

Received Date: 27<sup>th</sup> November, 2025

Revision Date: 20<sup>th</sup> December, 2025

Accepted Date: 21<sup>st</sup> January, 2026

## Artificial Intelligence in Architecture: Its Influence on Design Processes

Neha Suwal<sup>1\*</sup>, Pramisha Shrestha<sup>2</sup>, Sampanna Panthi<sup>3</sup>, Yana Sitaula<sup>4</sup>, Sweta Shrestha<sup>5</sup>

<sup>1</sup>Dept of Architecture, Kathmandu Engineering College, Nepal. E-mail: nehasuwal4@gmail.com

<sup>2</sup>Dept of Architecture, Kathmandu Engineering College, Nepal. E-mail: pramsa816@gmail.com

<sup>3</sup>Dept of Architecture, Kathmandu Engineering College, Nepal. E-mail: saampannapanthi@gmail.com

<sup>4</sup>Dept of Architecture, Kathmandu Engineering College, Nepal. E-mail: sitaulayana12@gmail.com

<sup>5</sup>Assoc. Professor, Dept of Architecture, Kathmandu Engineering College, Nepal. E-mail: sweta.shrestha@kecktm.edu.np

**Abstract**— *The paper investigates how Artificial Intelligence (AI) is affecting architecture, specifically through its effects on design, creativity and making architectural work more effective. It investigates how AI can be used in architectural design, for creating sketches, analysing the site and automating records. The paper discusses uses of AI in examples such as Zaha Hadid Architects and Foster + Partners, along with revealing problems related to data, ethics, and skills development. According to the study, AI should be taught in architectural programs, appropriate tools made and principles for ethical use put in place.*

**Keywords** — *Artificial Intelligence, Architectural Design, Generative design, Machine Learning, Sustainable Architecture*

### I. Introduction

Architecture has long been a field where creativity, intuition, and manual skill come together to shape the built environment. With the rise of advanced technologies, particularly Artificial Intelligence (AI), this traditional design process is undergoing a significant transformation. Artificial Intelligence refers to the simulation of human intelligence in machines that are programmed to perform tasks typically requiring cognitive functions such as learning, problem-solving, pattern recognition, and decision-making [1]. AI technologies—such as data-driven analysis, generative design algorithms, and real-time environmental simulation—are enabling architects to explore new design possibilities, optimize performance, and improve efficiency in the planning and construction phases. These tools can manage vast amounts of data, predict outcomes, and automate routine tasks, thereby freeing architects to focus more on creativity and innovation. From hand-drawn sketches to computer-aided design (CAD), each new tool has expanded the capabilities of architects [2],[3]. Today, AI represents the next major leap in this progression, offering intelligent support in analysing site conditions, sustainability

metrics, and user behaviours. As a result, architects are now able to envision and execute more complex, responsive, and sustainable built environments [1].

### II. Problem Statement

Although AI shows promise in architecture, not much is known about how AI technologies are being used in the field. This study aims to look at how artificial intelligence affects the way buildings are designed and the teamwork involved. This study analyses past cases and literature to find out the best approaches and difficulties associated with incorporating AI into architecture.

### III. Research Objectives

The objectives of research are:

- To find out the role of AI in the process of designing architecture.
- Looking at examples of designers and architecture companies that have found success with AI.
- To talk about how AI will influence architecture education and industry.
- To recommend strategies for making the most of AI tools in workplaces and at universities.

### IV. Significance

This work helps to enrich the study of the relationship between AI and architecture. It outlines the ways AI can make design better and what challenges may come with using it. These results matter to architects, educators, and researchers aiming to keep up with technological advancements in design.

### V. Methodology

#### A. Literature Review

Academic journals, conference papers, theses, and white

\* Corresponding Author

papers between 2015-2024 were systematically reviewed. The review was focused on using digital databases which aimed at AI uses in generative and parametric design, the use of applications such as Grasshopper, Dynamo and Autodesk Generative Design, Artificial intelligence (AI) as a method of sustainability modelling.

### B. Case Study

The case study approach used the architecture firms that represent the innovative integration of AI in the design process such as parametric modelling, generative design, sustainability modelling, and adaptive planning since they are the pioneers of such integration. They selected projects that they could illustrate the application of AI scripts and tools like Grasshopper, Ladybug, and Autodesk Generative Design and their own proprietary systems. The tools are the convergence of computation and design intelligence and creative iteration.

