

FUTURE OF WORK IN CONSTRUCTION

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The construction industry currently faces a confluence of major challenges and opportunities. Over the next 30 years, the global population is projected to grow by around 2 billion people, with the projection to increase from around 4.2 billion to around 6.7 billion.

To meet the need of the growing population, 13,000 buildings, along with supporting physical infrastructure, must be constructed every day. At the same time, as demand sharply rises, we face a shortage of skilled labor compounded by growing challenges around resources and environmental impacts.

Historically, construction productivity lags other economic sectors and the economy as a whole. Nevertheless, there may be a way to close that gap, scale the industry, and rise to the occasion by adopting design-to-make production processes alongside digital technologies.

These trends within industrialized construction can bring much needed certainty of cost, schedule, and scope to the architecture, engineering, and construction (AEC) industries. Along with certainty, industrialized construction creates a more sustainable and resilient industry, while addressing skilled labor shortages, waste, diversity, and worker safety.

It is an essential and necessary transformation but doesn't come without a significant process and mindset change across the industry. As a new generation of designers, engineers, and builders emerge from universities and other industries, their impact on this new

way of working will be critical. Their skills and education will shape the built environment and further the transformational change that industrialized construction will bring.

At the heart of the AEC industry are the roles of the workers, whether onsite or offsite, performing the execution to bring a project to fruition. In this white paper, we look at the Future of Work in Construction. Why industrialized construction, and when adopted, what will the actual work, workers, and workplace look like? How can industry and academia collaborate to educate the workforce of tomorrow?

To find out, our research team surveyed and interviewed a select cohort of experts from both industry and academia across the US and UK. This research is the first step to understanding what the future of work in construction may look like, with some recommendations for forging the path ahead.

Amy Marks

*Head of Industrialized Construction
Strategy and Evangelism, Autodesk
Construction Solutions*

Construction must change. It is a key driver of value creation in economies around the world, but it is inefficient, suffers from low productivity and is often mired in disputes. Coronavirus acts a key catalyst for this change in terms of technological investment, social distancing and productivity challenges.

As a global professional body, thought leader and standard setter in construction, RICS is keen to further this debate and offer practical guidance on how the sector can grasp the huge opportunities that are emerging in terms of industrialized construction. The synthesis of off-site fabrication, additive manufacturing, robotics, artificial intelligence and the internet of things produce a perfect storm for a fragmented, information-intensive industry like construction. To harness and adapt this technology in an increasing and useful way will be the key industry challenge of the next decade and beyond.

Through a semi-structured interview process with experts in the UK and US, this paper considers the new roles and skills that will be required to grasp the opportunities that industrialized construction (IC) will bring. It considers how IC will increase safety, improve efficiency, increase certainty and profitability and improve skill shortages. Critically, for the RICS, it considers the new skills required including data analytics, production management, modeling and simulation and managing robots and drones. It also looks at the role of academia and industry in addressing those new skills.

RICS, through its own Futures research, is aware of these emerging trends and skills. We are conducting a review of our own standards, guidance and qualification routes to ensure that RICS professionals can optimize the opportunities that exist in the built environment. As well as greater specialization, there is a conflicting need for greater integration and collaboration to meet the demands of society in terms of greater connectivity and more homes.

We recommend that all RICS professionals read and consider this paper and provide their own thoughts on the recommendations. What are you doing to get ready for this change?

Alan Muse

Global Director of Built Environment, RICS



ABOUT THE AUTHORS

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Debra Pothier is a Senior Global Manager Construction Strategist, Autodesk Education with 20+ years of high-tech leadership experience in global strategy, business development, and marketing. She is a techno-optimist passionate about the digital transformation for building design and construction and leads the construction global education team. With over 17 years at Autodesk she has held both strategic and global senior positions developing the architecture, engineering and construction strategy and is a general manager for cross-functional teams. She is passionate about the advancement of construction technology while ensuring the next generation learns digital skills to be prepared for the future of work. Debra holds an MBA from UMass Lowell, Bachelor of Science from UMass Dartmouth, and a construction supervisors license in Massachusetts. She sits on various AEC advisory boards.



