MCX

CMAA
Construction Management Association of America

Member Communication Experience

What Is Construction Automation, and How Will It Drive the Future of Building?

Written by: Mark Davis, Autodesk Sr. Director

LEARN HOW CONSTRUCTION AUTOMATION PLAYS A KEY ROLE IN THE INDUSTRY'S DIGITAL TRANSFORMATION AND IN SOLVING THE GLOBAL HOUSING CRISIS.

While development and adoption of automation technologies has evolved more slowly in construction than in manufacturing, the time is now ripe for automated construction technologies to play a major role in helping to bring construction's digital transformation into full bloom.

The continued evolution of the construction industry will rely on automation in its many forms, from automated digital design and analyses processes to the automated creation of construction documentation and, ultimately, the act of construction. Automation of construction processes, whether they are used for off-site prefabrication that mimics advanced manufacturing's best practices or on-site construction robotics, will determine the construction industry's success in fulfilling its 21st-century dual challenges: high demand for buildings and infrastructure and the necessity of sustainability across the entire lifecycle.

Construction automation has the potential to address similar opportunities and challenges that automated manufacturing processes have helped resolve in other industries, including improving production time, material efficiencies, labor productivity, and worker health and safety, as well as compensating for labor shortages, reducing environmental impacts, creating new design opportunities, and so on. Put simply, automated construction has the potential to enable the industry to safely meet the global building and infrastructure needs of an increasing population. New technological developments and industry trends signal that now is the time for automation to take hold.

What Is Construction Automation?

The term construction automation captures the processes, tools, and equipment that use automated workflows to build buildings and infrastructure. In some cases, tools are deployed to automate work that was previously done manually, and in other cases, automated tooling enables new processes to be transferred or developed specifically for construction. Automation in construction can occur at various phases of a project, beginning with the software-based design stage, continuing with automated aspects of off-site and on-site construction, and ending by sharing collected data on the systems and energy use of finished buildings—all captured in cloud-based living models. Several core development strategies are needed to realize this integrated feedback loop, both in software and hardware. For example, collaborative robotics; industrialized construction strategies; new types of robots and automated machines; and real-time in-situ sensing, feedback, and adaptation are among the technologies and strategies that are converging to make automation in construction a widespread reality.

Industrialized construction (IC) is a term used to define the strategic deployment of materials, processes, and systems within the construction processes in ways that take cues from manufacturing. Industrialized construction is not synonymous with construction automation, but the two are fundamentally linked as the increased adoption of automated tools is enabling industrialized-construction strategies to have a radical impact on the way construction happens. Currently, the term industrialized construction mostly involves off-site construction, where the application of manufacturing techniques to the built environment is more widely spread.

Industrialized-construction processes produce elements of buildings and infrastructure, from single parts to components or entire assemblies, using technologies and strategies typically reserved for manufacturing processes. In the case of volumetric industrialized construction, complete volumetric modules—whole hotel rooms, for example—are manufactured in a factorylike environment and then transported to the construction site for assembly into a complete building.

Because of its origins in manufacturing, industrialized construction draws upon the certainty, safety, and quality assurance afforded by a predictable set of variables not found in traditional construction and has the potential to take advantage of advanced, highly automated manufacturing techniques. These are not new ideas—there are examples tracing back to the origins of the built environment—but now there is an unprecedented convergence of technologies that increase the value and impact of IC strategies deployed across the entire industry.

