# Vision Setting and Problem Solving: AI in Architecture is Changing Design

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Artificial Intelligence (AI) in architecture is becoming a pervasive, powerful tool — it's also a technology that finds itself at an awkward, intermediate stage of development. AI can solve simple, practical problems, like how to arrange a floor plan, with unmatched speed and variation. And it can paint broad, creative visions culled from the entire Internet's worth of imagery with just a brief text prompt. But connecting these two parts of the design process, the fundamental science and art of architecture, has proven elusive.

Feeding a string of architectural description ("Eco-topia Flintstones California Bungalow at the La Brea Tar Pits") into image generators like MidJourney doesn't result in anything buildable. And endless algorithmically generated floor plans can't be scaled up to express anything more than an efficient use of space — yet. But joining these two capabilities together will be, perhaps, the most profound design-technology advance of AI's age.

## How AI is Used in Architecture Today

AI in architecture design is based on computer programs that mimic human cognition to solve complex problems and respond dynamically to stimulus. A closely related subfield is machine learning, which refers to an AI system's ability to recognize patterns and learn from them, independently improving its cognition ability without human intervention.

AI has found relevance in architecture throughout the design process. Analyzing imagery on the Internet, image generators like Midjourney can develop richly detailed, near-photo-quality pictures from short text prompts. This can be a powerful boon to early concept brainstorming, the digital equivalent of a detailed napkin sketch. These images are also useful for reaching the broader public and can be used on marketing and promotional materials to illustrate basic design concepts and contexts.

Narrowly focused AI tools can optimize designs for building-performance metrics, generate floor plans from simple programmatic and spatial inputs, and reorganize floor plans dynamically as walls and partitions are moved — essentially automating mundane, omnipresent design tasks. AI engineers are working on integrating natural language text-based interfaces, like ChatGPT, in AI architecture tools like these. AI-assisted floor-plate

generation is a species of parametric design, which is long-established in architecture to generate endless formal variations.

But with greater AI computing power, architects and designers are incorporating generative AI into their workflows, which, instead of just outputting a pile of variations based on constraints, now ranks the quality of each variation based on a user-defined set of metrics.

Many architects are accustomed to having their designs mediated through digital processes such as building information modeling (BIM), and AI is changing what these models can do. In many ways, digital twins that contain all formal description and performance data of a building are the next evolution of BIM. AI could allow these models to be tested and prodded, able to examine how changing one variable might affect the building's energy performance, solar heat gain, or shade cast across the street, then continually and independently learn how to improve operations and design. This emerging technology is fed by networked Internet of Things sensors and devices that feed data directly to digital twins.

## Benefits of Using AI in Architectural Design

AI in architectural design is most useful for rapidly completing mundane, repetitive tasks and for optimizing designs by small increments, often referred to as artificial narrow intelligence. AI is most effective where these types of tasks overlap, as they often do. AI can instantly fill a residential tower with apartments shaped to fit the developers' specifications and can tune them to varying degrees of material and cost efficiency. Additionally, image generators can work as an unapparelled "mood board" for design inspiration, offering a quick visual synthesis drawn from vast image libraries. These detailed images can give architects an aesthetic target to aim for as they define structural and engineering systems.

In both of these scenarios, architects take on a more broad-based curatorial role instead of maintaining granular control of every design decision; they are defining parameters, selecting and discarding options, and offering advice and guidance to algorithms. That's a radical change in how architecture has been practiced. The dividing line is still being defined: Is this new tool a labor-saving device, just as CAD or BIM have become, or does it represent a fundamental shift in the creative process?

## 7 Examples of AI in Architecture Projects

Before designers begin creating iterations, using automated tools to organize site and contextual data can sweep away ambiguity and, hopefully, risk. These tools make technical, programming-heavy tasks more accessible to non-coders such as designers or developers. From research projects to commercial products, the following examples show how AI in architecture can create opportunities to improve the design process so human creativity can take center stage.

### 1. AI for Schematic Planning

Finch is a parametric planning tool with a wide range of design functions. It can generate floor plans with just a few input constraints, and these floor-plan designs can be automatically adjusted on the fly. You can select a wall, move it, then watch the surrounding rooms change their proportion, location, organization on their own. The platform incorporates local planning regulations and allows users to optimize for structural efficiency, number of units, or other variables. It can also slot floor plans into quickly defined site boundaries; divide irregular, organic shapes into subunits; dynamically connect stairs to varying floor heights; and trace the optimal route of a road through complex terrain.

### 2. AI for Urban Development

New AI tools can apply generative and iterative power to urban-scale sites, looking beyond individual building requirements. This concept is exemplified by Autodesk Forma, which offers cloud-based, AI-powered insights and automations that simplify exploration of design concepts, offload repetitive tasks, and help evaluate environmental qualities surrounding a building site.

Applied in the early stages of planning and design, Forma performs real-time analyses across key density and environmental qualities such as sunlight hours, daylight potential, wind, operational energy, and microclimate, without users requiring deep technical expertise. These machine learning and AI-powered environmental analyses can be used from day one of the design process to help meet business and sustainability targets. For instance, Forma's wind modeling reveals how buildings channel wind, using computational fluid dynamics to refine designs for human comfort.

### 3. AI for Better Bidding

ConXtech, a Bay Area–based modular-construction company, is using AI to gain control of one of the most unpredictable steps in construction: the bidding process.

