 2014)

Creativity is typically studied from the point of view of the four Ps: person, process, product and press. (Cropley & Cropley 2010) (Mahmoud 2020) According to investment theory creativity is in large part a decision and this perspective indicates that creativity can be developed. (Sternberg 2006) (Lutters et al. 2014) The question of creativity relates to problem-finding rather than problem-solving activity and sometimes it is more crucial to find an interesting question rather than to find solutions to existing ones. (Esling & Devis 2020) Exploratory creativity involves the generation of novel ideas by the exploration of structured conceptual space which can result in novel and unexpected ideas. Transformational creativity involves the transformation of some (one or more) dimension of space, so that new structures can be generated which could not have arisen before. (Boden 1998) The linear model of creativity defined through preparation (information gathering), definition (problem finding), incubation (reflecting on ideas), illumination (appearance of a solution) and verification (testing the quality of the solution),

has been widely replaced with a cyclical one where stages are performed in various combinations and are highly influenced by motivation. (Esling & Devis 2020) (Mahmoud 2020)

Creativity can be articulated around three major components of novelty (creative ideas are innovative), quality (appeal of the idea) and relevance (the idea is appropriate to the task and era). (Esling & Devis 2020) (Personal) P-creativity represents form of creativity new to a particular person and times and (Historical) H-creativity is considered new to history at large. (Pope 2005) Improbabilist creativity involves new or unlikely and improbable in nature combinations of existing ideas which is also a working definition of creativity in architecture. Impossibilist creativity is a deeper type involving mapping exploration and transformation of conceptual spaces. (Hakak et al. 2014) In the creative thought process eight core processing operations are identified: (a) problem construction or problem finding, (b) information gathering, (c) concept search and selection, (d) conceptual combination, (e) idea generation, (f) idea evaluation, (g) implementation planning, and (h) action monitoring. (Scott et al. 2004)

3. Creativity in architectural design

Creative solutions in engineering involve one or more of six principles: improvement, diagnostics, trimming, analogy, synthesis, and genesis. In another case, principles are defined as such: conceptual replication, redefinition, forward incrementation, advance forward incrementation, redirection, reconstruction and redirection and re-initiation. (Cropley & Cropley 2010) Difference between architectural, mechanical and industrial design processes is the aspect of the problem considered, the primary source of knowledge, the degree of commitment made to output statement, the level of detail, and finally the method of transformation. (Idi & Khaidzir 2015)

Functional creativity in the case of bridge design would need to display novel features but also satisfy specifications such as being built from specified materials, within cost limits and within structural constraints. In functional creativity novelty is essential but not sufficient which can result in examples of pseudo-creativity where novelty emerges only from non-conformity, lack of discipline, blind rejection of what already exists and simply letting oneself go. Quasi-creativity is another similar example which has many elements of genuine creativity such as level of fantasy but without connection with reality, daydreams being one of the examples. (Cropley & Cropley 2010)

Divergent thinking (creatively open) is defined as ability to generate a multiplicity of possible solutions and ideas whilst convergent thinking (critically focused) is the ability to concentrate on finding out the single best solution for the problem. Design creative process depends on both of the abilities which are also related to brain's two hemispheres, with the right brain having an imaginative and creative side and the left brain with critical and analytical role. (Mahmoud 2020) (Esling & Devis 2020) (Pope 2005) There are three types of architectural thinking: design, figurative (artistic) and normative-organizational. Interaction of different types of thinking are combined into a complex mechanism of thinking thus regulating the integrity of creative search in the process of creating an idea in a sketch form or verbal construction. (Kokorina 2022) Design thinking consists of three cognitive processes: preparation (designer learns what to focus on and what is relevant), assimilation (making sense of proposed solution, data and observations) and strategic control (decision making process). (Razzouk & Shute 2012) Design thinking may not be enduring concept to be used in academia or the management world and as a term it is being replaced with 'creative intelligence' or 'executive thinking' (Johansson-Sköldberg et al. 2013) Creation in this sense seems to be an order emerging from reiteration of disorder. Creativity in architecture is present as function of novelty and usefulness, allowing for assessment of different design outcomes and also in the application of skills, tools, instruments during the design process. (Paananen et al. 2023) Architecture is defined as an artform where focus is on finding functional and practical solutions. (Bölek et al. 2023) In the process of architectural design effective ideation is strongly related to the ability to represent ideas. (Paananen et al. 2023) Idea generation is of primary relevance at the early stage of design process is considered as the most creative phase and generating ideas continues to be of importance through the embodiment and detailing stages. (Casakin & Wodehouse 2021) (Casakin & Badke-Schaub 2015) (Idi & Khaidzir 2015) Ability to find new, surprising and socially valuable ideas can occur in three main ways: combinatorial (producing novel configurations of familiar materials), exploratory (discovering new paths in conceptual spaces) or transformative (when the space itself is disrupted giving way to ideas that were previously inconceivable) (Esling & Devis 2020) Creation of an idea is not a miracle but a process comprising of repeated steps of collection of raw material, conscious mind-processing of collected material, incubation, actual birth of an idea (eureka moment) and development and final shaping of an idea. (Goldschmidt 1998) Preparation (getting to know the problem environment), incubation (longer period preparing the mind for a solution search), illumination (integration of ideas in search for solutions) and verification (revision, analysis, evaluation of ideas) are four stages of creative

