Intersection of AEC and Artificial Intelligence

By Meghana Joshi

Media portrayal of artificial intelligence has been all about a dystopian future and robots. Artificial intelligence was once deemed a figment of scientific imagination, only seen in the characters of futuristic fiction movies. But, as time passed, theoretical and technological developments in computation have normalized artificial intelligence, whether it is Alexa playing your favorite podcasts, Nest fine-tuning your optimal comfort zone, or Siri responding to your questions. Workplace advancements in the AEC profession saw their beginnings with BIM. Still, we have come to realize that revolutionizing the way we draw barely scratches the potential of artificial intelligence in our industry.

The AEC industry is ramping up efforts to incorporate artificial intelligence and information technology to create efficient and impactful building experiences. While business intelligence focuses on producing comprehensible data and in-depth analysis, conceptual understanding of design data through artificial intelligence will help create highly efficient building designs within technical constraints such as site requirements and building codes. Adhering to the set of parameters defined by data, artificial intelligence will gradually phase out pencil and paper renderings and progress towards visually realistic images.

Parametric Design bridges the gap between machine learning and artificial intelligence, and software will continue to offer new and expansive design capabilities through multiple possible iterations within provided constraints. For the uninitiated, artificial intelligence helps us create systems that simulate human thinking and behaviors. In contrast, machine learning capabilities will help these AI systems continually learn and improvise from generated data. Parametric Design will generate solutions that will put the client and community's best interests forward in creating cities of the future.

The origins of modern parametric design began in the 1970s when Italian architect Luigi Moretti described architecture's goal as "defining relationships between dimensions dependent on various parameters." The 1980s and 90s saw a rise in mathematical models and evolving structures based on parametric criteria and computational design. Gehry and Partners launched Gehry Technologies in 2002, intending to provide a collaborative design platform and visualization tools for architects. This improved access to adaptive software and computational solutions, paving the way to non-linear imaginations that could be implemented with parametric design solutions. Zaha Hadid and Patrik Schumacher developed advanced parametric design systems and innovative adaptations for architecture and urbanism. In 2008, Patrik Schumacher coined the term "Parametricism" to define the architectural style based on computer technology and algorithms, resulting in fluid and seamless design. As cloud-based technology removed barriers to access, it is no longer a luxury afforded only by Star-architects/engineers. Social Justice-driven architects and innovators are creating modular and affordable housing designs with parametric frameworks to find optimal, safe, durable, and sustainable solutions to build strong communities.

Architecture paved the way for construction to seek optimization from artificial intelligence and machine learning. In the past decade, pattern recognition and critical thinking abilities have led to innovations beyond project management and construction administration. Artificial Intelligence quickly overhauled business intelligence through solutions focused on project delivery methods to control schedule and budget. The *generative method of design* is a unique way of integrating artificial intelligence to develop high-performance building designs based on goal setting and navigating tradeoffs in traditional design. Generative technology coupled with programs such as BIM360 can efficiently manage clash detection within building systems such as mechanical, electrical, plumbing, and fire suppression. Construction safety was enhanced when a Boston-based general contractor developed an algorithm to analyze job safety through photographs. Post-construction intelligent processes were created to operate buildings and facilities efficiently. Looking at a building through multiple lenses of design, construction, and management perspectives promotes a programming and planning process with long-range preparation for risk mitigation.

The digital shift in the AEC industry breaks down barriers within adjacent markets, helping create impactful ecosystems in the coming years. Facilities Management and Sustainability will rely heavily on technological evolutions based on artificial intelligence to manage their environmental footprint with micro- and macro-changes. The ability to evolve MEP systems based on historical data and revise and regenerate to adapt to site-specific conditions will contribute significantly towards mitigating the effects of building energy usage on climate change. Aesthetics and personalized comfort will be the center of smart building planning; everything from lighting to insulation can be analyzed and optimized. Reduced energy conservation will lead to reduced utility operation costs and minimize the various aspects of the building's "footprint."

Another example of an adjacent industry application would be Facebook's Artificial Intelligence team. Facebook has partnered with Carnegie Mellon on the "Open Catalyst Project" to create efficient and scalable means of storing and using renewable energy. Artificial intelligence-powered utility planning and management will create uniform access to renewable energy. General Electric's "Predix" utilizes artificial intelligence to make predictions about the energy infrastructure's machine health by performing in-depth

sensor analysis. Building materials are continually evolving through monitored manufacturing processes to reduce carbon emissions and environmental degradation. A cradle-to-cradle approach will begin with biodiversity conservation for raw materials leading to smart manufacturing and impactful recycling.

Of course, for some, this can create a worry of artificial intelligence replacing traditional building design. Is AI the revolutionary road towards automated building design and construction?

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Automation might render some human labor obsolete, but architecture is more than an aesthetic presentation of an enclosed space, just as engineering is more than a collection of beams, columns, pumps, fans, and wires. Repetitive tasks can be delegated to machines, but the empathy and emotional intelligence guiding the design and our duty to the public cannot be replicated. Beyond the standard definition of building design, AEC is about interwoven and interconnected social, environmental, and economic characteristics that define a community. Technological innovations powered with artificial intelligence and machine learning will change built environment interactions, experiences, and services but the algorithms also come with their own biases. Value judgment and diverse-thought leadership through human control will create fair systems leading to an equitable and inclusive future.

As people become more accepting of innovation and technology and address social injustices in design while also achieving commercial successes, the limits are boundless. Thinking beyond the realm of design, architecture, and engineering will open inter-professional dialogues and collaborative digital innovations to take the AEC industry forward. By blurring traditional industry boundaries, we can positively impact how we build and experience the built environment. Architect Michael Sorkin said, "There is a big danger in working in a single medium. The logjam you don't even know you're stuck in will be broken by a shift in representation."

For our generation, that shift will be brought about by artificial intelligence. Just ask Rachel!▪

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