

Artificial Intelligence and Generative Art in Architecture: Use and Reflections

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Abstract. This article addresses the topic of artificial intelligence applied to the process of creating images in architecture and urbanism. Through the broad incorporation of artificial intelligence tools for the production of texts and images, this article is the result of research that started with the following question: How can artificial intelligence be incorporated into the design process of architectural and urbanism projects. From a methodological point of view, this is an exploratory and qualitative research, in which a bibliographical survey was carried out that also provided the basis for the development of a workshop with beginning students in an architecture and urbanism course at a Brazilian federal university. As it is still a novelty, there is still a premature stage of incorporation of artificial intelligence, which requires a critical and reflective stance.

Keywords: Artificial Intelligence, Generative Art, Architecture, Design, Creativity.

1 Introduction

The current scenario of image consolidation as a dominant means of communication is reinforced by the recent proliferation of tools and images designed by Artificial Intelligence, shared mainly on social networks and other online platforms that favor this “viral” character.

These artificial intelligence tools bring with them the discourse, still much questioned by society in general, of a greater process of democratization of creativity and artistic production, providing access to the most advanced means with interfaces accessible to a non-specialized public. Such transformations impact not only artistic production and creativity but also the concept of authorship, plagiarism, and the practice of design professionals in their various areas.

Considering this still quite a nebulous scenario, this work presents the concepts of artificial intelligence (AI) and generative art (GA), as well as the use

of three of the main tools/platforms available (Dall-E, Midjourney, and Stable Diffusion) and their implications on creativity, limitations, and possibilities aimed at designing images focused on content about architecture and urbanism.

The discussions presented in this article arise both from the literature review and, mainly, from the holding of an applied workshop for beginning students at the Faculty of Architecture and Urbanism at the Federal University of Juiz de Fora. The main objective of the article is to bring some reflections on the potential of inserting artificial intelligence tools into the design process of architectural and urbanism projects. Although incipient, these reflections are necessary and urgent.

2 AI and Creativity in Architecture and Urbanism

In computer science, AI can be defined as the study and development of intelligent agents. In general, the term is applied when a machine imitates the cognitive functions associated with human beings, such as learning and solving problems (Nilson, 2009).

Historically, several studies have shed light on the dynamics between humans and machines. In 1936, Benjamin (2013) analyzed the impact of emerging technologies at the time on works of art. It dealt with issues relating to the work of art in the era of its technical reproducibility.

Nowadays, the discussion between art, creativity, and technology continues, especially in light of artificial intelligence, which has changed human performance in different fields. It is in this context that discussions about the authorship of the images generated, about unauthorized copies and plagiarism, about the misuse of images, and about possible liability for the works created become even more evident.

If, on the one hand, Oppenlander (2022) argues that it is necessary to expand the scope of what can be considered creative work, on the other, there are several artists fighting against the consumption of images produced by artificial intelligence.

The truth is that, with the advent of digital culture, society has gone through profound cycles of changes. According to Santaella (2022, p. 62)

“in Life 1.0, only biological evolution formats bodies and minds. In 2.0, the intelligent animals that we are, we added the cultural factor to evolution. Now, in 3.0, technological life has acquired the ability to drive evolution, not just biological, but also cultural. The flagship of Life 3.0 is AI, the most important agent of the 21st century, which will transform society, culture, economy, work, politics, our bodies, minds, and identity, in ways we can barely imagine.”

As can be seen, as mentioned by Del Campo (2022), the accelerated dissemination of AI image generators also attracted many architects and designers, seduced by the ease and speed of producing rendered images of the most diverse natures, provoking a new aesthetic, called by him as Post-Human Aesthetics, coinciding with the notion of Neo-human or Hyper-Hybrid Human by Santella (2021, 2022). This aesthetic features the active inclusion of other agents in the creative process and the broadening of human skills, with AI serving as one of the examples.

Over time, several studies have been applied to the conversation between intelligent human-machine mixed-initiative design systems for architecture. Even before computing was within the reach of architects, Nicholas Negroponte and others were exploring digital design ideas. As early as 1964, according to Steenson (2017), Walter Gropius recognized that there could be a role for these new machines in the profession, suggesting that creative design processes would lead to forms of control and freedom if used intelligently. It can be recognized that the tools and methods used by architects have always had a direct impact on the way buildings are designed, and with technological evolution, new approaches have been presented for the creation process, and have become more than ever, crucial elements within this design process.