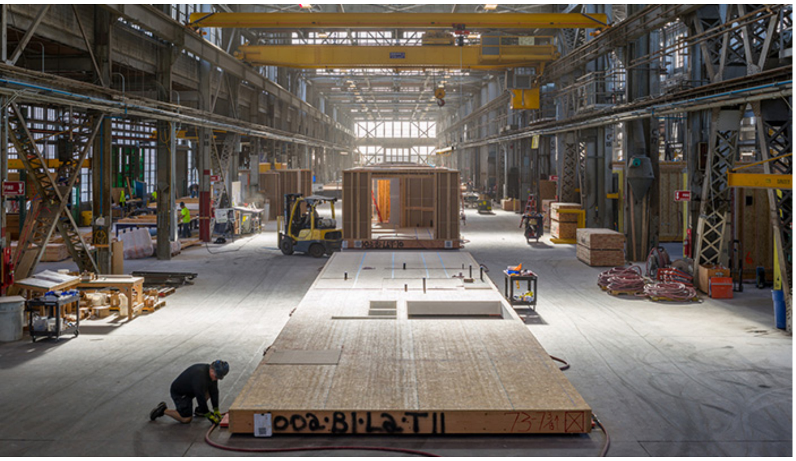
In automated industrialized construction processes, traditional paper drawings can be eliminated, as data from 3D models and other digital artifacts go directly into an automated production line for fabrication. Production lines may include industrial robots, overhead gantries, conveyors, or other automated equipment that complete the translation of materials to building components and assemblies. It is critical to evaluate opportunities for automation as they relate to impact on the environment; the workers; and of course, the return on investment (ROI). My colleagues and I agree that the best possible outcome is a carefully choreographed and collaborative relationship between humans and machines, similar to what is seen on many automotive assembly lines.

A Brief History of Construction Automation

It's easy to think of robots and automated tools flying about a construction site as part of a far-out speculative future, but the reality is that strategies critical to the deployment of these tools have been in existence for millennia, and ideas of mechanized automated construction have been demonstrated for centuries. Early examples of off-site construction are spaced more than 2,000 years apart, from the prefabrication techniques used to build the Terracotta Army in third-century BCE China to the prefabricated panels assembled on-site for housing in Berlin in the 1920s.

Yet modern construction automation featuring robotics did not take off until after the first industrial robots were invented in the 1950s and the automotive industry put them to work in 1960s. Factory automation spread throughout the industrial world, and construction robotics began to surface in the 1960s and 1970s. Facing a construction-labor shortage due to an aging population and disinterested younger workers, Japan innovated construction automation and robotics in the 1970s and 1980s. Japanese architecture and engineering companies such as the Shimizu Corporation, Obayashi Corporation, and Takenaka Corporation created robots and remote-controlled machines for excavating, handling materials, placing and finishing concrete, fireproofing, earthworks, placing rebar, and other construction tasks.

Beyond some examples that were driven largely by extreme perceived labor pressures—and in light of the steep initial investment, complexities of implementation, trade segregation, and lack of construction-specific tools—the construction industry has been slow to develop and adopt automated processes. Today, however, a revitalization of construction automation is underway, assisted by collaboration among businesses, governments, and academia. The robust data and sophisticated architectural-design and data-management possibilities coming from BIM (Building Information Modeling) and artificial intelligence–infused generative design approaches are combined with rapidly advancing robotics and Internet of Things (IoT) technologies to fuel construction's digitalization and convergence with manufacturing techniques. Lower-cost hardware, combined with new workflows that link design-to-robotic fabrication workflows, afford new opportunities for the transfer of industrial robotics to the field of construction.



Types of Construction Automation

OFF-SITE CONSTRUCTION AUTOMATION

Off-site construction automation describes practices that make the construction process more like modern automated manufacturing. Several similar but not synonymous terms fall under the umbrella of off-site construction, including prefabrication, volumetric and panelized modular construction, and precast. These practices move construction processes off-site and into factories, within a familiar and controlled environment that can be optimized to take advantage of automation, industrial robotics, digital production workflows, and design for manufacture and assembly (DfMA) strategies.

Off-site automation in the building industry is more common than automated on-site operations, and the proximity to manufacturing has made direct technology transfer from manufacturing more accessible, with one major caveat. In manufacturing, automated production lines are typically used in high-volume production, in which the part size, shape, and assembly sequence is consistent across many thousands of units. While the construction of buildings, roads, and bridges includes assemblies of manufactured parts, the diversity of materials and processes, along with the inherent variation from component to component and between projects, presents a unique challenge for tooling (the configuration of automated equipment in a production line), and the production line must be automated but also configurable enough to respond to variation.