ConXtech, like many construction companies, is solicited by owners and developers during the project-development phase. At that time, the viability of the project is not yet secured, and multiple options are still on the table. This forces companies like ConXtech to go through multiple iterations for projects that may never be built. In the end, millions of dollars can be spent on unsuccessful projects or unsuccessful bids. At the same time, owners and developers expect quick answers to arrive at viable and cost-effective solutions.

To shorten the bidding cycle and reduce the bidding costs, ConXtech worked with Autodesk Research to develop a prototype bidding platform that uses AI to find the most cost-efficient structural-steel design based on the costs of material procurement, fabrication, and construction. These costs are influenced by the vendors and subcontractors selected for the project and vary depending on the project's location.

### 4. AI for Volumetric Design and Planning

Japanese construction, engineering, and real-estate development company Obayashi also worked with Autodesk Research to envision an AI solution — one that lets architects plug in basic parameters for buildings and, with minimal guidance, get volumetric estimates and interior programming layouts. Used mostly for office spaces, the AI for this application was trained with a subset of Obayashi's portfolio of more than 2,800 Autodesk Revit files.

The AI tool understands abstract relationships between programs and the desired connectivity, size, and proportion expressed in a building's volume. To generate interior programming layouts, the designer and client work through a series of lexical parameters: simple sentences that specify building elements and their location and show how they relate to each other. This might be, "meeting rooms should be placed close to windows," or "lunchroom should be placed away from the lab for security."

### 5. AI for Regulatory Guidance and Aesthetic Photo Treatment

Similar to Obayashi, Maket excels at assisting architects with early-stage schematic design — generating floor plans by plugging in room dimensions, types, and adjacency constraints — and is integrating this feature with a natural language text interface. But Maket also offers a regulatory assistant that can read uploaded zoning regulation documents and answer detailed questions about them. Designers can also upload architectural photographs and use basic text prompts to apply different aesthetic treatments, adding interior and furniture elements to the photo.

### 6. AI for Real Estate Developers

Parafin uses parametric-iteration AI to balance program, cost, and commercial viability. Developed by architect Brian Ahmes and developer Adam Hengels, the program generates near-infinite derivations for objective profitability and performance.

Parafin is a cloud-based generative-design platform that's currently used for hotel developments. Aimed primarily at real-estate developers, it helps quickly evaluate the financial viability of potential building sites in early-stage planning. It asks for just a few parameters (number of rooms, parking, site, height, and brand guidelines for hoteliers) and can generate millions of iterations fulfilling these guidelines — all searchable by financial performance, cost, and more. It works through

a map- and menu-based interface in a web browser; highly detailed floor plans, 3D views, and Revit files are generated for each design.

### 7. AI for Performance Optimization

Cove.tool is an automated building performance design app cofounded by building scientist and architect Sandeep Ahuja. It uses machine learning to analyze how building designs can improve their energy and carbon consumption, daylighting levels, cost structures, and more, altering variables like building orientation and materiality and gauging the results. It can perform cost optimizations for a variety of criteria and rank results according to different quality standards, from code minimum to voluntary rating system accolades. In its level of granular detail, Cove.tool is essentially a preconstruction digital twin, integrating with machine learning algorithms that can incrementally refine a building's performance.

## Will AI Replace Architects?

Given how new AI is in the architecture field, it's difficult to say how it will affect architecture jobs — though it's hard to imagine that the tasks AI excels at, like assembling technical details and plans, won't reduce the need for the entry-level designers who typically focus on these things. And while AI's potential to free architects from detail drudgery is real, the temptation for employers to use this labor-saving tool to increase the pace of production is also well-established.

Today, there many areas of architectural design that AI hasn't penetrated. AI can't yet define the constraints that come with a building project, such as the program, size, audience, material, or geographic context. These parameters come from interactions with clients, which also can't be outsourced to AI. Th technology also has little understanding of how people move through space and interact with objects, and it can't yet generate 3D imagery via text prompt with the richness and detail with which it creates 2D imagery.

Across the architecture, engineering, and construction (AEC) industry, AI has been least used in robotics applications that interact with building sites or buildings directly — though this is changing, with reality capture robots that have some level of independence but still require a human for guidance.

AI in architecture is also limited by fundamental economic and selection-bias dynamics that affect the quality of data these applications draw on. AI algorithms are limited by how much data they have to learn from — in architecture, this data can be proprietary, which creates a disincentive to share it with potential rivals working on their own AI applications. Also, image-creation AI can only resynthesize what it has already seen, so if the Internet's bank of imagery is culturally or regionally biased (with, say, an overrepresentation of architectural imagery from rich, Western nations), the results will be similarly biased.

AI is an evolution of automation, and automated processes are already integral to design; they've just been labeled differently. "If I'm designing something in Revit, and it's automatically producing coordinated documents to construct that thing, I'm not worried about that," says Jim Stoddart of architecture studio The Living. "It is automation; it's actually doing all of these things I used to do manually."

Improved computing capabilities are providing more opportunity to balance human and machine intelligence, letting each do what it's best at. "Computers are not good at open-ended creative solutions; that's still reserved for humans," says Mike Mendelson, certified instructor and curriculum designer at the Nvidia Deep Learning Institute. "But through automation, we're able to save time doing repetitive tasks, and we can reinvest that time in design."

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## About the Article

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