According to Bernstein (2022), technology in architecture can be classified into two axes: the progression of technologies that comprise the types of architectural tools and the taxonomy of uses they support. The taxonomy described by Bernstein (2022) is a characterization of the capabilities of digital tools: (a) representation, (b) analysis and simulations, (c) realization/management, and (d) collaboration. Also, Braidà, Lima, Fonseca, and Morais (2016), when compiling 101 concepts of architecture and urbanism in the digital era, highlight the different possibilities and impacts of digital technology in the field of Architecture and Urbanism.

AI, broadly defined here as the ability to perform complex cognitive tasks in a way that produces results similar to the human mind, is an enabler of the various capabilities described in this taxonomy.

In architecture, lines of investigation focus on two main schools of thought. The first is optimization, such as possibilities for more effective floor plan configurations, material consumption, and construction site schedules, which would be aimed at assisting with problems related to disciplinary considerations and architectural foundations. And at the other end of the line is the investigation into the problem of design in architecture, which includes creativity, intuition, and sensitivity, elements that are very difficult to translate into codes, as they escape quantification.

In this context, the connections between artificial intelligence and generative art also deserve attention. The so-called generative art can be defined as the creation of images or artistic content made by autonomous systems (Boden and Edmonds, 2009). The way of generating images, through textual prompts, provides an expanded field of visualization and creativity possibilities. This

method uses a process called “diffusion”, which starts, at first, from a pattern of random dots and gradually moves towards an image, when it recognizes specific aspects of it. Many AI platforms are being developed and used to generate “generative art”, among which the following stand out: Dall-E, Midjourney, and Stable Diffusion.

All of these tools mentioned above use a large database of classified photos and generate, based on keywords, written in the command bar, new images. According to Liu and Chilton (2022), advances in machine learning begin to understand semantics and natural language as forms of interaction. These mechanisms have a learned relationship between images and the text used to describe them.

These images can be used to quickly visualize ideas and receive creative insights while the traditional project development work is carried out, as illustrated in Figure 2, where a reference image generated in DALL-E was used, and then the resulting volume with the Rhinoceros and Grasshopper software. Furthermore, there is a consensus that the development of methodologies for the creative process in the field of architecture and urbanism does not follow a linear logic, with the constant presence of evolution and feedback.

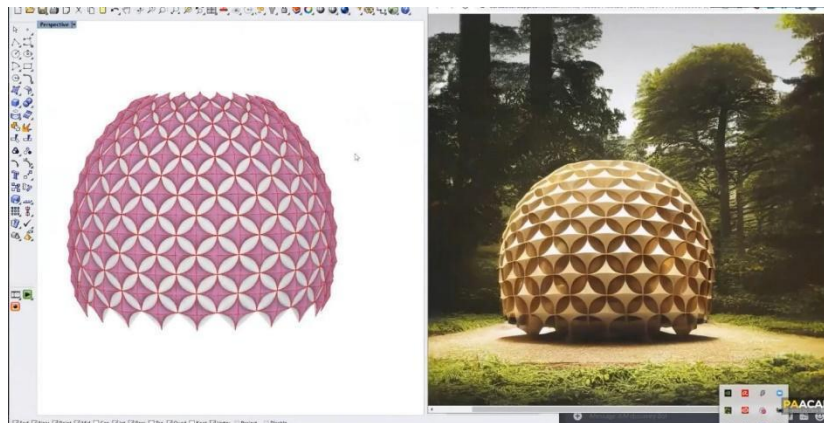


Figure 1. Reference images were obtained using the DALL-E platform and the model was subsequently developed using the Rhino3d modeling software. Source: parametric.architecture.com/deep-dive-into-the-secrets-of-the-prompt-crafting-with-fim-fu-in-midjourney-and-dalle-2/.

Another concept related to text-to-image conversion programs is that of generative design, which causes a change in the way design is conceived, which stops focusing on singular objects and focuses on creating a process that can generate an infinite number of objects or results through computational models (Dillenburger and Hansmeyer, 2013). Then we searched. Investigate the possibilities of applying these resources in the field of architecture and urbanism.

3 Methodology

From a methodological point of view, the research can be classified as qualitative and exploratory. The topic of artificial intelligence has still appeared timidly in scientific publications. Still, given the advances in this area, the discussion about creative processes and the use of computational and artificial intelligence tools are urgent.