Factory automation is a big investment, but in the long run, it can save time, money, and resources while improving quality control and quality assurance and providing safer, more comfortable conditions for workers by eliminating many of the repetitive tasks associated with typical construction processes. Factory-based construction can yield environmental benefits, creating less waste; using less water; reducing operational energy and dust pollution; and optimizing material use, reuse, and recycling. And when combined with automated processes, it will play a major role in meeting the global demands for buildings and infrastructure. Some of the most ambitious automated construction factories are meant to run around the clock with little human intervention.

It's like what Warren Bennis, an American scholar and pioneer in leadership studies, famously wrote: "The factory of the future will have only two employees, a man and a dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment."

ON-SITE CONSTRUCTION AUTOMATION

Factory-based automation in construction might be considered a technology transfer from manufacturing (with some exceptions), where automated tooling is configured to produce building elements rather than products. On-site construction automation, however, presents different, unique challenges and opportunities. Developing and deploying equipment becomes less of a direct transfer and requires new equipment and processes—a rich area for research, new business activity, and start-ups. Construction-automation machinery made for on-site operation must be portable enough to travel to jobsites, then set up, used, and taken down to move to the next job. In some cases, existing equipment, such as heavy earth-moving machinery, has been retrofitted, and new equipment is increasingly produced with an eye toward an automated or semiautomated future.

Some early examples of on-site automation resulted in building systems that were specialized to work with those automated construction systems and, in many cases, reduced the uniqueness of the building. Today, there is a second go at automated construction that supports variations across units while also using standardized elements. For example, automated equipment that places concrete reinforcement eliminates repetitive tasks on the jobsite; allows performance-driven variability in rebar placement without incurring extra cost; and, by placing material precisely where it is needed, reduces waste.

Boston-based start-up NeXtera Robotics makes on-site construction-automation systems—for example, its Oliver construction site-scanning and layout robot. Certain on-site construction automation machines may also be applicable to off-site prefabrication, such as the drywall installation robots NeXtera is developing, but applying these machines on-site can save the builder shipping costs.

Other companies are also focusing on the challenge of layout—a tedious exercise where precision is needed. Dusty Robotics, for example, deploys mobile robotic platforms that draw construction data from a digital model and transfer that data to the construction site, essentially printing the construction instructions directly on the floor of the building itself, saving time and labor and improving accuracy.

ROBOTICS IN CONSTRUCTION

Robots, particularly industrial robotic arms and mobile robotic platforms, play a major role in the conversation around automation in construction. One might envision a future with construction-specific robots, but today, manufacturing-based robots are transferred to construction. Companies such as ULC Technologies develop custom solutions and integrate industrial robotics into construction site–suitable work cells. Its Roadworks and Excavation System, for example, conducts automated, surgically precise repairs of under-road infrastructure with minimal site disturbance. Collaborative robots, or cobots, are robots with various levels of autonomy that work alongside people. Cobots typically include safety standards with double-redundant safeguards so that they don't hurt anyone. The robots made for construction may be specially designed to navigate the uncertain and always-changing environment of an active worksite.

An example of on-site human-robot collaboration can be seen in Construction Robotics' (CR) SAM100 (Semi-Autonomous Mason) bricklaying robot. This robotic system operates alongside construction workers to make their jobs quicker, less strenuous, and less repetitive. With the SAM100, the human mason owns the site setup and the final wall-quality assessment while the SAM distributes and places the individual masonry unit.

AUTONOMOUS CONSTRUCTION EQUIPMENT

Just as autonomous automobiles are coming to the streets, semiautonomous and autonomous construction equipment is coming to construction sites. Early models are already being tried, and experts predict that autonomous vehicles for construction will eventually be commonplace. Industries such as agriculture and mining have long benefited from equipment automation and remote control, and increasingly these types of machines are being deployed in construction. Like other forms of automation, this equipment offers the potential benefits of enhanced safety, increased productivity, and higher efficiency.