### A. Literature Review

The fast-growing development of Artificial Intelligence (AI) began to seriously affect the architectural sphere. AI implementation has not only been on the form generation mode but also ventured into the energy modelling, environmental simulation mode and the building lifecycle optimization mode [5], [6]. In the case of a building, an AI-powered system can be used to map the way it will perform in different climatic conditions, allocate the right amount of space in terms of functionality and comfort, and automate all the technical documentation at a high-level accuracy [4]. Additionally, collaboration between professions is also being transformed by AI with both architects and engineers along with stakeholders collaborating very closely via shared platforms of data and digital twins [11]. In its further development, AI is turning into an all-embracing design partner that does not only improve the level of creativity and efficiency but also promotes sustainability, precision, and resilience in the built scene.

#### 1. Influences and Scope

The integration of AI technologies is changing how architects go about thinking and implement a design and enables a division of manual tasks to intelligent and data-driven processes. The next developments are determining the impact of AI in the discipline:

a. *Generative Design Algorithms*: It gives the architect the freedom to test a vast amount of design simulations by supplying limitations like spacing needs and restrictions or environmental issues.

- b. *The Parametric Design Tools*: Tools as Grasshopper and Dynamo enable developing complex geometries and have possibilities of analysing various environmental performance indicators inside the design space [4], [6].
- c. *Machine Learning Models*: It has the potential to interpolate the historical construction performance data, make a forecast of the upcoming performance of the real estate under construction, propose any possible material efficiency options, and facilitate such a decision-making process towards more sustainable performance and cost-effective results.

#### 2. Integration in Design Process

The passive tool is a thing of the past in architecture, as the AI is becoming a proactive co-creator integrated into every step of the channel of design and delivery. In concept development as well as facility management, AI is beneficial in making informed decisions, the process of iteration, and proper documentation. AI has begun to be incorporated in many phases of the architectural workflow not just as a device but an adaptive design companion:

- a. AI can also be of help in the conceptual and schematic design where automatic contextual design options are generated through the collection of spatial data, programmatic requirements, and environmental studies.
- b. Throughout the course of development, it assists with an examination of constraints and improvements to spatial arrangement and structure logic and material behaviour.
- c. Data-based AI simulation enhances aspects of building elements such as energy efficiency, acoustics, and daylight to support energy efficiency and occupant comfort and sustainability of buildings [5].
- d. By automating the process, through documentation, AI minimizes the element of human error during the CAD/BIM drafting and fixing the determination of fine detail and fastening workflow.

#### 3. Challenges and Limitations

Although there is a transformative potential in the application of AI in architecture, the usage of AI in architecture comes with critical issues that are likely to necessitate to be nipped in the bud to ensure a responsible and adequate application:

- a. There's a worry that AI could reduce human creativity or cause designs to become very similar.

- b. AI systems rely on having good quality data, but this is not always possible.
- c. Many ethical questions may arise such as security, bias, property rights, and privacy.
- d. Training is required for proper integration and use in design process.
- e. Often architects lack the skills needed to use AI tools, making their adoption harder.

## B. Case Study

### A. Zaha Hadid and the parametric design

The firm of Zaha Hadid Architects (ZHA) stands out for its expertise in advanced use of software to shape its designs. These landmarks were designed by the company with the use of AI and the latest modelling advances. The parametric approach to design has been characteristic of Zaha Hadid Architects; this philosophy preconditioned the adoption of AI-assisted working paradigm. The company uses the computational tools in form-making, optimized performance as well [9]. They also apply deep learning networks to identify formal relationships and produce variations with respect to facade systems, structural elements and masterplans [9].

#### 1) KAPSARC (King Abdullah Petroleum Studies and Research Centre)

KAPSARC in Riyadh, Saudi Arabia is one of the most successful projects of ZHA, at which environmental design, parametric modelling, and AI-based optimization merge [10]. The project reveals how the use of AI can improve the form and performance with its modular hexagonal configuration and environment responsiveness.

#### AI and Design Integration

##### a. Generative Design and Parametric

- To form the special tessellated geometry, ZHA used software tools, Rhino + Grasshopper [9].
- AI was able to help in the production of several formal iterations that were air and solar gain optimized as well as programmatic efficiency.

##### b. Environmental Stimulation

- The behavior of sun path, Daylight and structural behavior was simulated using ladybug and Karamba [10]. Massing and orientation were tuned by the use of AI-based algorithms to achieve the least amount of passive cooling, with the fewest outgoing heat.