process. (Kowaltowski et al. 2010) Incubation of creativity can last from few moments to days or weeks and neuroscience researchers found out that most of the learning occurs during the first night of sleep after training but that improvement can continue for up to another four nights. (Amabile et al. 2005)

“Fixation” effect appears in the process of creating design solutions. A designer can become fixated to one idea and consequently produce similar ideas or solutions over and over again. This especially can hinder the conceptual design preventing the designer to take wider perspective on the problem and to consider all of the relevant knowledge and experience that are required to solve the problem. It may be possible that designers usually prefer to rely on a simple satisficing design strategy rather than indulging in the well-motivated process of optimization. (Cross 2001) Fixation is a persistent problem in creative designs and strategies which should help to overcome it are further researched and include actions such as freeing imagination through the use of digital worlds and abstract design tasks. (Casakin & Wodehouse 2021) Fixation is more frequently observed with novice designers who laboriously try to design out the imperfections in the existing concepts instead of being able to discard the concept and return to a search for a better alternative. (Cross 2021)

4. Creativity and AI tools

Even though it has been reported that use CAD (Computer Aided Design) tools early in the design process can sometimes lead to premature fixation, AI image generators on the contrary offer a very dynamic environment where ideas are materialized in the seconds and this moves the pressure on the very ideation process – asking from architect to come up with different ideas very rapidly. AI tools may be a useful way to enhance creativity and help tackle obstacles that prevent creative thinking in architectural design, but in design in general. With fast generation of relevant variations architects could explore the problem-solution much faster with much less cost that it was previously available with sketches, CAD or internet images.

AI tool can be designed to generate artifacts autonomously, substantially untouched by human hands, or the AI tool can be seen as a creation tool that can enhance creativity and assist the human in generating artifacts. Whatever is the case the selection of most favorable result is done by human. To designer, AI is like an evolved brush to a painter. (Esling & Devis 2020) (Pope 2005) The development of machines capable of learning and changing their own programs opens up the space for a literature machine which will at certain point feel unsatisfied with its own traditionalism and starts to propose new ways of writing, turning its own codes completely upside down. (Pope 2005) EMI (experiments in musical intelligence) is a program that composes in the styles of Mozart, Stravinsky, Joplin and it employs powerful musical grammars together with list of signature motifs of individual composers. Another program generates jazz in style of Charlie Parker and it is based on knowledge about harmony, rhythm, jazz canons and large set of Parker specific motifs which can be varied and combined in a number of ways. This program is developed by accomplished jazz-saxophonist because without strong musical skills it would be impossible to identify relevant motifs or evaluate specific processes for using them (Boden 1998) AI is successful in the organizational and retrieval of knowledge but the combination of conceptual elements drawn from memory stem from largely more complex processes. Social context component of creativity can be limiting to human creativity whilst computational approaches can be freed from these societal biases and generate an almost infinite number of solutions. In try to represent human creative behavior as an AI system it has been noted that there are no equivalent steps of computation representing steps of problem finding and illumination, critical to creative process. (Esling & Devis 2020)