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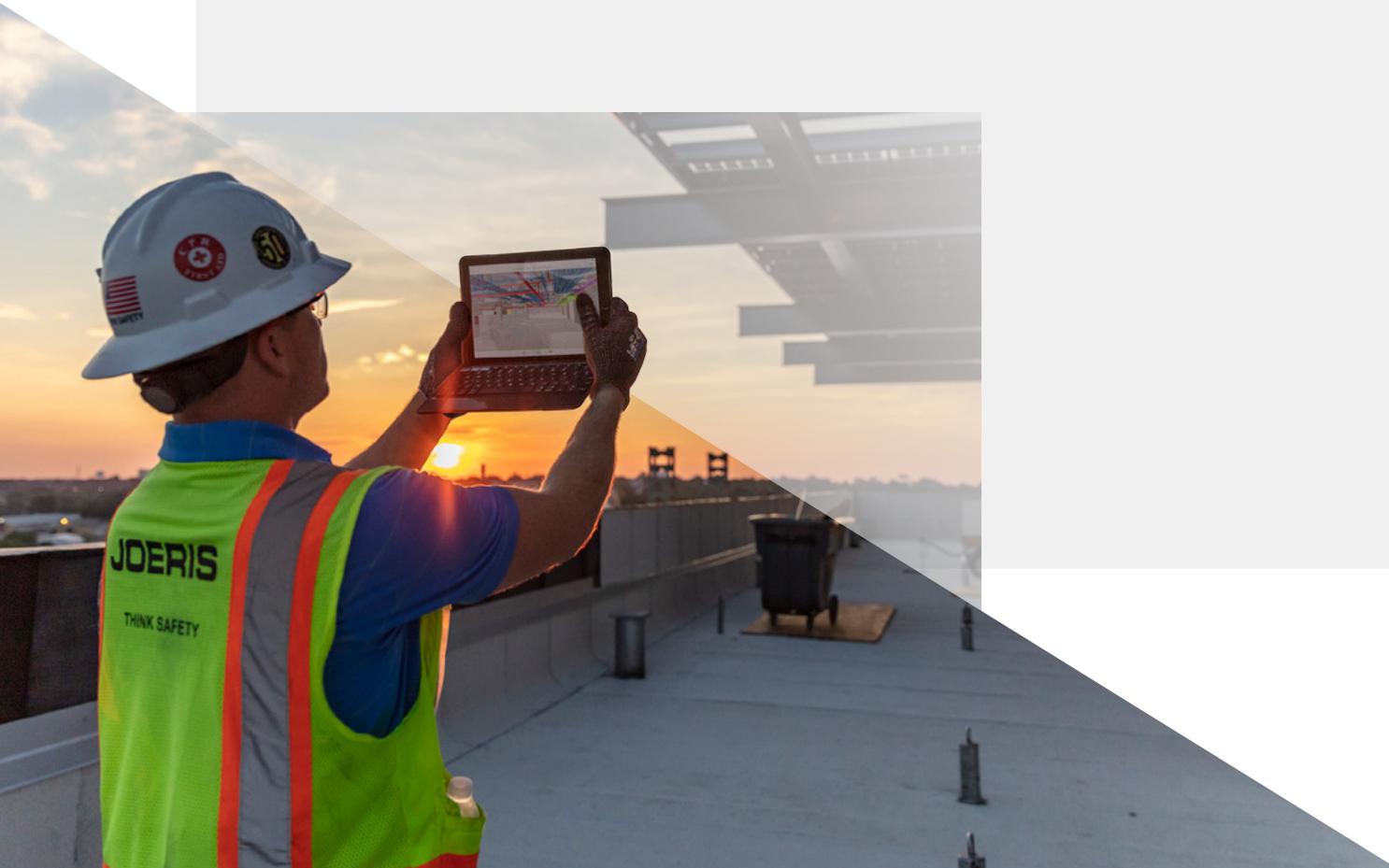
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1 Industrialized Construction and the Future of Work

In the Fall of 2019, Autodesk and RICS conducted a study on the Future of Work (FOW) in Construction that aimed to define the impact of industrialized construction (IC) on the work, the worker, and the workplace during the construction phase of a project.

Definition of industrialized construction: IC is a construction system that uses innovative and integrated techniques and processes such as building information modeling (BIM) and common data environment (CDE) to connect the design-to-make process by embracing these five megatrends:

- Prefabrication and offsite construction
- Additive manufacturing
- Robotics and automation
- Big data, artificial intelligence (AI), and predictive analysis
- Internet of Things (IoT)

Our study involved three main steps: (1) setting the context for the study; (2) conducting the survey; and (3) analyzing the data collected and providing final recommendations. The study framework is shown in Figure 1.

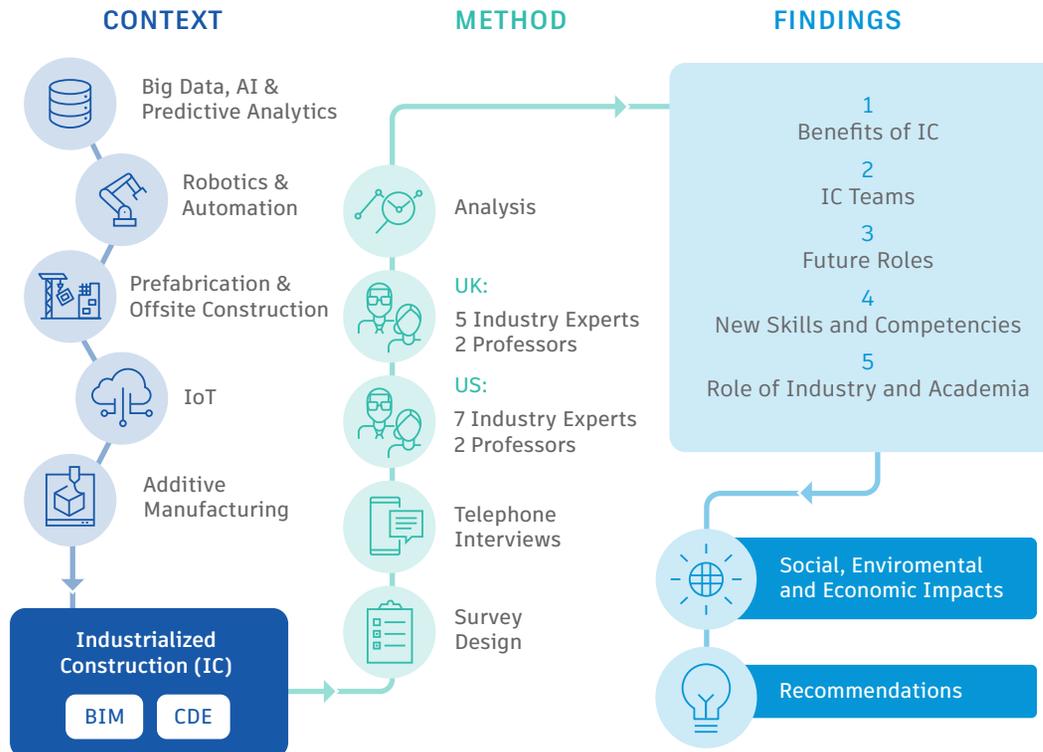
The survey focused on the following key areas for exploration:

- The current state of adoption of IC and the five megatrends
- Benefits of IC for organizations and the industry in general
- Emerging and future teams and roles that will result from the industry transitioning to IC
- Role of industry and academia in the transformation