Initially, bibliographical research was carried out, searching for productions on artificial intelligence and creativity in Architecture and Urbanism and in related fields. This theoretical framework served as the basis for the discussions brought up in this article, resulting from the development of a workshop, carried out with beginning students of the Architecture and Urbanism course at the Faculty of Architecture and Urbanism at the Federal University of Juiz de Fora, Brazil.

To propose the workshop, three tools/platforms were initially tested: Dall-E, Midjourney, and StableDiffusion.

In general, image creation platforms using AI resources work in the following way: the process begins with a “prompt” text, responsible for describing to the model the steps to generate the images. Words generally contain the subject of the image and its qualitative characteristics, adjectives, and context. Words define atmospheres, materials, styles, or artistic movements. From a command, images are generated and, if necessary, you can request more variations or increase the resolution of the images.

This form of AI imaging described above is present in similar ways across the three AI imaging platforms tested.

Initially, when using diffusion models to produce images, the presence of two main characteristics is noted: (1) agility in image generation and (2) randomness. It appears that the processing to generate new images takes little time, that is, in a few seconds new images can be created. There is also a high degree of randomness in the generation of images by AI, often resulting from the current lack (or little) of training in artificial intelligence. The results are sometimes very different from those initially imagined by a human mind. However, if, on the one hand, the results are surprising because they do not correspond to a possibly stereotypical image, on the other hand, it opens up a space for the system user to carry out a new exploration, boosting a creative process that is still unprecedented.

When comparing the images generated by Dall-E, MidJourney, and Stable Diffusion (Figure 2), from the insertion of the same keywords (prompt), it is observed that the aesthetic quality of the images produced via MidJourney stands out, as they are more aesthetically pleasing and quite consistent with the instructions given for the tool.



Figure 2. Architecture images obtained from the three tools (Midjourney, Stable Diffusion, and Dall-E, respectively) using the same prompt. Source: the authors.

Therefore, in the workshop reported in this article, applied in the context of an Architecture and Urbanism course, it was decided to use Midjourney.

DALL-E was also used to generate variations of the images obtained through Midjourney, allowing enlargement and modifications, such as changing a covering, the color of an element, or furniture insertion (Figure 3). The objective was to create a workflow that best combined the potential of the tools, seeking possible control over the creative exploration process, as well as specific decisions regarding the results presented.

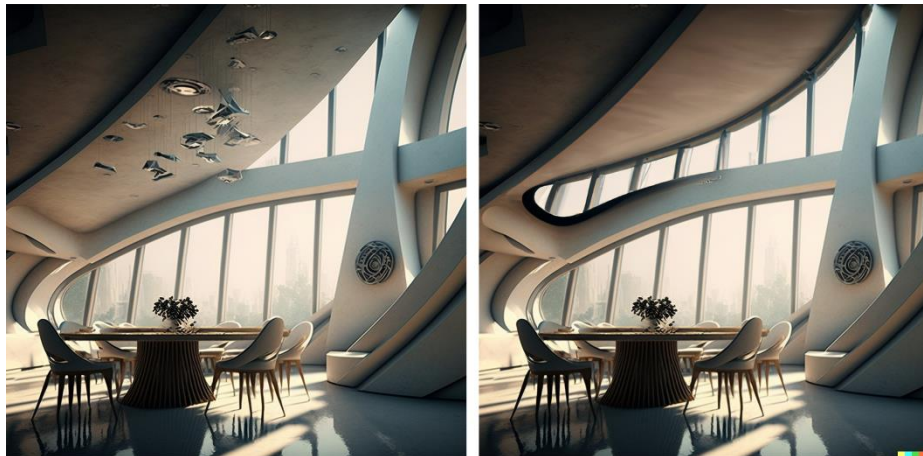


Figure 3. On the left, an image generated in Midjourney. On the right, the same image with modifications made using DALL-E to alter the ceiling material and incorporate a new window. Source: the authors.

3.1 Workshop with Architecture and Urbanism students

The workshop entitled “Use of Artificial Intelligence for Image Design in Architecture” was held at the Faculty of Architecture and Urbanism of the

Federal University of Juiz de Fora (UFJF), over two days, with 53 participants from different periods.