Automated construction equipment extends automation beyond a building's individual parts and components and allows the industry to consider the jobsite a factory in the field. Working with construction engineering company Black & Veatch, San Francisco's Built Robotics used its autonomous track loader, dozer, and excavator to explore automated trenching systems to accelerate utility-scale construction of renewable energy systems. Black & Veatch also teamed up with Honda to test an autonomous work vehicle on a solar construction site.

Heavy-equipment industry leaders such as Caterpillar are working on construction vehicles that will likely become fully autonomous but are currently semiautonomous. For example, Caterpillar's remotely controlled D11T dozer has cameras onboard that a worker uses to operate the vehicle from a trailer hundreds of feet away. Caterpillar—along with Bechtel, Brick & Mortar Ventures, and others—worked with NASA to host the 3D-printed habitat challenge, focusing on 3D printing buildings on-site—the site happened to be Mars.

In Australia, Rio Tinto has deployed a fleet of more than 100 self-driving trucks and other vehicles to work on its iron-ore mining operations. Although it's not yet a construction application, this example portends what's on the horizon for construction. Rio Tinto's driverless vehicles keep their remote operators—about 1,000 miles away—safe while maximizing precision and efficiency.

Boston Dynamics has commercialized a robotic platform for a variety of construction scenarios, including as-built laser scanning for inspection and construction scheduling. Its Spot autonomous quadruped can easily navigate a construction site every night with a Lidar scanning attachment to collect rich, high-fidelity point-cloud data tracking daily changes.

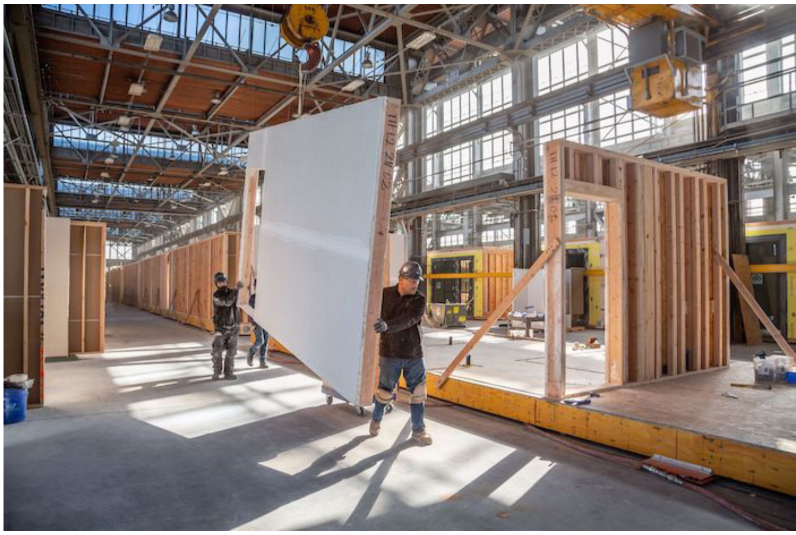
The future is bright for automation on the construction site as new typologies, technologies, and attitudes emerge. Even as more on-site equipment becomes automated, skilled labor is necessary to ensure things run smoothly, and new staging and sequencing strategies must take robots into account.

Examples of Construction Automation

HOWICK

Headquartered in New Zealand, Howick has been building high-tech machinery for more than 40 years and is currently specializing in precision steel roll-forming machines that produce framing for construction. In a recent project, Windover Construction's Virtual Design & Construction team used a Howick X-Tenda 3600 telescopic steel-framing machine to fabricate 935 predrilled, pre-labeled roof trusses in 15 hours for the Cape Ann YMCA in Gloucester, MA. Then, with the help of Fologram's mixed-reality (MR) technology, which applies "holographic templates" to an MR headset user's field of vision using connected 3D-model data, Windover assembled the trusses in three days with just one person working at a time, shaving about 70% off project time and cutting costs by about half.

Howick's machines simplify assembly by automating the production of complex roll-form parts out of a coil of steel and providing detailed assembly instructions within the parts. Howick and Virginia Tech's Center for Design Research are deploying this equipment in remote areas of Zambia to reduce the production time of community medical clinics in from six months to six weeks.