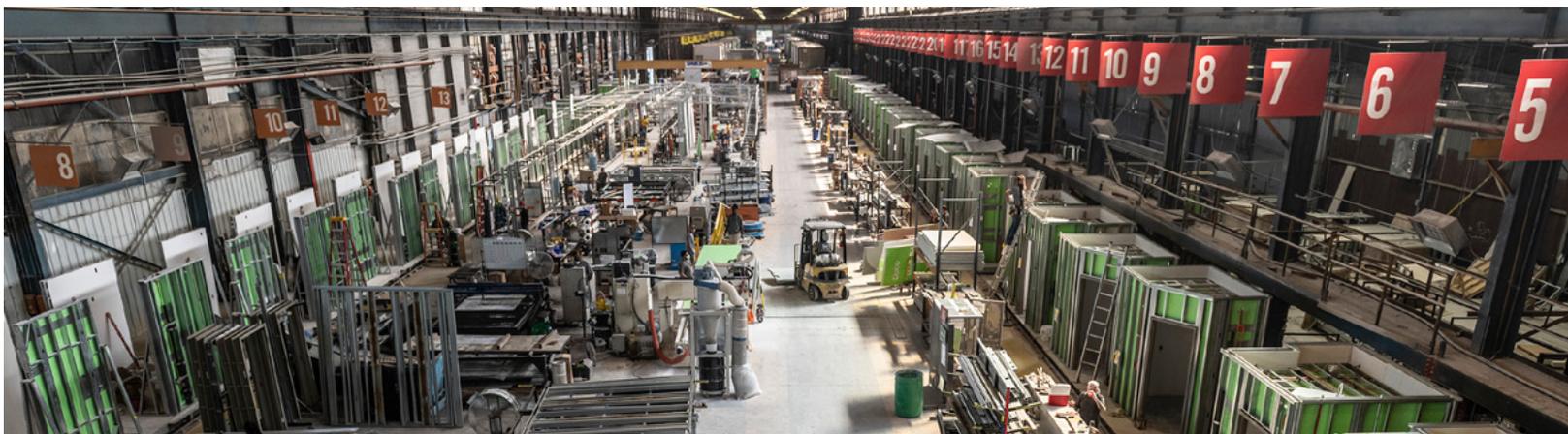
Construction industry experts were contacted based on expertise and industry experience. Using a semi-structured interview process, the team conducted telephone interviews with 12 industry experts (seven US-based experts and five UK-based experts) and six university professors. Each interview lasted 30 to 45 minutes. The transcripts of these interviews were analyzed in detail, and the findings are reported in this paper.

Primarily, the experts painted a picture of how current roles will change and what new roles and new teams will emerge over the next 5 to 25 years. Insights into new skills needed for existing roles were also provided by the experts. Based on these key insights the report sets out main impacts on key stakeholders, such as clients, construction companies, industry professionals, academia, and professional, statutory, and regulatory bodies. This study informs how academia and professional organizations can work with the industry to help reskill the existing workforce via credentialing and prepare the next generation of graduates.

FIGURE 1 OVERALL FRAMEWORK OF THE STUDY



2 Why IC? The Big Picture



Why is the industry looking to industrialized construction?

It is widely known that the industry faces an enormous skills gap given the \$10 trillion global construction output, with a need to build 13,000 buildings each day between now and 2050 to support an expected population of 7.7 billion people living in cities.¹ The McKinsey Global Institute estimates that, by 2030, there will be up to **200 million construction jobs worldwide**.² The US Bureau of Labor and Statistics projects construction sector job growth at 12%.

Combine this accelerated growth with the estimate that 41% of the construction industry's workforce will retire by 2031, and you have a massive skills shortage that will drive up costs and reduce efficiency and profitability.

The construction sector is currently at a tipping point. Rapid urbanization and climate change require that the industry relinquish its “business as usual (BAU)” mindset and risk-averse operating environment. Productivity has grown at an average rate of only 1% annually over the past 20 years, compared with 2.8% average annual growth in the overall economy and 3.6 % average yearly growth in the manufacturing sector. Given that the construction sector is 13% of global economic output³, if construction productivity matched that of the overall economy, the improvement would be **\$1.6 trillion each year**.⁴ Furthermore, if construction productivity paralleled that of the manufacturing sector, there could be an estimated **\$2.2 trillion savings every year**.

Faced with these findings, construction sector stakeholders are exploring IC to help offset this massive skills shortage. IC is a system that uses innovative and integrated techniques that connect the design-to-make process.

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JOBS WORLDWIDE**

¹ Autodesk (August 2018). Here's What Building the Future Looks Like for a 10-Billion-Person Planet, <https://www.autodesk.com/redshift/building-the-future/>

² McKinsey Global Institute (November 2017). Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages, <https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages>

³ The Economist (August 2017). Can we fix it? The construction industry's productivity problem, <https://www.economist.com/leaders/2017/08/17/the-construction-industrys-productivity-problem>

⁴ McKinsey Global Institute (February 2017). Reinventing construction through a productivity revolution, <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/reinventing-construction-through-a-productivity-revolution>

But there is a significant challenge on the supply side of talent: both secondary and higher education institutions are not equipped to close this skills gap in terms of technology training and volume.

In a study conducted in the UK two-thirds of the 130-responding architecture, engineering and construction (AEC) firms reported hiring an “AEC outsider” in the past 24 months to help with their innovation efforts.⁵ Roles that are being filled by outsiders include software programmers, data analysts, and virtual reality experts.