Creativity was traditionally considered as a domain general ability and recently it started to be seen as domain specific and this means that the generation of creative outcomes implies an ability that should be domain content. (Casakin & Wodehouse 2021) One needs to know enough about a field to move it forward but knowledge about a field can result in a closed and entrenched perspective meaning that knowledge can both help and hinder creativity. (Sternberg 2006) Expertise is a fundamental part of creativity as it allows to obtain more efficient reasoning based on appropriate problem representations and recalling domain-relevant patterns. (Esling & Devis 2020)

In order to use and apply the AI tools, it is necessary to understand how AI tools are made and how they operate because it is the internal structure of the AI tools that affect the possibilities for its manipulation in order to receive a desired output. AI tools are characterized by various degrees of control and there are many parameters that influence the output of AI generators. Having in mind that not even the designers of AI generator tools know in detail how exactly does AI generate its outputs rather different approach needs to be taken in order to have more control over the AI tool. In this sense, AI tools do not resemble classical tools in any way but is an intelligent, powerful and in a sense a tool which is “aware” in its own sense and can’t be controlled in a straightforward manner. Just as designers deviate from conventional use of CAD to complement the use of sketches (Häggman et al. 2015) the same approach could be seen as “reasonable” when using AI tools. Figure 1 shows design outputs made by AI model Seedream 4.0 based on the prompt entered by the author. The actual prompt that created

these images was crafted through trials, explorations and adjustments which eventually lead to desired conceptual design outputs.



Figure 1 Bird house concepts generated by the author using Seedream 4.0 Image Generator.

AI multimedia generators are transformed into a tool when used within a specific process and it is up to designers, developers, architects- the whole community – to fully utilize the possibilities given with AI technology. In this sense, cognitive participation involves a multidimensional, multilayered and dynamic interplay of convergent and divergent thinking (Pope 2005) towards the final output of architectural design, that is a strictly dimensioned description of a physical building. Knowledge about the principles of AI, about how tools are created and how they operate when used is the first step in discovery of new use cases in architectural design. At the same time the knowledge about the actual process of architectural design is also required in order to identify steps where AI could be successfully applied and integrated to increase efficiency and quality of project outputs.

5. Creative intelligence in architectural design

Ability to design partially depends on ability to visualize something internally in the 'mind's eye' but it also depends on the ability to externalize visualizations and in this sense, drawings are a key feature in design process. (Cross 2021) Imagery is a mental picture formulated in the mind of a designer and such representation comes in abstract form. Mental imagery and perception are tools to represent ideas in the mental stage. (Idi & Khaidzir 2015) Designers visual intelligence is responsible for the connection between mind and drawing by associating different represented shapes. Drawings, photographs, sketches, 3D models, animations, simulations are some of the media used by architects to simulate ideation and communicate design concepts. (Paananen et al. 2023) Visual intelligence is specially developed in architects who go through visual training during their education and professional experience which enables architects to depict emergent shapes and patterns which are fundamental for intermittent reinterpretation of a design idea. (Bueno & Turkienicz 2014)



Figure 2 Bird house concepts generated by the author using Seedream 4.0 Image Generator.

AI (image, video, 3D) generators are used in the similar way where the ideas are first formulated – mentally visualized – in the mind of the architect and then described to be digitally represented by the AI into a useable, communicative media output. In this sense the ability to invent, visualize and communicate ideas is the most determining factor of the output delivered by the AI tool. Ability to imagine, but also to describe and communicate the idea, becomes crucial in authentic creative utilization of AI generator tools. Multi-modal nature of developing AI models (ChatGPT, Gemini) offer possibility to describe the ideas and intentions using only text, or only image, or combination of both, or video, and many other digital media formats can be used as an input. In this way architects have a lot of different options to find most optimal and informative way to instruct the AI to produce the accurate output which can be in form of text, image, 3D model, video, web environment. The variety of multimedia formats that can be generated by the AI can be utilized in many parts of the architectural design process, but at the same time each output format demands different set of instructions to be accurately produced. Success of using AI to improve the architectural design process depends on the creative ways in which architect can describe the intentions and what is wanted from the AI as an output but it also depends on ability to invent possible ways to integrate the advantages of AI in the process of architectural design. Figure 2 shows additional variations of the bird house concept design which are generated by the AI by changing parts of the input prompt to bring the output closer to the imagined idea. Use of AI tools in conceptual explorations demands for the input to be actually designed, crafted, as a sort of blueprint for the AI to follow and to deliver accurate output, and with complex ideas/outputs and with large amount of input information there is a large space for different structuring, ordering and organizing the input for the AI. Different inputs will provide different outputs by the AI and the case is that even the minor changes in the input content or structure can deliver very different output results.

