THE GEMINI

AEC firms explore how digital twin technology can bring more consistency to the design process and construction site.

By John Caulfield, Senior Editor

LAST YEAR, JUST UNDER HALF OF ORGANIZATIONS THAT IMPLEMENTED INTERNET OF THINGS TECHNOLOGY were either already using or planned to use digital twins. And by 2020, at least half of manufacturers with annual revenues of $5 billion or more will have launched at least one digital twin initiative.

Those estimates from research firm Gartner—based on a 2017 survey of 202 organizations in the U.S., Germany, and Japan—confirm a trend that's been building for several years.

Research service Markets and Markets projects that the digital twin market will expand at a compound annual rate of 37.8% to $15.66 billion in 2023. According to Forrester, digital twins are already driving IoT platform adoption. And as the cost of IoT technologies and sensors has come down, so too has the cost of creating digital twins.

What's a digital twin, you ask?

Simply put, a digital twin is a virtual replica of a real object: a product, a structure, a facility, a system. The concept is predated by NASA's "pairing technology" to operate, repair, and maintain spacecraft outside of the range of physical monitoring.

Digital twin enables users to test how an object might perform under certain circumstances, and to predict outcomes—all without the need to actually be close to the object being twinned.

So far, the manufacturing sector has been the primary adopter of digital twin. And the $10 trillion engineering and construction sector, "which remains severely underdigitized," has shown greater interest of late in technological solutions that can incorporate artificial intelligence-powered algorithms, according to McKinsey (mck.co/2HxLkmq).

One of the first use cases for digital twin technology is related to gridshell construction in Germany. Façade construction specialist Seele Group is a partner in the consortium testing the technology.

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DIGITAL TWIN APPLICATIONS: 7 STEPS TO A BETTER-MANAGED JOBSITE

"What if we could have instant access to all the information about a construction site, down to the smallest detail about every person, tool, and bolt?"

That's a question asked, and answered, in a blog authored in January 2018 by software development firm Intellectsoft. The unnamed author presents digital twin as a concept that can make this wish come true, and lays out seven possible real-time digital applications on construction sites:

1) Automated progress monitoring, which would verify that the completed work is consistent with plans and specifications. An automated means of data collection and comparison would produce models less susceptible to human error.

2) Tracking changes in as-built models, as often as hourly. Detecting discrepancies would lead to an analysis of historical modeling data, which a project manager could use to make changes to avoid future mistakes, and fix problems earlier in the project.

3) Automatic resource allocation monitoring and waste tracking, allowing for predictive approaches to resource management.

4) Safety monitoring by using digital twin to track people and hazardous places in real time.

5) Quality assessment, such as checking the condition of materials like concrete, coatings, and finishes through image processing algorithms, which could trigger additional inspections.

6) Optimizing equipment usage through advanced imaging and automatic tracking.

7) Monitoring and tracking workers, which would require a digital record of all personnel and their locations within the jobsite. This information could be used by rescue teams in the event of an emergency.

DIGITAL TWIN STARTUP AIMS TO MAP THE PLANET'S METROS

WHEN PEOPLE TALK ABOUT DIGITAL TWIN, it's usually in the context of a single product or building. But Michael Jansen's ambition is to digitally replicate the entire world, or at the very least every smart city.

Jansen is Chairman and CEO of Chicago-based Cityzenith, whose Smart World suite of 5D software platforms map and visualize data provided by metropolises to an intuitive real-time 3D simulation.

Cityzenith brought Smart World to market in 2009 and rolled out its latest version, Smart World Pro, last year. Users of the newer product can aggregate BIM, CAD, GIS tools, spreadsheets, documents, sensor feeds, and even social media posts, all of which can be dragged and dropped onto the platform.

Jansen describes Smart World Pro as "a design-to-demo digital twin," whose features include an all-in-one dashboard, universal data importing, a natural language search, and a "Mapalyze" app suite of analytical tools that allows users to run project analysis "on the fly" and export and share results quickly. An application from Unity Technologies that powers the platform's back end provides greater flexibility, says Jansen.