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If IC is to be the way forward, this industry must transform itself to meet the housing and infrastructure requirements placed on it. IC is a big idea that will require integration of all phases of the project lifecycle (vertical integration), all members of the project team (horizontal integration), and inter-project learning and knowledge management (longitudinal integration). Modular or offsite construction, a key component of IC, can play a significant role. The adoption of modular construction in the US and Europe is growing, and it is estimated that this adoption alone can lead to savings of \$22 billion a year.⁶

In order to push this transformation forward, many changes will need to be made by key industry stakeholders. One essential need is to address the future of work, the worker, and the workplace in the construction sector. With close to 7% of the world’s working population employed directly or indirectly by the construction sector, the IC transformation must be looked through the lens of talent. Motivated by this aspect of the construction industry transformation, this study provides high-level findings by projecting new teams and roles the sector is likely to need and by suggesting how industry and academia can work together to pave the way forward.

⁵ BD+C Giants 300 Technology and Innovation Study 2019, <https://www.bdcnetwork.com/exclusive-research-download-final-report-bdcs-giants-300-technology-and-innovation-study>

⁶ McKinsey & Company (June 2019). Modular construction: From projects to products, <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products>

3 Key Findings and Insights

The industry experts interviewed reported a positive outlook toward the adoption and implementation of IC. Three key themes emerged, listed below and explained in detail in the following sub-sections:

1. Top benefits of IC
2. Future IC teams, roles, and skills
3. Role of industry and academia in developing new initiatives

In addition to the main themes, the following additional high-level insights emerged:

1. While IC deals with how built environment assets are designed, constructed, operated, and deconstructed, its use has broader implications for the construction industry and society. If done right, **IC can lead to better social, environmental, and economic outcomes**. For example, IC can have a significant positive impact on the housing problem that we face today on a global scale, as well as make the construction industry more attractive as a potential career path for students.
2. IC is primarily driven by the five megatrends listed in this report. However, it is essential to acknowledge the linkages of IC with other trends and technologies such as **circular economy, social impact, blockchain, edge computing, lean and agile principles**, and more.
3. To promote IC and bring it mainstream, it is essential for the industry to **adopt a product-centric approach**.



4. Experts also highlighted the **role of international standards** developed by a non-commercial entity to promote industry-wide adoption of IC.
5. Market forces must align with the trends behind the IC approach so that the demand for IC is large enough to **drive economies of scale**.

We found that there are several ongoing public sector-led efforts to promote IC in the UK, such as the UK Housing, Communities and Local Government Select Committee report on modern methods of construction⁷ and the Platform approach to Design for Manufacture and Assembly (P-DfMA) by the UK Infrastructure and Projects Authority.⁸

One of the experts interviewed, who represents an industry organization with over 100 members, reported that over 30% of major UK construction companies are “**active and invested, in some cases quite heavily**” in IC. In a recent report by McKinsey⁹, it is estimated that the annual volume of IC could reach more than \$130 billion by 2030 in the building sector alone in Europe and the US.

Construction organizations have a wealth of knowledge of construction processes and best practices. It is important that this knowledge be retained in transitioning to IC; construction employees should be reskilled in specific technologies to ensure customized products and clients.

⁷Modern methods of construction, UK Housing, Communities and Local Government Select Committee report, <https://publications.parliament.uk/pa/cm201719/cmselect/cmcomloc/1831/183102.htm>

⁸Platform approach to Design for Manufacture and Assembly (P-DfMA), UK Infrastructure and Projects Authority <https://www.cdbb.cam.ac.uk/news/2019ResPlatform>

⁹McKinsey & Company (June 2019). Modular construction: From projects to products,

<https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products>

3.1 Top Benefits of IC

The industry experts interviewed ranked the following as the top 6 benefits of IC to their organizations and industry as a whole (as shown in Figure 2):

1. Make construction processes **Safer**
2. Improve **Efficiency**
3. Reduce **Project Duration**
4. Reduce Construction **Cost and Rework**
5. Increase **Profitability**
6. Improve **Staff Recruitment and Retention**

All the interviewed experts are supporters of pushing the idea of IC forward. In their opinion IC is a chance to bring a positive shift and competitive edge for the companies that adopt it. Reducing construction costs and rework and making construction processes safer were the mostly commonly cited reasons among experts across both the US and the UK. Improving recruitment and retention, particularly by improving the ability to show younger staff how projects fit together, was also a commonly cited benefit and tied for most-cited among American experts.

Industry experts provided the following justification and support for their views:

“Definitely Safety; I think is first and foremost, creating a safe environment for the team that we have working on the volumes that are going through our facility here. And then also positively affecting the duration of construction and the overall cost of construction, really wielding these IC tools so that we can affect each of those 3 focus areas with effectiveness.”

Tim Nichols, Director of Strategic Partnerships at Factory OS

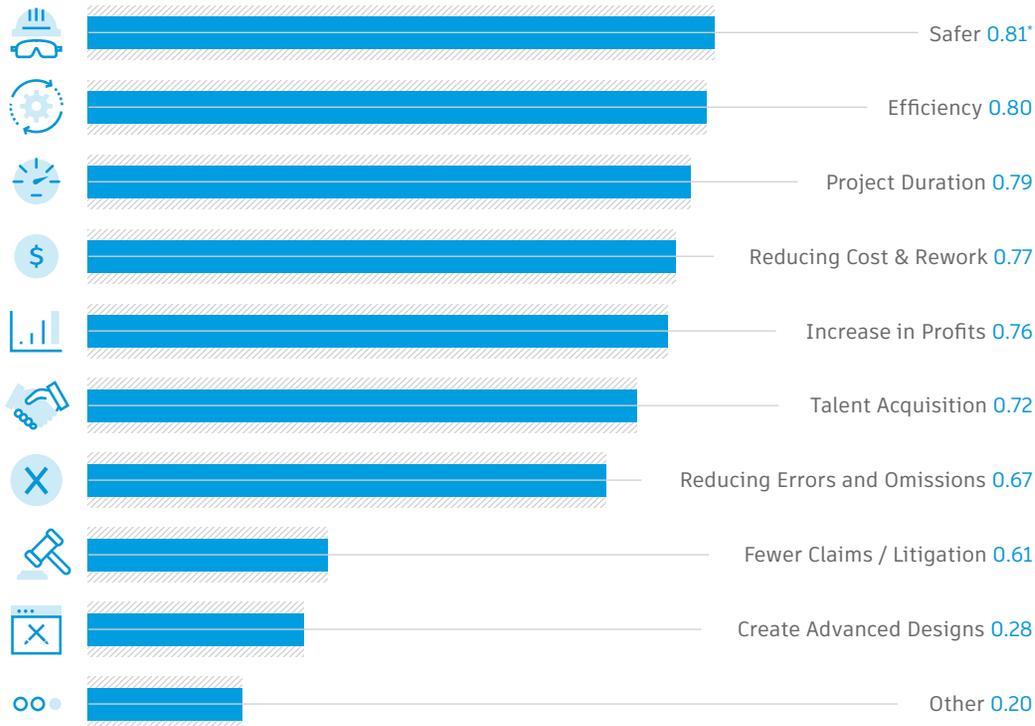
“The top 5 out of that, for us, would be: safer, creating good middle class jobs while increasing profits, recruitment of staff, lowering the cost of construction, project and time efficiency.