FACTORY_OS

Vallejo, CA–based Factory_OS exemplifies industrialized construction by building multifamily apartment buildings—much of them designated as affordable or assistive housing—with maximum efficiency in a smart-factory setting. The company is constructing units on a 33-station assembly line. By leaning on proven manufacturing technology and construction processes, Factory_OS can build high-quality modular homes faster, at a lower cost, and with less waste than traditional on-site construction.

A team from Autodesk Research is working with Factory_OS on an ambitious project to make the production of affordable, sustainable housing as efficient as possible by improving the company's connection from design to fabrication to assembly, and ultimately, to building operations.

Factory_OS uses QR codes to track all parts and assemblies, so when parts for a wall come off a saw, they're all indexed and tracked. That's all part of the manufacturing influence: repeatability, quality, taking the variability out. If you need 10 of those walls, the automated saw cuts 10 kits; a mobile robotic platform can deliver the kits to a framing station.

We are working to demonstrate a digital connection to Factory_

OS's design catalog in Autodesk Revit to create a multi-scale BIM model—that is, a multi-objective design optimization that allows control of the entire site, individual buildings, modules that together make up a building, all the way down to the components that make up the modules, all connected with generative design. Factory_OS then employs human-centered forms of automation to fabricate finished modules and load each module onto semitrucks to be transported to the local construction site.

On the building site, once grading is complete, workers pour a foundation and deliver finished modules from the factory with flooring, windows, lighting, appliances, plumbing fixtures and interior finishes all complete. Modules arrive watertight, fireproof, and shrink-wrapped. Workers then fasten them together, connect systems and utilities, and the building is ready to occupy. This new workflow will let Factory_OS complete the design and factory construction of a 200- to 300-unit multifamily apartment in just a few weeks.

APIS COR

Apis Cor develops 3D printers and 3D-printing mixtures for efficiently constructing walls that mimic the design of traditional concrete masonry unit (CMU) walls, meeting the requirements of traditional CMU building codes.

In late 2019, Apis Cor 3D-printed a two-story, 640-square-meter government building in Dubai, United Arab Emirates. The company produced a proprietary high-viscosity, gypsum-based 3D-printing mixture on location, and a crane moved its construction 3D printer around the site to complete the build, using only three workers. Since then, Apis Cor improved its 3D printer to build at least eight times faster and at half the cost of traditional masonry construction.

Apis Cor is essentially a manufacturing firm making construction equipment and doing manufacturing on-site as a service. In these scenarios, one might contract the company to bring its machine to your site to produce a structure or part of a building; then, they move on to something else. The contract manufacturer supplies the design parameters, owns the equipment, and provides the service, not unlike contract manufacturing of products, except the factory comes to the site.

Apis Cor is collaborating with another Autodesk Technology Centers resident team, the structural engineering firm Thornton Tomasetti, which reviews the structural integrity of the 3D-printed walls and helps create standards for 3D-printed construction that, ideally, industry associations will accept into their building codes.

BAMCORE

Sustainably harvested bamboo makes up the basis for BamCore's custom-engineered, hollow-wall structural lumber system, and the company uses industrialized, data-driven digital construction tools to quickly and efficiently erect its wall panels on-site. Each custom-fabricated, engineered bamboo-wood hybrid panel is cut to fit into adjoining panels and is precut to accommodate every door, window, light switch, and outlet. Sequential numbers allow for precise installation. Color-coded lines indicate the position of every electrical and plumbing line.

On-site crew members get a 3D animated model of the project on a mobile app that transforms digital building models into sequenced animations, which they easily follow to build the walls. BamCore's prefabrication from digital construction tools offer faster build times, fewer errors, less waste, and lower cost.