Smart World Pro pulls data from a variety of sources, including large building owners (one of the platform's users is Cushman & Wakefield), large AEC firms, data streams from IoT sensors, and public information services for cities, counties, and states.

Cityzenith has amassed curated public and commercial data sets for "several thousand" cities, and fully loaded 3D models for "hundreds" in a dozen countries. Last December, the Indian state of Andhra Pradesh selected Smart World Pro as its 3D City Information Model for the development of Amaravati, a new $6.5 billion smart city capital that Foster + Partners and Surbana Jurong have designed.

"Amaravati will be born as a digital twin, the first entire city that I know of to do that in the world," says Jansen.

Smart World Pro is also being used for Hinkley Point, a 3.2-gigawatt power plant that is the largest infrastructure project in the U.K.

Cityzenith takes what Jansen calls an "enterprise approach" to its pricing. First-time customers can get their foot in the door with a $20,000 package. Using the platform for projects costs between $30,000 and $75,000, and mapping metros can run into the hundreds of thousands of dollars.

The company has raised more than $10 million and is profitable to the point where currently it isn't seeking investor capital. As for growth, Cityzenith has somewhere between 30 and 40 customers, but Jansen is thinking much bigger when he says his platforms target "everyone in the building industry" that manages assets.

"The problem that Smart World Pro solves is the complete lack of interoperability among tools," says Jansen. "The industry needs a single pane of glass for all of the tools being aggregated."

"Engineering and construction stakeholders can use neural networks, using drone-generated images and laser generated data capturing project progress, to teach an AI how to create 3D "twin models" to match BIM-generated models," McKinsey wrote. These applications could reduce decision-making cycles in a construction project "from a monthly basis to a daily basis"—through full automation of the project scheduling and budgeting using a combination of BIM, AI, drones, and laser scanning capabilities.

Digital twin could be the remedy for an AEC industry where what gets designed sometimes only vaguely resembles what finally gets built. The digital twin can be used "for visualization, modeling, analysis, simulation, and further planning," suggests software development firm Intellectsoft, which offers several digital twin applications for construction sites (see sidebar, page 29).

GERMAN CONSORTIUM TESTS TWINNING

There are questions that need to be answered before the AEC industry fully embraces digital twin. Right now, how information is layered onto any complexity, such as a model, is up the client. Consequently, there are "different levels of fidelity" between models and the finished product, explains Bella Nguyen, PhD, Senior Research Consultant with Arup, which next month will release a white paper on this topic. "How real is the digital twin? That's what we're trying to make sense of," says Nguyen.

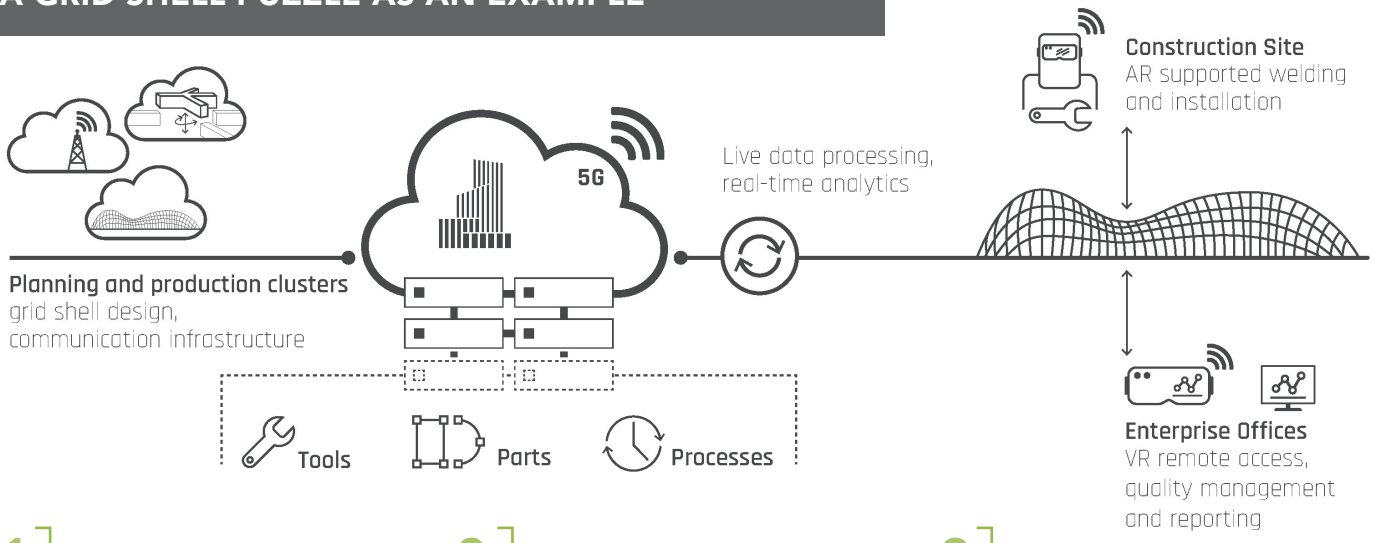
In Germany, a consortium called DigitalTWIN, made up of several partners representing industry and research, is working on a project to develop digital tools and technologies that enable the integration and automation of services, processes, and workflows for the construction industry.