The use of AI tools to generate creative content does not demand any technical skill or specialized knowledge – the architect communicates with the AI using natural language or sketches, drawings, voice recordings – architect/designer/creator communicates ideas through common means of design and thinking communications in order to produce more complex digital formats such as videos, 3D environments, simulations in a highly efficient and timely manner. The free versions of AI models (ChatGPT, Gemini, Grok, Deep Seek, Kimi, Claude, Meta) offer possibilities to generate text, images, code and models like Sora 2 and WAN can generate high quality videos. Projects like World Labs offer possibilities to create a walkable 3D experience. In most of the cases the input is in the form of text and/or image, whilst the image itself can be anything – it can be a reference image or it can be a diagram describing the idea visually. Development of the AI technologies and products that can find use in architectural design is advancing and it is hard to foresee what kind of tools and possibilities will open for architects in the future. What seems to remain important is the ability to imagine an idea of high quality and relevance and to properly explain the idea in order to make the most use of very significant capabilities of AI models.

Using real input data (photos of the location, online maps, terrain) to generate architectural designs can be useful tool to create variety of rendered proposals in extremely short time. Generating realistic architectural renders in

very short time assists the architect to present variety of options to the client during the conceptual design phase when most important design decisions are being made. Using real world parameters to generate new designs with the assistance of AI enables easier integration of generated ideas into architectural project further in the project development. AI outputs lack detailed technical information (or structural quality) but are more focused on the exploration of potential solutions and to enhance the communication between the architect and other stakeholders. These methods represent one of many ways in which different AI tools can be used to solve problems and increase efficiency in contemporary professional architectural practice. Finding ways to successfully integrate the emerging AI technology into the architectural design process demands creativity which has to come from domain specific knowledge about the AI and also demands creativity to develop means of communications between the architect and the AI.

6. Conclusions

Creativity plays an important role in the way AI tools are integrated in architectural design. Text prompting, visualization, parameter manipulation, application in design process – there are many levels where architect can show creativity in order to maximize utilization and usefulness of AI image generator. This includes tweaking and playing and learning how different models works and what each of the parameters do in order to control the output. When manipulating with AI (through text, images, diagrams, schemes, sketches) the balance between AI's conformation to given constraints and freedom to explore is very important – too much constraints can lead to “overcook”, which is usually a result with bad output quality. Creativity is present on different levels – on the very conception of AI – it requires imagining and understanding abstract concepts of extremely large and complex calculations of data and statistics – the creativity required to relate the AI technology with its concrete application – the creativity required to write prompts and design inputs – there is plentiful of space within the architectural design process where creativity can play the role in more successful and efficient utilization and integration of AI tools. Changing parameters to better understand the model, making different inputs to observe how they affect the output image, understanding how prompt and the starting image relate to the output, are some of interactive activities between the architect and the AI image generators in design process. One cannot expect from the development and emergence of new technologies to be perfectly suitable for the needs of architectural design. The reality seems to be rather that new technology or a segment of it, gets eventually recognized to be useful within specific procedures in architectural design. Through this interaction between the development of technology and experimentation within the field of architecture, concrete tools and methods are being developed and further tuned to be more suitable, user friendly and efficient in executing tasks within design process.

Instead of trying to solve the whole building design process, different AI tools can be used to tackle specific design challenges – for each challenge there can be a different AI tool that is most suitable to ease the process – but at the end it is the creativity which plays essential role in how a specific tool is used to improve the design process. Even though there is a lot of different project development phases where AI can be implemented, the conceptual design phase remains crucial as it determines the overall cost and success of the project. Publicly available AI tools are being developed on a daily basis and the use of AI by architects is likely to increase rapidly. New ideas about how to use the developing technology to improve processes within the construction industry as a whole and in its segments are likely to emerge. Understanding the role of creativity in the context of the development of AI may be highly important due to high level of capabilities and opportunities that the AI technology offers. Extreme competitive advantages that are given with AI tools will have to be further utilized and explored by the creativity of the architects through experimentations, reiterations, and development of overall communication with the AI.

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