Jay Bradshaw, Executive Director at Carpenters 46 Northern California

“The number one benefit is safety followed by cost-savings or time-savings. That’s because of coordination and assembly in a controlled environment where you have a supply-chain process in place.

Kaushal Diwan, National Director of Innovation, DPR

FIGURE 2 TOP IC BENEFITS



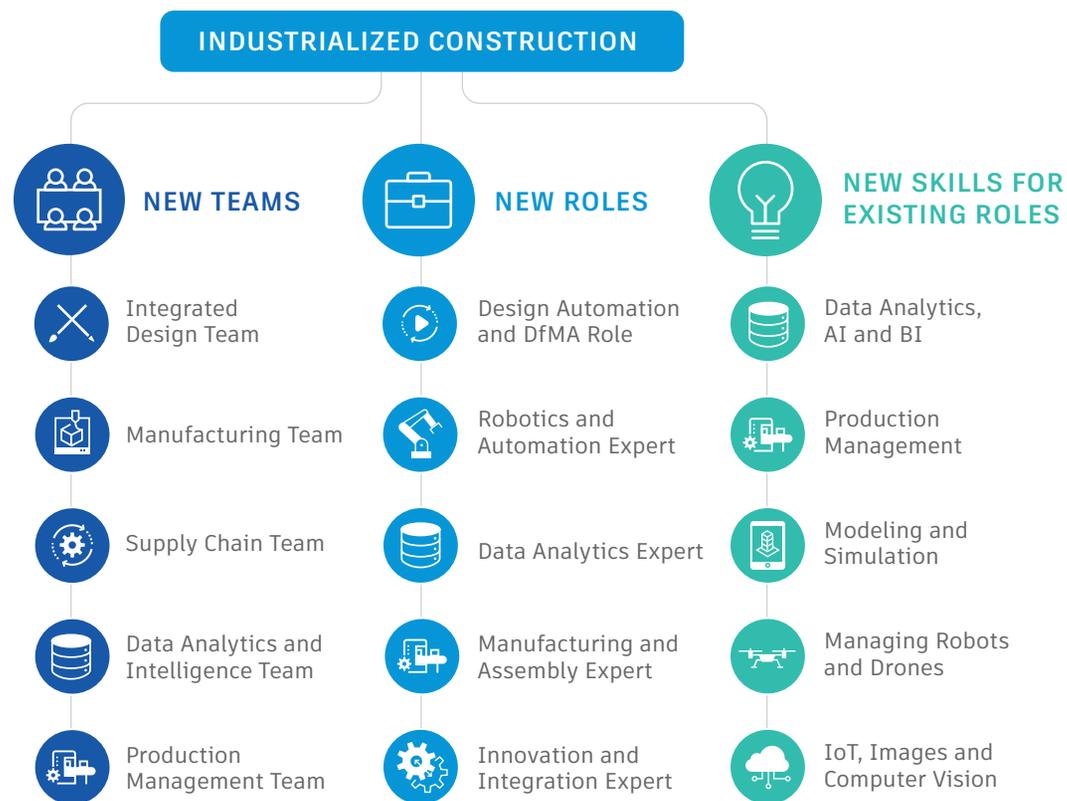
* Relative Importance Index (RII) scale 0.0 to 1.0

3.2 Future IC Teams, Roles and Skills

Based on the expert interviews and review of current reports, we found that the construction sector is ripe for disruption. Driven by technology and a need to enhance efficiency, construction companies are creating new teams and functional roles. Existing roles are being revised to incorporate the usage of the five megatrends of IC (see Figure 3). We project productivity gains will result from these structural changes in the industry. Using the framework provided by McKinsey in a report titled “A Future That Works: Automation, Employment, and Productivity,”¹⁰ we estimated the automation potential of the construction sector (as shown in Figure 4). First, the tasks performed by various team members in the construction phase were grouped into the following categories:

1. **Manage:** overall management of the design and construction process, including managing human resources
2. **Expertise:** applying expertise to decision making, planning, and creative tasks
3. **Interface:** integration of various functions and interfacing with stakeholders
4. **Unpredictable physical:** performing physical activities and operating machinery in unpredictable environments
5. **Collect data:** collecting data from multiple design and construction processes
6. **Process data:** processing data for deriving evidence for decision making
7. **Predictable physical:** performing physical activities and operating machinery in predictable environments