Initially, participants were introduced to the topic of applying artificial intelligence in the context of Architecture and Urbanism, as well as the concepts of generative art. It began with a presentation of the historical evolution of representation in architecture and its importance in the transformations of design practice.

This discussion of creation tools and technological evolution is fundamental for discussing creative processes. It is observed that the techniques and technologies used in the creative process directly affect the result since the designed products carry signs or marks of the modes of production. Awareness of the importance of inputs and mastery of their influence on results are fundamental to overcoming creative naivety.

After installing the tools, via Discord, workshop participants explored Midjourney, both in a guided way and individually, based on their curiosities.

At the end of the given period, the entire group met for a presentation of the results and a discussion. Some of the results obtained revealed great formal/aesthetic appeal, combining visualization or architectural styles.

For the next stage, a volumetric study was carried out and the images obtained were used for initial concepts in modeling and CAD design software, aimed at shape study, prototyping, and rendering, with a regressive process to the nature of the design processes. The VERAS tool (which was developed by Evolve.Lab group and generates visualizations from a three-dimensional model created in Revit, Sketchup, or Rhinoceros programs) was also presented. To exercise this stage, participants carried out tests with single-family residence models or models made in design disciplines in previous semesters, obtaining variations from this initial model, as shown in Figure 4.



Figure 4. On the left, an image obtained through the Revit software; on the right, images generated using the VERAS tool. Source: the authors.

At the end of the workshop, a questionnaire was administered, so that the student's perception of the topics covered could be evaluated and the answers could support reflections arising from the use of artificial intelligence in the creative process, especially in the field of architecture and urbanism. With the questionnaire, answered anonymously, it was possible to make a more precise characterization of the participants.

A more detailed (expanded) version of the results of the questionnaire application can be found in the article entitled "Artificial intelligence and creativity in architecture", published in Portuguese, in the Brazilian scientific magazine "Educação Gráfica" (Graphic Education), see Almeida, Luciano and Braida (2023).

The initial questions of the questionnaire asked about the moment of training in the course and whether they had already had contact with any AI tool, most of which were in the initial and intermediate stages of the course. The questions and results are presented in the infographic below (Figure 5.).

One of the questions sought to understand which alternative would most resemble the design process in relation to a task required in the Architecture course by the participants, focusing on the initial stages of creativity and decision-making.

The alternatives were arranged in six options, including: 1. Regressive/Formal: begins with the abstraction of sketches, drawings shapes, or other concepts. You can also make use of models and other physical elements. 2. Iconographic/Referential: projects and images are searched on websites, applications, and other search engines to create representation, project, and idea references. 3. Programmatic: description of the project's needs program, organization by sector, flows and other project constraints, followed by a possible outline of plans and/or forms. 4. Problem-Cause-Solution: delineation of the problem and key issues of causes relating to the project to define the project scope. Search for solutions that satisfy these limitations, which may be theoretical, constructive, legal, or environmental, among others. 5. Digital/simulation: use of digital tools with volume abstraction and pre-sizing in CAD software, followed or not by carrying out simulations and delimiting parameters made in digital interfaces. And finally 6. None of the above.