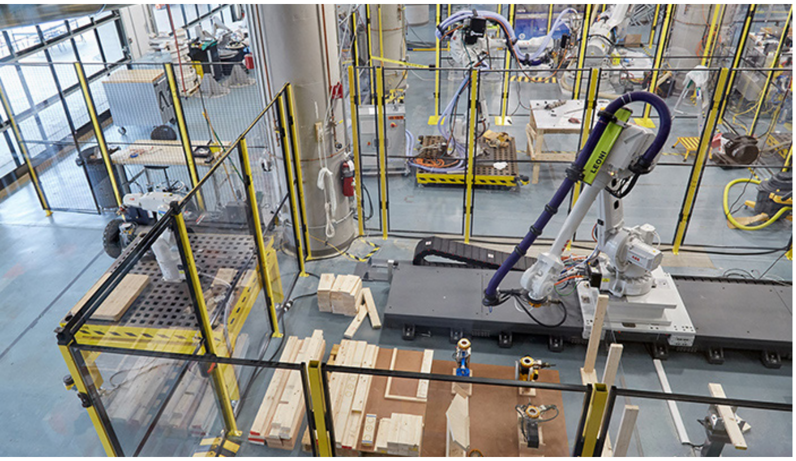
What Are the Benefits of Construction Automation?

SUSTAINABILITY

Many of construction automation's benefits are correlated and cascading so that focusing on increasing one benefit leads to experiencing additional benefits. Automation helps complete projects faster and more efficiently, which usually also results in environmental benefits and more sustainable construction. For example, Intelligent City in Vancouver, Canada, employs robotic automation on its prefabricated modular homes, with the result of 15% greater production efficiency, 38% faster completion, and 30% waste reduction. Global construction company Skanska uses on-site robot welding to fabricate steel reinforcement baskets, which has improved quality, employee productivity, and safety. It has also reduced the cost and environmental impact of transporting bulky finished reinforcement baskets to building sites.

Much needs to be done to revamp the construction industry toward sustainability and environmental friendliness. The construction and demolition sector of the U.S. economy generates about 23% of the national waste stream, according to the Bureau of Transportation Statistics. And buildings (both their construction and operation) account for almost 40% of global carbon-dioxide emissions, according to Architecture 2030. Fortunately, construction automation contributes to the sustainability initiatives of the industry in a variety of ways:

» Automation technologies, such as drones, aid in the construction of renewable-energy facilities, such as wind turbines and solar roofs.
» Off-site modular construction makes maximum use of materials by increasing recycling and decreasing waste material. Efficiently transporting off-site modules to jobsites can reduce the average miles that workers travel by 75%.
» Electric construction heavy machinery, such as the Caterpillar all-electric 26-ton excavator, can reduce carbon emissions by as much as 52 tons from a single machine.
» Because construction robotics tend to perform tasks faster and more accurately than people, they can cut down on production delays, which reduces pollution from running machinery and keeping a jobsite active. Their accuracy also reduces material waste from errors and rework.



With the population demands, it's not overblown to call this a housing crisis. If people just keep building the way they're building, the planet will be ruined. There's literally not enough sand to make the amount of portland cement needed to meet the numbers. So people have to change the way they build.

Automation will play a part in new recycling abilities that can begin to address resource shortages. For example, the British nonprofit WRAP is working with Autodesk on recycling plate glass from buildings by crushing it in a hopper and melting it down to make clean new glass.

REDUCED LABOR-SHORTAGE GAP

Two recent surveys conducted by ABB Robotics and the Associated General Contractors of America (AGC), in partnership with Autodesk, confirmed the magnitude of the labor shortage in construction:

» 80% of construction firms have a hard time filling hourly craft positions.
» 91% of construction businesses expect to face a skills crisis during the next 10 years.
» 45% of construction firms say the local pipeline for training skilled workers is poor.

Addressing the labor shortage in construction will take a variety of initiatives, such as reintroducing trade education into middle and high schools. However, increasing the use of construction automation can have a combined effect of lessening the reliance on traditional skills, whose experts are retiring, and attracting younger workers who are accustomed to and excited by working with advanced technology. In fact, 81% of the respondents of the ABB Robotics survey plan to implement or increase their use of construction automation within the next 10 years. That strategy also helps companies make the most of the employees they do have by giving them the technology they need to be 100% efficient.