FIGURE 3 IC TEAMS, ROLES, SKILLS AND PRODUCTIVITY GAINS

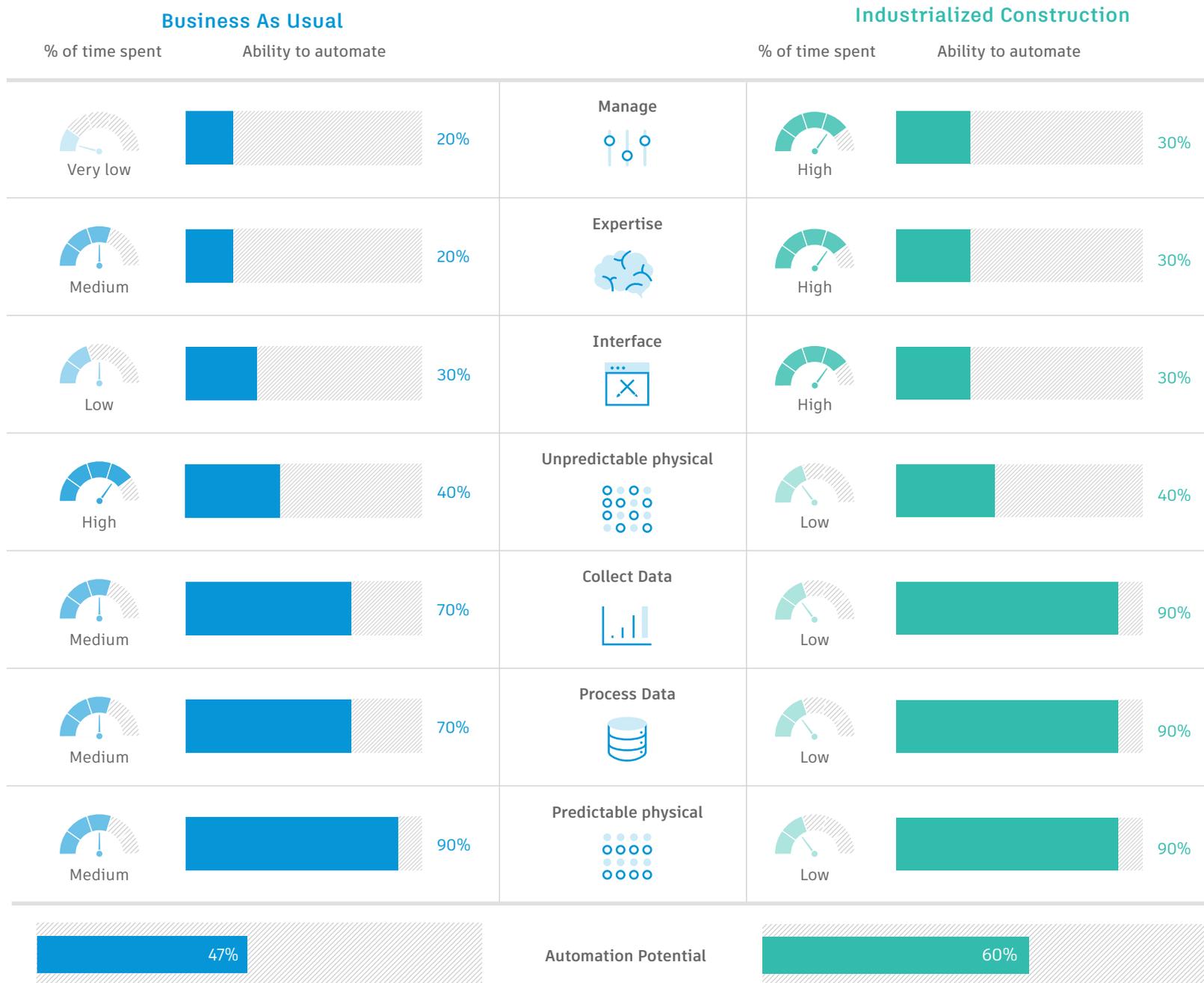


Then, we take two scenarios (BAU and IC) and compare the percentage of time spent and the ability to automate for each of these seven activity types, resulting in the automation potential for each scenario. McKinsey has estimated the current automation potential for our sector as 47%. We expect that with the adoption of IC the automation potential

of the industry can reach 60%, which is the current estimated automation potential for the manufacturing sector. We project that with the adoption of IC, the percentage of time spent on value-adding tasks such as managing, providing expertise, and integration can be significantly increased.

¹⁰ McKinsey Global Institute (January 2017). A Future That Works: Automation, Employment, and Productivity, https://www.mckinsey.com/-/media/McKinsey/Featured%20Insights/Digital%20Disruption/Harnessing%20automation%20for%20a%20future%20that%20works/MGI-A-future-that-works_Full-report.ashx

FIGURE 4 AUTOMATION POTENTIAL OF IC



Source: McKinsey Global Institute (January 2017)

3.2.1 NEW TEAMS

A significant diversity of new teams within IC companies was reported. For example, the experts talked about digital/computational design; engineering; offsite manufacturing; logistics (supply chain); data science/data analytics; robotics; artificial intelligence; machine learning; virtual reality; applied research; systemization (industrial/product design); and physical prototyping. The core motivation to create these new teams is to make construction more efficient and deliver a positive shift within the industry.

With the establishment of these new IC-related teams, the building process can be organized using a quicker and cost effective process with higher-quality results. The experts highlight the fact that the creation of these teams makes construction a more attractive industry for the

next generation, as well as leads to improved workplace safety by increasing time spent working in controlled environments. These new teams are driven both by client need and as a reaction to rapid development in the technology sector. With this broad background, we found that the experts expect the industry to form the five following new teams (or departments) as the penetration of IC increases in the sector:

1. **Integrated Design Team:** This model-centric team or department drives the design-to-make philosophy within the organization. This team is responsible for developing the conceptual design, including the details for utilizing technology and practices such as AR/VR, connected BIM, DfMA and prefabrication.

