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Automation and Robotics: Rethinking Engineering and Construction Jobs

by Sabine Hoover, Jay Snyder and Alyssa Menard

What talent shortage? Tomorrow's built environment could go "robotic" not only to gain efficiencies but also to solve the current and looming labor shortages in engineering and construction.

Approximately 50% of the current positions in the construction sector could be automated,¹ and that's a good thing. With disruptive changes to business models expected to have a profound impact on the employment landscape over the coming years, the push toward using more automation and assistive technologies (e.g., exoskeletons) could quite possibly be the one light at the end of every engineering and construction (E&C) firm's tunnel right now.

More than ready to start working smarter, better and faster, E&C companies aren't alone. Across many business segments—from warehousing to retail to distribution—we're seeing an uptick in the amount of automation, robotics, artificial intelligence, machine learning and other advanced technologies being used to augment existing workforces. And while the notion of a machine completely replacing human labor might seem far-fetched for many, there is already a strong movement toward humans and machines working together in the built environment.

“Developments in genetics, artificial intelligence, robotics, nanotechnology, 3-D printing and biotechnology, to name just a few, are all building on and amplifying one another. This will lay the foundation for a revolution more comprehensive and all-encompassing than anything we have ever seen. Smart systems—homes, factories, farms, grids or cities—will help tackle problems ranging from supply chain management to climate change,” the World Economic Forum (WEF) points out in [“The Future of Jobs.”](#) “In many industries and countries, the most in-demand occupations or specialties did not exist 10 or even five years ago, and the pace of change is set to accelerate.”²

These trends are expected to have a significant impact on employment across all industries, ranging from new job creation to job displacement and from increased labor productivity to widening skills gaps. The WEF further points out that, “As entire industries adjust, most occupations are undergoing a fundamental transformation. While some jobs are threatened by redundancy and others grow rapidly, existing jobs are also going through a change in the skill sets required to do them.”³

According to the WEF, 65% of students who are entering primary school today will wind up working in job types that don't even exist in today's business world. In light of this rapidly changing employment landscape—which includes the E&C industry—being able to anticipate and prepare for future skills requirements, new careers and these employment changes is more important than ever for companies that want to maintain their competitive edge.

¹ “Efficiency eludes the construction industry.” The Economist Group Limited. 2017.

² “The Future of Jobs, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution.” World Economic Forum. 2016.

³ Ibid.



Today's E&C Talent Reality

Despite rising talent shortages and high levels of recruiting difficulty, many E&C firms still don't see talent development as a strategic priority. According to FMI's most recent [talent development study](#), recruiting talent has long been a challenge for the E&C industry, and it will only become more severe in the future—across a broad range of industry sectors. Since 2013, talent shortages across the U.S. E&C industry have been worsening, with a record 89% of participants reporting talent shortages in the 2017 FMI study (Exhibit 1).

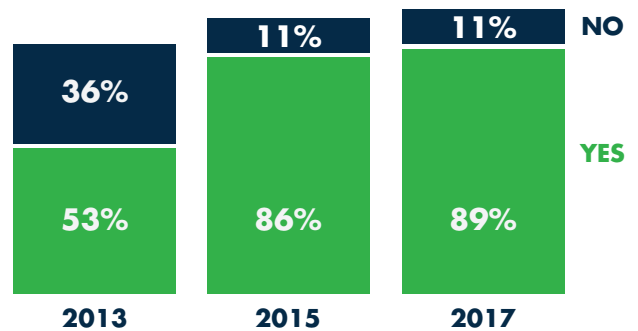
These labor trends could prove troublesome in the future, thanks to the volatility of workforce demand and composition, skilled labor scarcity, and tech-related demand for new and broader skill sets at all levels. Furthermore, improvements in technology are generating opportunities for industry innovation, and **E&C firms need leadership and people with the right mindsets to drive learning and embrace change at a rapid pace.** To succeed, company leaders and HR managers must prioritize talent development as a strategic imperative and fundamentally change the way they think about training and talent development.

Some firms are already making headway at the intersection of humans and robots, with new startups introducing a wave of innovation in robotics, drones and software. “A big part of the reason is that construction companies can't find workers, but robots don't mind getting dirty,” according to [“Digital Trends.”](#)⁴

“It's hard to find qualified people to handle a loader or a haul truck or even run a plant,” said one plant manager. “Nobody wants to get their hands dirty anymore. They want a nice, clean job in an office.” One Colorado masonry firm recently taught its employees how to use the SAM bricklaying robot, which can lay 3,000 bricks during an eight-hour shift using a conveyor belt and robotic arm. The employees didn't see the robot as a threat to their jobs, but instead welcomed the chance to automate some basic tasks while performing their craft (and concurrently managing SAM).