Fabian Schmid, PhD—the consortium's leader, and Head of Development of Digital Tools and Systems Integration for consortium partner se commerce GmbH, a division of the façade construction specialist Seele Group—notes that when his group started looking for partners three years ago, Seele's designers were struggling to use the digital tools that the company's R&D department had developed. "Pen and paper were often faster," he recalls.

So one of the consortium's goals is to create more flexible systems. "What we're looking to do is create a simple, out-of-the-box tool" that can be used in the field, says Schmid.

Last June, the consortium initiated three use cases, two of which are directly relevant to the construction industry.

ASSEMBLY SUPPORT WITH AR TECHNOLOGY USING A GRID-SHELL PUZZLE AS AN EXAMPLE



1 DIGITALTWIN cloud cluster for multi-purpose use in project planning, supply chain and fabrication.

2 Scalable 5G wireless network for the construction site with real-time access to the DIGITALTWIN cloud cluster.

3 Real-time data exchange and analysis between construction site and enterprise offices using the cloud cluster.

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A consortium in Germany is working on a research project involving three use cases for which digital twin is a tool. One of those use cases revolves around gridshell construction, and how the technology might speed up the positioning and installation of components. The research project is scheduled for completion in 2021.

Use Case 3 addresses effective and efficient installation using digital tools, as well as those tools' flexible and safe use in harsh jobsite environments. AR technology in safety goggles would enable users to find their way around sites and provide information that otherwise would be documented and communicated solely by drawings.

A grid-shell construction is being used to demonstrate a process chain from assembly planning and logistics to assembly support. Personnel will be able to see installation sequences in order to identify and locate correct parts and tools. The assembly is also compared with a digital model.

Schmid explains that one of Use Case 3's objectives is to accelerate the positioning and installation of components. He notes that, typically, positioning and tolerances are based on paperwork backed by laser scanning that's manually checked for accuracy. This process can take anywhere from six days to two weeks. If the use case works, engineers could check the positioning and tolerances in an afternoon using a powerful services infrastructure onsite and AR glasses, all supported by a cloud infrastructure that has the calculations. The consortium demonstrated this concept at Munich's BAU show in January.

Use Case 1 addresses availability and visualization of live measured data at the building through the digital twin, using edge-cloud and cluster computing technologies. To offer customers a facility management service that is optimized and target-oriented, the conditions of a building's glass façade are continuously monitored, including temperature, humidity, air pressure, and the weather.

A digital twin permits collaborative sharing of this measurement data by users, operators, product manufacturers, and consultants. The use case allows the development of a fundamental platform that could range from hardware connectivity, rights management, data safety, and security; the integration of specific algorithmic analysis; and the implementation of AR technologies such as visualization using a 3D model or remote access for maintenance support.

Schmid acknowledges that there's still much hype surrounding digital twin, AR, and IoT. "A lot of people think that a 3D model with meta data is a digital twin, but it's not. We see a lot of products out there, but other views [from architects and engineers] need to be respected."

He envisions a future of holistic digital twin whose tools and workflow processes help users solve problems. For that to happen, "we have to change how tools and software are designed."+

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