The Future of Making Will Be Powered by Generative Design and Generative AI

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The day the Golden Gate Bridge opened to vehicles, 32,000 of them ventured across. Now, more than 100,000 cars cross this iconic span every day, with vehicles weighing nearly twice what they once did. It's incredible to think that engineers designed a structure a century ago that can hold the volume and load it does today. It was a painstaking process, from the first sketches being drawn up in 1921, to testing the viability on a 1:56 scale model, to the bridge opening in 1937. It was an incredible feat. But imagine if those engineers had access to generative design and generative AI tools - iterations and simulations would have been digital, and those orange towers would have gone up in a fraction of the time.

Design is a process of exploration. Whether it's for architecture, engineering, construction, and operations (AECO); design and manufacturing (D&M); or media and entertainment (M&E), it is, at its core, a process of iterating and testing. And design is quickly evolving. It began with computer-aided design (CAD). Then, automation technologies like generative design came along and enhanced these workflows. Now, generative AI promises to make processes even faster. Generative design and generative AI are springboarding off human ingenuity and taking design to new heights. Individually, these technologies are powerful. Together, the possibilities are almost limitless.

GENERATIVE DESIGN DELIVERS HIGH-POWERED PRECISION

For each design problem, there are hundreds, sometimes thousands, of different ways to approach it, and coming up

with solutions has long been a cerebral, human process. Generative design came from a relatively radical idea: "What if people's brains can't think of all the possible solutions to bridges? What if software could help explore that?"

This was around 2009, when people were starting to leverage the cloud for large computations. And the key moment for generative design was inverting the relationship between design and simulation. Software can imagine every crazy bridge formulation and run simulations on all of them. Some come back with a bridge that is going to fall, others that will work, and some that designers want to explore further.

Generative design leverages real-world physics, creating final outputs that are incredibly accurate solutions to specific design parameters. But there are some impediments. Humans must input exact specifications of their design problem to yield the right results, which is time-consuming. Generative design also

uses immense amounts of computing power - it can take a day or more to process complex projects. But it's still far more efficient than humans. For instance, the Mercedes Formula One team used generative design tools for a better rear suspension part. It took significant time and expense to set it up, but the team now has a manufacturing process that takes just 48 hours instead of six weeks.

Generative design is often thought of as a manufacturing tool, but it can be applied to any design and make process. In the media and entertainment industry, production schedules take months to prepare with tens of thousands of tasks that often rely on one another. Now, M&E companies have applied the notion of generative design to generative scheduling. When a timeline is disrupted, generative design can quickly rationalize all the changes. It's proving to be a critical tool as productions grow more complex.

Generative design delivers levels of improvement that were once unheard of, like engineering products that use 40% fewer materials, are 40% lighter, 40% cheaper, and 30% stronger than anything designed before. The system is exhibiting things that are beyond human understanding. But despite what it can do, generative design does not look at all bridges constructed before, then learn from them when formulating a new design. In other words, it's not using data. This is where generative AI comes in.

GENERATIVE AI FOR FASTER DATA-POWERED DESIGN

AI has gone through three different waves and hype cycles. It began to catch on, then became an untouchable technology that nobody believed in, then it came back again. This third wave has likely carried AI past the breaker and cemented it into society for good. ChatGPT played a big role in this, pushing AI into the mainstream almost overnight. For two decades, the world has been making progress in developing artificial intelligence tools, but OpenAI finally demonstrated AI in action.

Trained on incredible amounts of information, generative AI can find data connections that humans cannot. It's easy to use, approachable, and incredibly fast. Type in some basic information and within seconds there are multiple responses. This is important to a creative person iteratively refining a design. They're getting responses that are opening possibilities and shifting their learning. They can input additional prompts to improve the responses. This cyclical design-user interface resonates with how people in AECO, D&M, and M&E work.

But generative AI is not particularly precise. If it imagines a bridge, it might be inspiring, but it would be a bad idea to make that bridge because generative AI does not run simulations. It's not actually reasoning about every aspect of bridge engineering. Rather, it's pulling from data of other bridges that have been built in the past, so the output will not be as specific to an engineer's plans as that of generative design tools.

The hurdle with generative AI is training the neural network to generate something useful. It needs a dataset that tells it the preferred answers to specific questions based on human reasoning. This data needs to be organized and in the cloud for AI to be most effective. ChatGPT is impressive because it had trillions of words on the internet to train on. For every AI project about 80% of the initial work is just getting the data into the right representation to do something with it. But when that data is present, generative AI has incredible potential. McKinsey projects that it will deliver $2.6 to $4.4 trillion in productivity value.

THE COMBINED POWER OF GENERATIVE DESIGN AND GENERATIVE AI

The design and make world is headed toward finding ways to leverage the last 15 years of work in generative design and simulation and bring it together with generative AI. With proven results, generative design has gained widespread trust in the design and make world. And trust in AI is catching up despite remaining undercurrents of caution. In Autodesk's upcoming 2024 State of Design & Make report, 76% of industry leaders express trust in AI, 78% believe it will enhance their respective industries, and 79% see AI yielding greater creativity.

Think about what the two technologies could accomplish together. A workflow would begin with generative AI to deliver initial candidate solutions. A designer may iterate on those or a subset of them can be input into generative design tools to run simulations, and delivering results that meet their requirements. And as data improves over time, these technologies will develop an organic rhythm, generating instantaneous, precise results.

The world is not even 10% into the current AI revolution. Things are going to get far crazier in the next 10 years, especially as generative design and generative AI create workflows that are faster, easier, and more accurate than ever. This will help analyze, automate, and augment design work, leaving humans to do what they do best: create. It will be a future of innovation and impact, with designers and makers at the helm of a new world.

About the Author

Mike Haley leads the Autodesk Research group, where they identify, evaluate, and develop disruptive technologies that improve the practice of imagining, designing, and creating a better world. His team combines research, development, and user experience in coupled iterative cycles to develop new products and foundational technology. For the past several years, Haley's team has been focused on bringing geometric-shape analysis and large-scale machine-learning techniques to 3D design information with the intent to make software a true partner in the design process.

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