Exhibit 1.

Are you facing talent shortages?



Source: 2017 FMI Talent Development Study

⁴ Mark Austin. “Construction companies are welcoming their new robot workers.” Digital Trends. March 24, 2018.

“There are lots of things that SAM isn’t capable of doing that you need skilled bricklayers to do,” Brian Kennedy of the International Union of Bricklayers and Allied Craftworkers told “Digital Trends.” “We support anything that supports the masonry industry. We don’t stand in the way of technology.”

In another example, ETH Zurich University researchers are using robotic construction to develop a computer-designed modular home. The project, known as [Spatial Timber Assemblies](#), uses computers to design individual units that are built by robots. Those robots saw the timber beams to the right size, drill the required holes and then work together to put the beams in place. Once in place, the beams are bolted by human employees. Furthermore, building material usage is minimized because no reinforcement plates are required.

“If any change is made to the project overall, the computer model can be constantly adjusted to meet the new requirements,” said Matthias Kohler, professor of architecture and digital fabrication at ETH Zurich. “This kind of integrated digital architecture is closing the gap between design, planning and execution.”⁵

⁵ “ETH Zurich robots use new digital construction technique to build timber structures.” De Zeen. April 16, 2018.

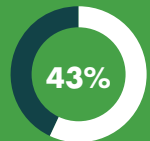
Today’s Big Talent Challenge¹



face talent shortages



have changed training programs

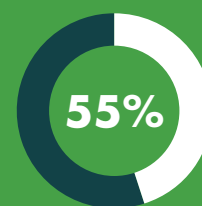


don't prepare a training budget

5.8 out of **10** training and development programs aren't very effective.



5 out of **10** rating of performance management programs among construction firms.



of survey respondents don't have any formal processes in place for identifying and developing high-potential employees.

¹ All statistics for “Today’s Big Talent Challenge” are based on “FMI’s 2017 Talent Development Study.”



Taking Construction to New Heights

As the first fully integrated modular solution for design, manufacturing and construction, [FullStack Modular](#) is literally taking construction to “new heights.” Roger Krulak, CEO, says the company offers a full volumetric, modular solution that focuses on multifamily, dormitories and hotels ranging from eight to 45 stories. A full 85-90% of the work is done in the factory. “It’s stacked up like Legos, bolted together and the sides are installed, with all of the connection work completed in the field,” says Krulak.

A design-manufacture-construct solution, FullStack Modular works with general contractors to create a complete built environment. “We have a design-focused team, a manufacturing-focused team and a development-focused team—all with targets of both process and product,” Krulak explains. “And we work together from the beginning, which is a huge change from design-bid-build projects.”

Krulak points to one company that’s using 10-12 robotic welders to complete tasks that are difficult for humans to do (e.g., welding while upside-down) as just one example of how automation is infiltrating the E&C space. “When you take tasks that are incredibly hard for humans to complete, and you supplement your manufacturing activities with robotics, you can increase production,” says Krulak, who adds that this specific firm has increased production tenfold within the last five years without having to hire more workers.

“Are you going to replace humans with robots? The answer is no. In order to be effective using robotics, you need to know better than any human being how to do something and the logical thought process that goes into decision-making. That is very hard. So maybe one day things will be built by a machine, but it’s hard to believe that robots will replace humans altogether,” says Krulak.

With a strong foothold in the modular construction market, FullStack Modular is helping to bridge the gap between a labor shortage and a billion-unit housing shortage. He sees prefabrication playing a key role in that charge. “Maybe it’s paneled wall systems or a bathroom pod or pre-assembled HVAC mechanical racks for a ceiling of a hospital,” he says. “Just try one and see how it changes the whole process.”

The Construction Site of the Future

If Balfour Beatty's vision is correct, construction sites will be human-free by 2050. Instead, teams of robots will be constructing structures with dynamic new materials, and drones will be flying overhead, constantly scanning and monitoring progress. Concurrently, the collected data will be used to predict and solve problems before they turn into real issues, and all with limited human involvement.


“The role of the human overseer will be to remotely manage multiple projects simultaneously, accessing 3-D and 4-D visuals and data from the on-site machines, ensuring the build is proceeding to specification,” the company states. “The very few people accessing the site itself will wear robotically enhanced exoskeletons and will use neural-control technology to move and control machinery and other robots on-site.”⁶

In assessing the current use of robots in factory settings, the human-free construction site isn't that difficult to envision. From automated registers in Target stores to autonomous vehicles on our roads to voice-activated technologies in our homes, these innovations are already altering how we work, live and play today.