2. **Manufacturing Team:** The manufacturing team or department primarily resides in the offsite or onsite factory where design drives the production of components and modules for the construction site. This team heavily relies on prefabrication, additive manufacturing, and advanced materials.
3. **Supply Chain Team:** This team is responsible for procurement, as well as coordinating the logistics of getting modular units from the factory to the site. In the current scenario this team connects manufacturing to construction assembly.
4. **Data Analytics and Intelligence Team:** This team is integral to connecting the other four teams, providing data streams and communication to streamline the design to construction process. It utilizes more technology and controllable systems, and ultimately provides a safer environment for all to deliver a higher-quality product.
5. **Production Management Team:** Stationed on the construction site, the production management team's role is to ensure that all components and modules are assembled correctly and on-time. They are responsible in the integrated deployment of technologies such as drones, image capture and processing, robotics and automation, IoT, etc.

FIGURE 5 NEW IC TEAMS AND THEIR EVOLUTION OVER TIME

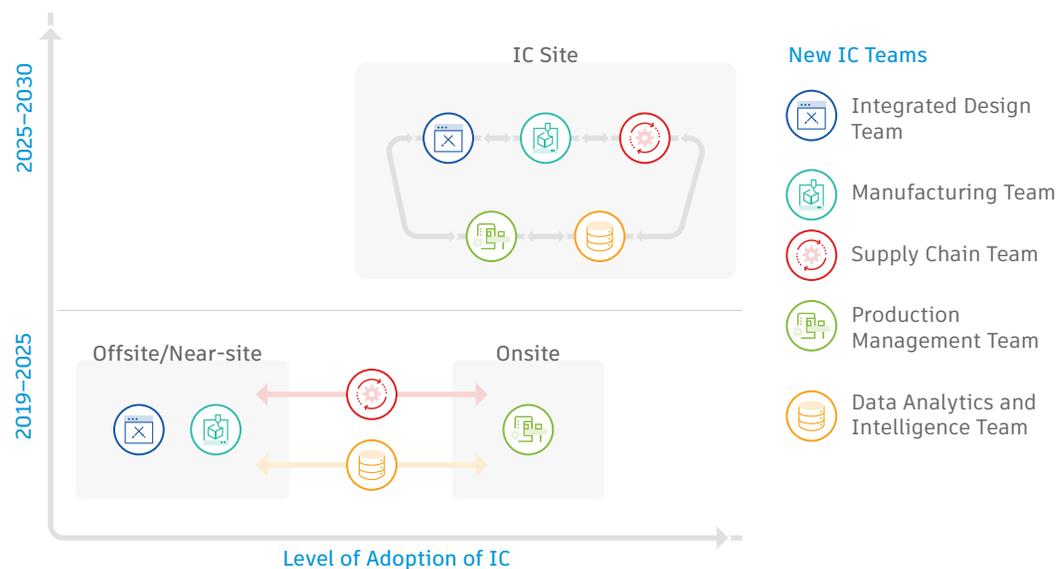


Figure 5 shows the new IC teams and their evolution over time. As the adoption of IC increases, these teams will work more closely as the boundaries between offsite and onsite become blurred.

The experts predicted a progression over time in the usage of these megatrends within IC companies. Figure 6 shows the use of the five IC megatrends by the newly created IC teams. Figure 7 shows the changes within robotics and automation that can be expected over the next 5-to-10 years. Currently, robotics is used primarily in the offsite portion of IC, but this usage is likely to change over the next five years as the use of robotics onsite increases. In ten years, the experts felt that the use of robotics and automation would increase significantly, especially since the boundaries between offsite and onsite teams will be removed.

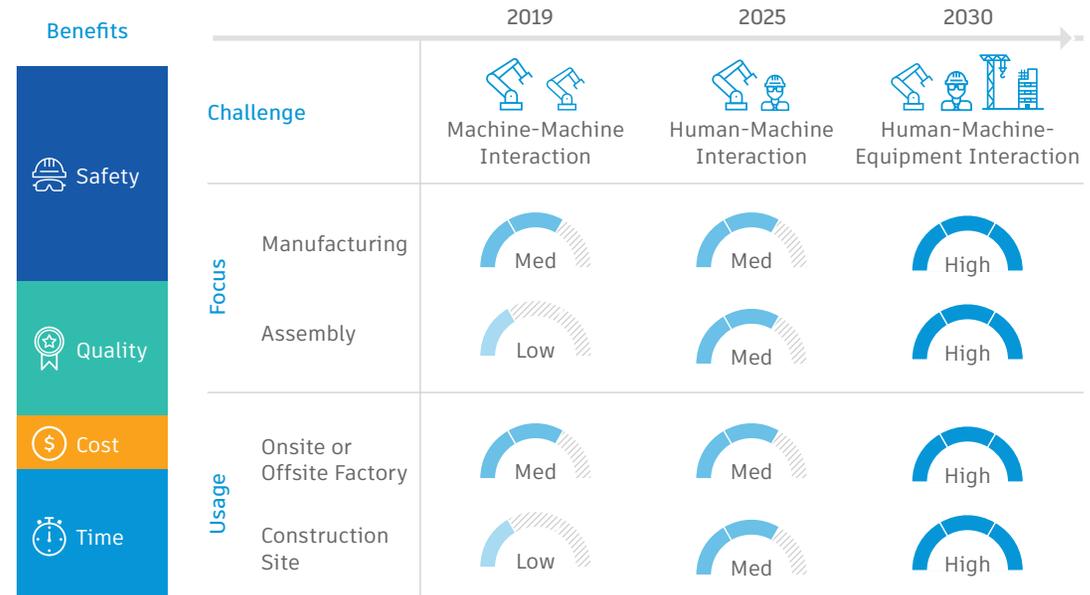
“ *Industrialized construction requires a fully integrated team. You need a design team that is accountable to manufacturing and designs for production. You need specialized manufacturing teams to optimize agile factory production that serve dynamic construction projects. Supply chain and logistics teams have to be equipped to ensure just in time delivery and maintain dynamic inventories. All of those teams have to execute with a common shared goal of fully industrialized construction, if one pillar fails they all fail.*