But machines don't automate jobs; they automate tasks. For example, instead of drilling holes, a person's job may be to work with and maintain a faster, more accurate hole-drilling robot. Introducing such technology is also likely to increase the base pay for workers with the necessary skills. And instead of automation shrinking the number of jobs, the consulting firm McKinsey & Company expects an additional 200 million construction jobs by 2030 if countries commit to improving infrastructure and affordable housing.

For those reasons, construction automation will have to come in conjunction with new strategies for lifelong, personalized education that upskills and reskills workers throughout their careers, subsidized by construction firms and/or governments.

Already half of the general contractors from the AGC/Autodesk survey reported being engaged with career-building programs.

In addition, universities are responding to the emerging opportunities for new career paths related to automation. Schools such as ETH Zurich, University of Pennsylvania, Carnegie Mellon, and others have created specialized undergraduate and graduate programs focusing on the automated future of the construction industry.

INCREASED SAFETY

The construction industry is known as one of the more dangerous industries for workers. In 2019, 1.7% of American construction workers missed work due to injury, according to the U.S. Bureau of Labor Statistics, and about 20% of all American worker fatalities were in construction, according to the Occupational Safety and Health Administration (OSHA).

By automating more construction processes and tasks with off-site industrialized construction, drones, autonomous robots, and more, the industry can protect more people from the risks that cause most construction injuries and fatalities, such as falls and collisions with objects. Robots can also handle larger and heavier loads and work in spaces that are unsafe for people.

Automation and industrialized construction can bring more construction processes into controlled environments, with less risk to human safety. There are factories in Sacramento, CA, that run lights-out 24/7 with no humans in them. That's a very safe environment when people aren't around. If automation can force things indoors or make things easier to assemble on-site, it lessens the risk from things you can't control.

IMPROVED EFFICIENCY AND PRODUCTION

McKinsey & Company notes that in the United States from 1947 to 2010, productivity in construction hardly increased while manufacturing productivity multiplied by more than eight. That time period coincided with a great effort to automate manufacturing, and by its end, there was still a glut of unfilled manufacturing jobs as automation created demand for skilled labor. McKinsey also predicts that construction automation is likely to increase productivity while not depleting construction job opportunities. The examples of construction automation's efficiency seem to bear out that prediction.

Automation at the architectural design stage uses artificial intelligence (AI) functions such as predictive design to fulfill mundane tasks and allow the designer to spend more time on creativity. And data collected from construction automation and shared digitally helps different teams collaborate in new ways.

But perhaps the greatest benefits to efficiency are conferred at the actual construction stage. Examples in Great Britain include Ilke Homes, which prefabricates steel frames and modular units in a factory that is safer and more secure than a construction site and then installs them on-site faster and cheaper than building houses from scratch. And Construction Automation says that its Automated Brick Laying Robot builds its brick-and-block homes with increased productivity, improved health and safety performance, lower costs, and guaranteed quality.

EXPANDED INSIGHT AND ANALYSIS THROUGH DATA COLLECTION

By its nature, construction automation leaves a trail of data; properly analyzing and making changes according to that data can reduce risk, increase profits, and save time and materials. Conversely, bad data—which is inaccurate, incomplete, or inconsistent—is estimated to have cost the global construction industry $1.85 trillion in 2020 alone. Construction-management software can help wrangle and analyze data quickly and accurately.

Unfortunately, a majority of customers in the field today design and create a building, then retain very little information they can contribute toward the next project. A lot of architecture firms think about their projects as snowflakes: Every one's unique; they all start from scratch. That's highly inefficient. If people start construction projects from scratch every time, they'll never have that intelligence to drive effective automation.

Rather, the goal should be to collect enough data from construction automation to apply toward future projects by knowing what went right and wrong, what may have failed on the machine side, and what people did well so that every successive project is a fraction more efficient. Repeating this process will develop a collaborative AI and human-based system that gets smarter as it is constantly refreshed, resulting in both the human knowledge and machine knowledge getting richer and each project going better.

INCREASED PREDICTABILITY AND BETTER QUALITY

Standard construction processes for inspection and permitting are inefficient when compared to manufacturing. Once a manufacturer proves that it can build something repeatedly at a certain predictable level of quality, it receives a United Laboratories (UL) Listing, which is an inspection approval. The more the construction industry adopts automation and industrialized construction, the more it can cut down on the inspection process while relying on repeatable, predictable quality building components.