##### c. Optimization and Predictive Modeling

- The predictive performance during the earlier stages of design was retrieved with the assistance of AI [10].
- Such parameters as foot traffic, movement of wind and use of material were tested, improved to iterations.

##### d. Façade Design Driven by Performance

- Structural loads and exposure to the sun were also mapped using AI-aided tools to make shading systems a part of the facade.
- It had led to a climate responsive envelope that allows aesthetic and energy efficiency [9], [10].



Fig. 1 KAPSARC (King Abdullah Petroleum Studies and Research

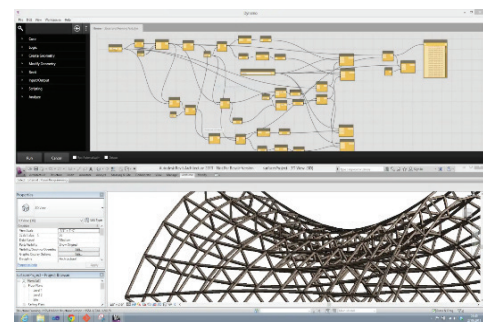


Fig. 2 Use of grasshopper interface for façade panel layouts

### B. AI-Generated Houses by Norman Foster + Partners

NFP is known as a high-tech modernist and sustainable design-soaked firm through which AI powered decision support is utilized in site selection, prototyping phases of a design, and long-term performance assessment [11]. AI has been used privately by NFP in experimental housing projects, although the public has not yet seen AI-made residential buildings from them. NFP is concerned with sustainability indices, data-based decision-making, and smarter urban living [11].

## Application of AI

### a. Generative Design Prototyping

- NFP has tools of AI that generate tens of thousands of layout alternatives depending on site datum, costs, and climate [11].
- Using sustainability, cost-efficiency, and spatial performance, the AI prioritizes these options [10].

### b. Sustainability Modeling

- NFP is embedded with AI-based BIM (Building Information Modelling) solutions which will allow knowing about the amount of carbon that was emitted into a building, energy consumed per hour, and maintenance life span even before building construction [11]. The designers are able to check of energy efficiency and operational sustainability prior to construction.

### c. Modular and Prefabricated Constructions

- Prefabricated parts like wall panels and facades are adjusted at the local level to suit weather and logistic conditions that are unique to the area by AI [11]. It has the capacity to increase mass production and yet have site responsiveness and beauty.

### d. Partnership with Autodesk

- A Working with Autodesk, NFP simultaneously applies Generative Design in Revit and aims to optimize facilities layout and space [11]. This has seen the use of experimentation of real-time artificial intelligence feedback loops in design.

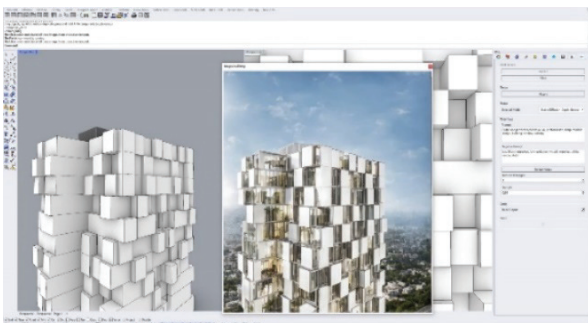


Fig. 3 Using Rhino to infuse design ideas

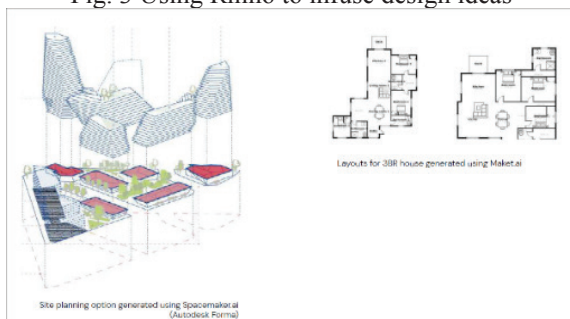


Fig. 4 Use of AI tools for site and layout planning

## VI. Analysis and Discussion

The start of Artificial Intelligence in architectural practice demonstrates an evocative change in the articulation of design, its analysis and practice. It is no longer a hit of a large firm; the growing accessibility, the visual programming interface, and cloud-based systems are helping architectures on the different levels to add AI to their processes.

### 1. Ease of Use and Accessibility

Most recent AI use cases do not need substantial programming expertise anymore, and architects can concentrate on imaginative discovery and results-oriented performance.