“We believe that the rise of digitization and robotics in construction will bring about a huge increase in productivity in what is a very large but historically low-productivity sector,” Balfour Beatty points out. “Infrastructure is a political and economic priority in many countries across the world. Increasingly complex projects are being commissioned to stimulate sluggish economies, upgrade old systems and cater to growing and changing populations. With high economic growth and fast-growing populations leading to significant urbanization, the demand for new infrastructure is predicted to see massive growth in coming decades.”⁷

⁶ “Innovation 2050. A Digital Future for the Infrastructure Industry.” Balfour Beatty, June 2017.

⁷ Ibid.



Fastbrick Robotics: Changing the Industry One Brick at a Time

Another innovation example is the Australian Fastbrick Robotics' revolutionary bricklaying machine, the Hadrian X, a globally patented 3-D robotic bricklaying system. Mike Pivac, CEO of Fastbrick Robotics, states, “At this point in time, there's an immediate need to produce about 3,000 of the firm's robotic machines just to fill the gap between housing availability and the demand for that housing globally. I also believe the expected demand and adoption of the machines in the coming decades will be very strong, resulting in many thousands more entering service.”

“Our focus at the moment, in addition to completing the development work on the Hadrian X machines, is to scale the production and distribution with a strong manufacturing partner who can also support the machines in the field globally,” says Pivac, noting that approximately 1.5 trillion bricks are laid worldwide every year. “We'd like to tag about 5-10% of that laying activity over the next decade.”

Preparing Your Workforce for Digital Transformation

In light of today's technology and E&C trends, leaders need to think about how they will change processes, systems and operations in preparation for the inevitable digital transformation. Done right, it can be a game changer. But you must ensure that your change management plan addresses both technology and culture, or you will be doomed to fail.

“For us, digital transformation is really that intersection of technology innovation and business innovation,” says Mark Peacock, principal and Global IT Transformation practice leader with strategic consultancy The Hackett Group. “It’s how you’re taking digital technologies and as a company really, fundamentally changing the way you’re delivering products and services. It’s about applying technology innovation to come up with new business models, which really drive new revenue above the line and new ways to deliver products and services.”⁸

This attitude also applies to today's E&C industry where innovative firms have figured out how to reinvent their business models by leveraging new technologies. In our recent article, “[A New Era for Modular Design and Construction](#),” we discuss companies such as [BLOX](#), which is fundamentally changing traditional business models by applying technology innovation and creating new business frameworks.

However, one of the key challenges that company leaders often underestimate is culture. According to [research](#), digital readiness isn't exactly being practiced by all organizations or embedded in all corporate cultures. The latter is a particularly important point in a world where culture change and education must be hardwired into your success plan.

⁸ Thor Olavsrud. “Change management for digital transformation: What's different?” CIO from IDG. August 3, 2017.

Automation Is Here

Automation potential:¹

38%



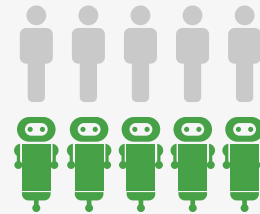
for **unpredictable** physical work in construction.

70%

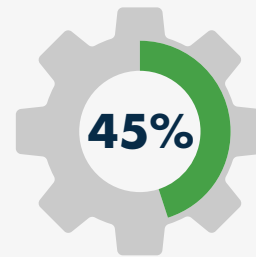


for **predictable** physical work in construction.

50%



of current positions in the construction sector could be automated.²



of tasks people are paid to do each day could be automated with current technology.³

65%

of the jobs that will be performed by Gen Z do not even exist yet.⁴



¹ McKinsey

² Economist

³ Manpower Group

⁴ Manpower Group

The importance of culture in the context of innovation and change management was also confirmed in “[FMI’s Innovation Series](#),” in which the authors captured thoughts of three leading industry disruptors: Russ Becker (APi Group), Tom Scarangelo (Thornton Tomasetti) and Atul Khanzode (DPR Construction). Each of these leaders has led innovations and positive disruptions within the E&C industry in different ways. Here are five of their key takeaways around the power of their internal organizational cultures:

- 1. Building a culture of innovation takes time and requires many real-time course adjustments.** Consistently reinforcing the value of innovation, testing disruptive ideas and rewarding people for successful implementation are great ways to build a common mindset across the company.
- 2. Internal collaboration influences external collaboration.** Corporate cultures that are accustomed to collaboration in all areas of the business can lean on each other to build off each other’s ideas and solve problems. It’s not just an expectation for these companies; it’s a natural way of working to get things done. When this happens inside the company, partners on the outside notice and are willing to collaborate on new or different methods for project delivery and/or addressing challenges when they arise.
- 3. Cultures that encourage trust and collaboration can more readily generate innovative ideas and withstand disruptive changes.** Khanzode noted that, “Our work is really about bringing people together. When humans trust each other and feel connected, they are willing to take risks, be vulnerable with radical ideas and try new approaches.” Demonstrating trustworthy behaviors from the bottom to the top is not only expected but also rewarded within DPR.
- 4. Many innovative cultures, like Thornton Tomasetti’s, recognize opportunities where others see risk.** Scarangelo noted that, “Cultures that focus on the big ideas and simultaneously see challenges as opportunities are the ones that are keeping up in this market. We encourage all of our engineers to see a challenge and spend time finding the opportunity to innovate with each other on every project.” This doesn’t happen in the occasional pocket; it’s encouraged on all internal and external teams throughout the organization.
- 5. Setting a vision for innovation and clarifying what innovation means within the context of a company is key.** When everyone knows where he or she can win in the marketplace (related to innovation) and how it applies internally, the culture is likely to rally behind the vision and help support it throughout the ebbs and flows.

Every firm is different, so there is no right or wrong way to prepare for the melding of culture and digital transformation. There is also no best path to recruiting and retaining the most suitable workers, but companies that take a thoughtful approach to developing their culture and assessing their employment needs will be best-equipped to thrive. With the right people in place—and a willingness to embrace technology and use it to augment the workforce—it becomes much easier to capitalize on future opportunities, persevere through cycles and overcome critical challenges.



“It’s not just an IT strategy,” Peacock says. “Some people equate digital transformation with analytics on steroids. If that’s all you’re thinking, you’re not going to get that fundamental business change. You need a business-led strategy that’s supported and enabled by IT. Being able to pull that together means you need to develop an overall strategy from an enterprise level that can then be cascaded down.”

Put simply, it takes a clear vision of the bigger picture to get all stakeholders working from the same playbook. As part of that process, it is equally as important to utilize open communication to develop and apply a well-thought-out technology strategy that achieves that vision. Some key steps for getting a technology strategy started may include (but are not limited to):

- Refer to your company’s existing technology strategy to ensure that the initiative aligns with it. If you don’t have one, develop one.
- Develop a business use case for the technology (i.e., the business “need”), focusing on the details of the problem you are addressing.
- Review the technology strategy to revalidate that it supports the firm’s overall business strategy. If it doesn’t, reconsider the business need before moving forward.
- Determine the magnitude of the problem and define the scale that the solution must be capable of handling.
- Evaluate the company’s culture and how employees will respond to technology as part of the solution.
- Assess the company’s and employees’ level of technology and/or innovation fatigue. For example, has the amount of change (and/or new technology or innovation initiatives) been overwhelming to the organization? Does the company have an appropriate change management process when introducing new technology tools into its business processes?

Technology isn’t going to stop transforming the world, and E&C must be a part of that change. By embracing automation, robotics and other technologies that promise greater efficiency, better safety, higher productivity and significant cost savings, E&C firms can ride the wave of technological innovation while also maintaining strong business visions and a focus on the future.

Finally, many industry experts believe that automation will make us all more creative in the long run. “We’re going to allow machines to do what machines do with excellence, and humans can do what humans do best,” states Malcom Frank, author of “[What To Do When Machines Do Everything](#).” A teacher, for example, could utilize a robot to review homework and identify students’ needs in an environment of differentiated learning. “The rote work has been removed,” he says, “freeing up humans to do higher-impact, more creative work.”⁹

Of course, human judgment, logic and creativity aren’t going to disappear just because robots and drones can operate autonomously and/or with little supervision. These innovations may change the way we do things—with surgeons using robotics to help them complete medical procedures, or drones used to take inventory of construction materials that are in the warehouse or the yard—but the processes themselves will still require a human being. The only difference will be that individuals will now be freed up to be more creative and innovative, and to take the E&C industry to entirely new levels.



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⁹ David Johnson. “Find Out If a Robot Will Take Your Job.” Time Magazine. April 21, 2017.



About FMI

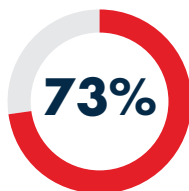
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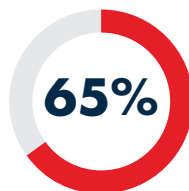
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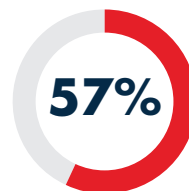
FMI Client Highlights



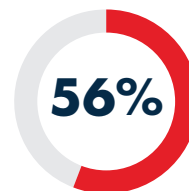
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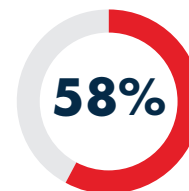
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