Factory_OS has done a really good job at having inspectors on-site who work for the county but who stay at the factory for when they're needed. They inspect all of the processes that Factory_OS has invented and standardized.

SCALABILITY

Industrialized construction makes large-scale projects easier when components are standardized. If a building needs, for example, 2,000 plumbing walls or a large number of bathroom pods, an off-site manufacturer can prefabricate those components in advance, store them, and deliver them to the site exactly when they're needed. Not having to wait for the materials, supplies, and labor to source components allows large projects to proceed on schedule. And if those components are standardized (with degrees of customizability), a building project can scale up in size with less difficulty.

What Is the Future of Construction Automation?

As the manufacturing sector has shown, once automation reaches a threshold of adoption, there's a point of no return when businesses of a certain size must implement automation to stay competitive. ABB Robotics's global survey found that only 55% of construction companies use robotics as of 2021 (which is lower in the United States)—but given the stated interest in implementing construction automation, the skills shortage, and the push to improve sustainability in construction, heavy adoption of automation and robotics will likely become the norm in construction before too long. But how will that adoption look?

For one thing, construction automation will continue to adapt manufacturing technologies for shaping the built environment. Autodesk's affordable, sustainable housing project with Factory_OS will continue exploring advanced manufacturing technologies for producing volumetric modular construction. The Autodesk Technology Centers are also involved with several other companies working in construction-automation innovation, including working with Factory_OS to develop an innovation lab to deploy more automation technologies into its factory.

Shimizu's latest deployed robot, the Robo-Buddy Floor, is an industrial robotic system that assists craftspeople with installing raised flooring. Another element of the Shimizu Smart Site is a three-robot team where one robot takes materials, such as drywall, to a robotic elevator that moves things up to a third robot that unloads the elevator. If you squint your eyes, that's an automated manufacturing facility. It just happens to go vertically as well as horizontally. Shimizu's system essentially views the entire building site as a factory. It has different interconnected robotic technologies that treat construction as a system of interconnected rather than distinct trades.

Construction automation is starting to move in a direction like distributed manufacturing, where sophisticated automation aids on-site assembly like Shimizu's Smart Site with ever-improving modular, prefabricated industrialized construction like Factory_OS. While distinct from construction automation, industrialized construction plays a role in potential for automation to improve the way things are built.

A lot of the same things that are challenging manufacturing—productivity, labor shortage, material waste, production time—are the same problems as in the building industry. Automation has been the way the manufacturing industry has solved, or is attempting to solve, all of those things. Now, construction automation is poised to tackle the mounting challenges in developing the built environment.

It's clear that during the past 50 years, construction automation has grown significantly—and it's in a prime position to help solve some of the problems plaguing the current construction industry. It will help address the skilled-labor gap by attracting younger workers who are excited by advanced technology. It can help make jobsites safer for all workers and increase insight and analysis through data collection. And perhaps most importantly, it can help tackle the housing crisis. Construction has been notoriously environmentally unfriendly, and with the global population on the rise, designing and building more sustainable structures—using things like automation technologies, off-site modular construction, robotics, and electric construction equipment—can help make a better world for many generations to come.

About the Author

As Senior Director, Design Futures in Autodesk Research, Mark Davis and his team explore and validate new technology, next-generation software solutions, and immersive experiences. Over the last five years, the team has applied research in AI, simulation, and advanced manufacturing to develop Generative Design, integrated into Autodesk Fusion 360. This research has been used in projects with Mercedes-Benz, Philippe Starck, and NASA's Jet Propulsion Lab.

About the Article

Republished from Redshift. Redshift is a publication from Autodesk dedicated to inspiring construction, manufacturing, engineering, and design leaders.

Special thanks to Nathan King, DDes, Global Technology Centers Network Team Lead at Autodesk; and freelance technology writer Markkus Rovito, both of whom helped compose this article.

Photos: All Courtesy of Autodesk