- Autodesk Revit, Rhino, and Grasshopper are among the tools that ensure that a visual scripting environment is available to the user where he manipulates geometry, automate logics, and even simulate environmental conditions [6], [7].
- Platform such as NVIDIA Omniverse Cloud and Autodesk Forma to enhance remote collaboration, real-time simulation, and generative design to make architectural projects more interconnected, iterative, and interdisciplinary [11].
- The expanding amount of university courses and courses carried out online that can train individuals in parametric modeling and AI-based support mechanisms are rendering it simpler to learn and utilize technologies.

### 2. Inferences and Insights

The use of AI in architecture is an issue that has been accompanied by a number of crucial observations and implications in both a practical and emerging literature context:

- Development of Plug-ins such as grasshopper and generative design allows architects to experiment with data driven shapes making adaptive and site responsive architecture possible [4], [6].
- Although we are worried about AI taking over the creativity factor, case studies are indicative that the AI in the responsible use furthers the creative work of the architect [9], [11].
- The moral issues on data ownership, authorship, and design bias that should be explicitly considered and addressed by policy criteria and clear tool use.
- To be able to adopt effectively, schools need to instill a well-balanced education program in the future

architects, it must include a design theory, technical software practice, and the proper use of AI.

## VII. CONCLUSION AND RECOMMENDATION

The application of Artificial Intelligence in the architecture design process is continually becoming a guarantee of success, boosting performance, efficiency, and creativity. These case studies show that AI can be a tool to enhance its complement towards human creativity as part of a wise balance of technology and creativity. Nevertheless, issues related to the lack of technical expertise, ethical issues, and data credibility should be resolved to bring about responsible adoption. The numerous accomplishments of integrating artificial intelligence (AI) in the architectural design shows that AI is not competing with architects but is supplementing them- by what we call adopting a generative approach to the design process by harnessing data analysis and performance-driven methods of optimization. The practicality of AI is apparent in all phases of the architecture process, enhancing the accuracy, time required, and limit human error during a project that extends to the conceptualization of ideas and through the construction documents.

### *Recommendations*

- Adopt AIs related tools, ethics and methodology in architectural education and engage the architectural students of the future in their studies to meet the future quality requirements of the industry.
- Make AI programs architecture-friendly and highly intuitive, minimizing the need to have programming expertise.
- Encourage collaborations between architecture firms, software developers and researchers to develop AI systems in co-design that have actual relevance.
- Stimulate the innovative policy and assure privacy, transparency, and fair AI technologies access during the design.

### **Acknowledgement**

We would also like to thank our mentors and faculty members in Kathmandu Engineering College who have given us the constant support and guidance during the process of this paper. We are also deeply thankful to the supervisors and friends for their unwavering support, encouragement, and understanding. Their motivation and belief in my abilities have been a source of strength throughout this journey.

Thank you all for your contributions to making this work possible.

## **References**

- [1] R. Oxman, *Theories of the Digital in Architecture*. Routledge, 2017.
- [2] B. Kolarevic, *Architecture in the Digital Age: Design and Manufacturing*. Spon Press, 2003.
- [3] P. Schumacher, *The Autopoiesis of Architecture, Volume I: A New Framework for Architecture*. Wiley, 2009.
- [4] R. Aish and R. Woodbury, "Multi-level interaction in parametric design," *International Journal of Architectural Computing*, vol. 3, no. 1, pp. 93–108, 2005.
- [5] J. P. Duarte and A. Pina, "Generative design: A new design paradigm," in *Proc. 36th eCAADe Conf.*, 2018, pp. 1–8.
- [6] K. Shea, R. Aish, and M. Gourtovaia, "Towards integrated performance-driven generative design tools," *Automation in Construction*, vol. 14, no. 2, pp. 253–264, 2005.
- [7] B. Kolarevic and K. Klinger, Eds., *Manufacturing Material Effects: Rethinking Design and Making in Architecture*. Routledge, 2008.
- [8] M. Burry, *Scripting Cultures: Architectural Design and Programming*. Wiley, 2011.
- [9] Zaha Hadid Architects. (2020). *Design technology and innovation*. <https://www.zaha-hadid.com>
- [10] A. Alsaad and M. Abusharar, "Environmental design optimization of KAPSARC headquarters," *Sustainable Cities and Society*, vol. 36, pp. 91–99, 2018.
- [11] Foster + Partners. (2022). *Generative design at Foster + Partners*. <https://www.fosterandpartners.com>