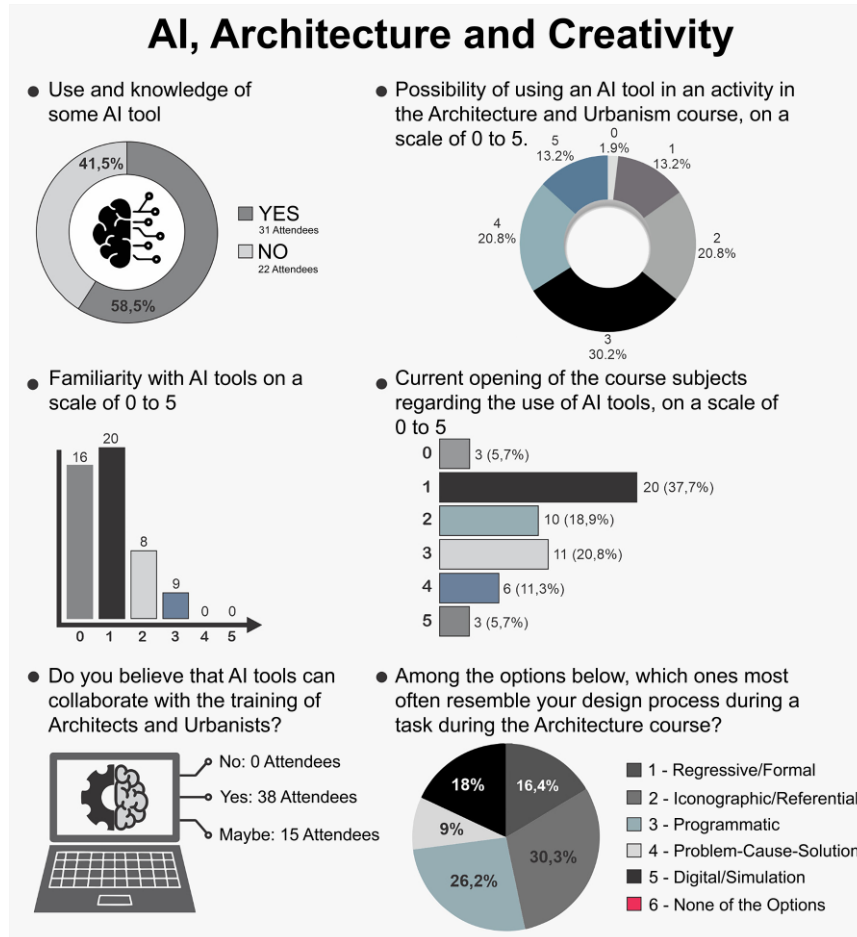


Figure 5. Infographic with the results obtained from the questionnaire carried out in the workshop. Source: the authors.

The responses naturally point to diversity in each participant's design process, as can be seen in the graph. The considerable number of responses with the "Digital/Simulation" alternative stands out, revealing the growth of the digital scope in the initial stages of design in classes beginning to form the course.

4 Discussion

The results, both from the literature review and after the workshop and questionnaire, demonstrate that the use of AI in architecture is still in its early stages, revealing possible use on several fronts. As for creativity, it presents

itself as an additional resource, which does not replace or invalidate any other already consolidated method of conceiving and organizing knowledge.

It is possible to say that there was good receptivity from the workshop participants during all phases, with easy assimilation and learning, as the tools are very intuitive due to their friendly interface, as well as the quality of the results when it comes to first contact. A question was also raised about the displacement of design processes, starting from the initial point of abstraction made by AI image generators, with the image being produced beforehand, and not because of the internal arrangement of spatially defined layouts.

In contrast, Mahfuz (2013), when talking about the dangers of conceptualism and the repeated application of non-architectural ideas to the design process, is that of escaping the unknown regarding the final result, and the presence of a dominant non-architectural concept is, most of the time, the imposition of an arbitrary and personal will on the development of the project, which starts to focus on and validate this primary concept. Thus, the formal identity of the object is no longer based on the program, place, and construction for the benefit of the initial image, and the consequences would be the loss of the tectonic qualities of much of the recent architectural production.

Therefore, according to Gobin et al. (2016), the use of digital becomes a generalizing expert system again, and the architect's dilemma continues as it has been since the emergence of the profession, with the classic difficulty of translating conception to representation, and from representation to realization, persisting.

It is important, in this sense, to look for ways to overcome barriers in obtaining engagement and feedback, break the instrumental limits that currently exist, and implement ways to refactor the tools.

Although the software, tools, and problems involved continue to be complex, experimentation and integration can help to dispel these conjectures, especially given the new knowledge models that are increasingly being incorporated into the profession of architecture and urbanism.

5 Conclusion

It is still premature to predict what the contributions and transformations will be in the field of architecture and urbanism following the incorporation of artificial intelligence tools, but the possibilities of use are diverse. It is, therefore, undeniable that the interest in and production of new resources will grow exponentially.

On the one hand, we have ethical concerns and concerns related to the threat to the human creative faculty. On the other hand, creative potential can be seen in human-machine relations. Thus, on the one hand, there is a more conservative (or culturalism) stance, in which doubt and distrust in technology prevails. On the other side, we see the most progressive stances, in which the

stakes in digital technology are extremely high and understood as inevitable in contemporary times.

We believe that, like other technologies already incorporated throughout the history of architectural and urban design, artificial intelligence has great potential for transformation. However, when looking back, there is still a need for caution and more research into the risks and potential so that we are not utopian and can incorporate this technology in a conscious, critical, and reflective way.

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