Raghi Iyengar, Founder Manufacton

FIGURE 6 USE OF IC MEGATRENDS BY IC TEAMS

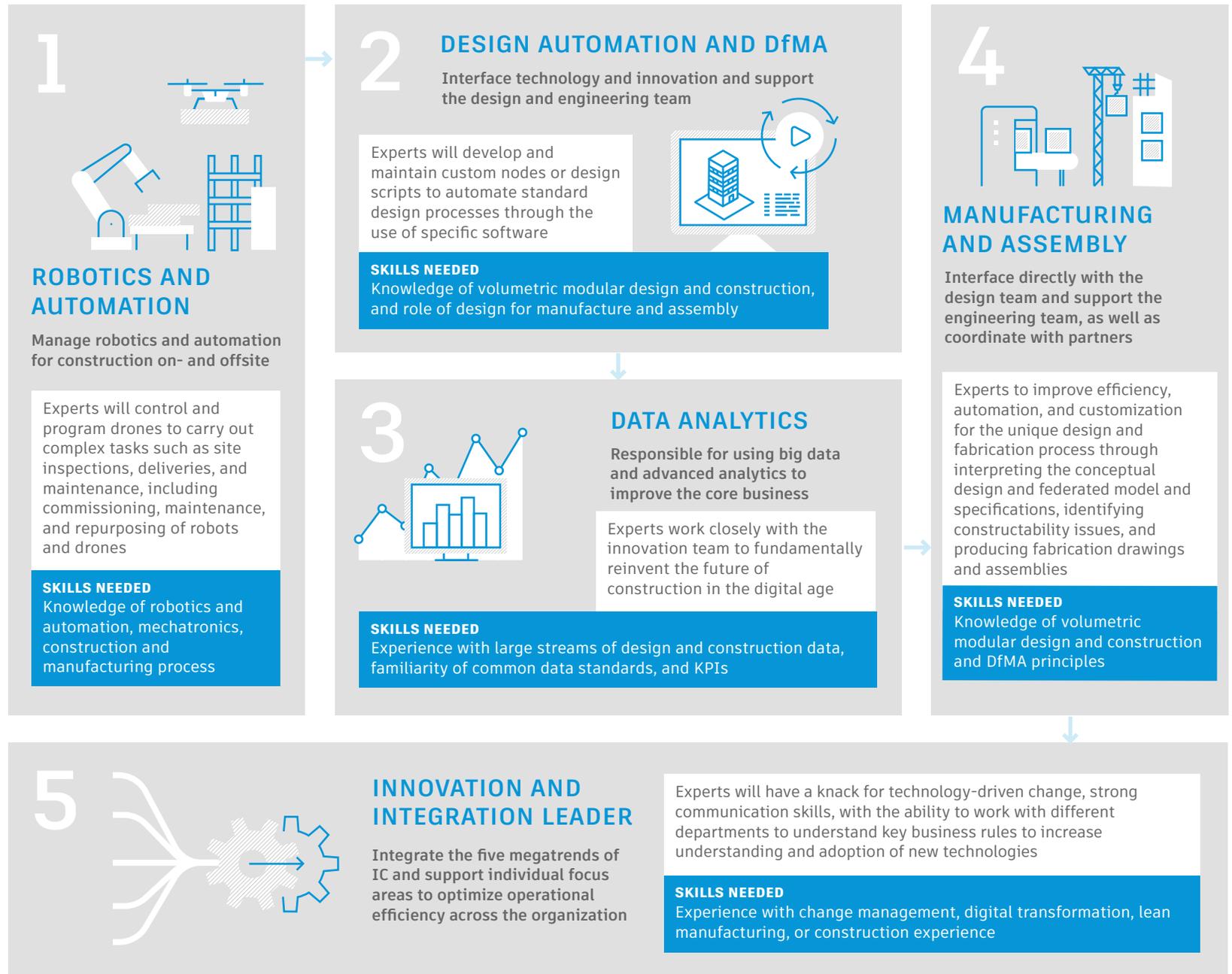


FIGURE 7 GROWTH IN THE APPLICATION OF ROBOTICS IN IC COMPANIES



3.2.2 NEW ROLES

The creation of new IC teams also results in new IC-related roles. The most often appointed new emerging roles in these teams include:



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Regarding new IC-related roles in the next three to five years, the experts pointed to different possibilities, such as:

- Implementation consultants/BIM specialists
- Creators of new design configuration apps
- Design Automation specialists
- Materials Science specialists
- Site and additive manufacturing specialists
- Robotics / AI / VR specialists

According to the experts, these new roles will optimize existing businesses and adapt them to the changing technology environment, giving construction companies a competitive edge. The implementation of new technologies like artificial intelligence or robotics demands new skill sets and will lead to the opening of more technology-based roles within the construction industry. These new IC roles are also more attractive to the next generation and will lead to increased gender diversity within the construction industry.

There will be a mix between these new roles and existing roles, and/or retraining of existing construction professionals with invaluable construction expertise. It was noted that these new roles would not replace existing professionals, but rather the current roles will be retrained simultaneously.



3.2.3 NEW SKILLS FOR EXISTING ROLES

Figure 8 shows in-demand skills for existing roles. Currently, experts are searching for staff with skill sets in data analytics, artificial and business intelligence, advanced planning, and scheduling skills for modular construction.

“These are the top technologies impacting the industry; data science, AI, machine learning and robotics. With a steady streamline of data flows it provides powerful predictive analytics that helps construction firms thrive across all phases of construction.”

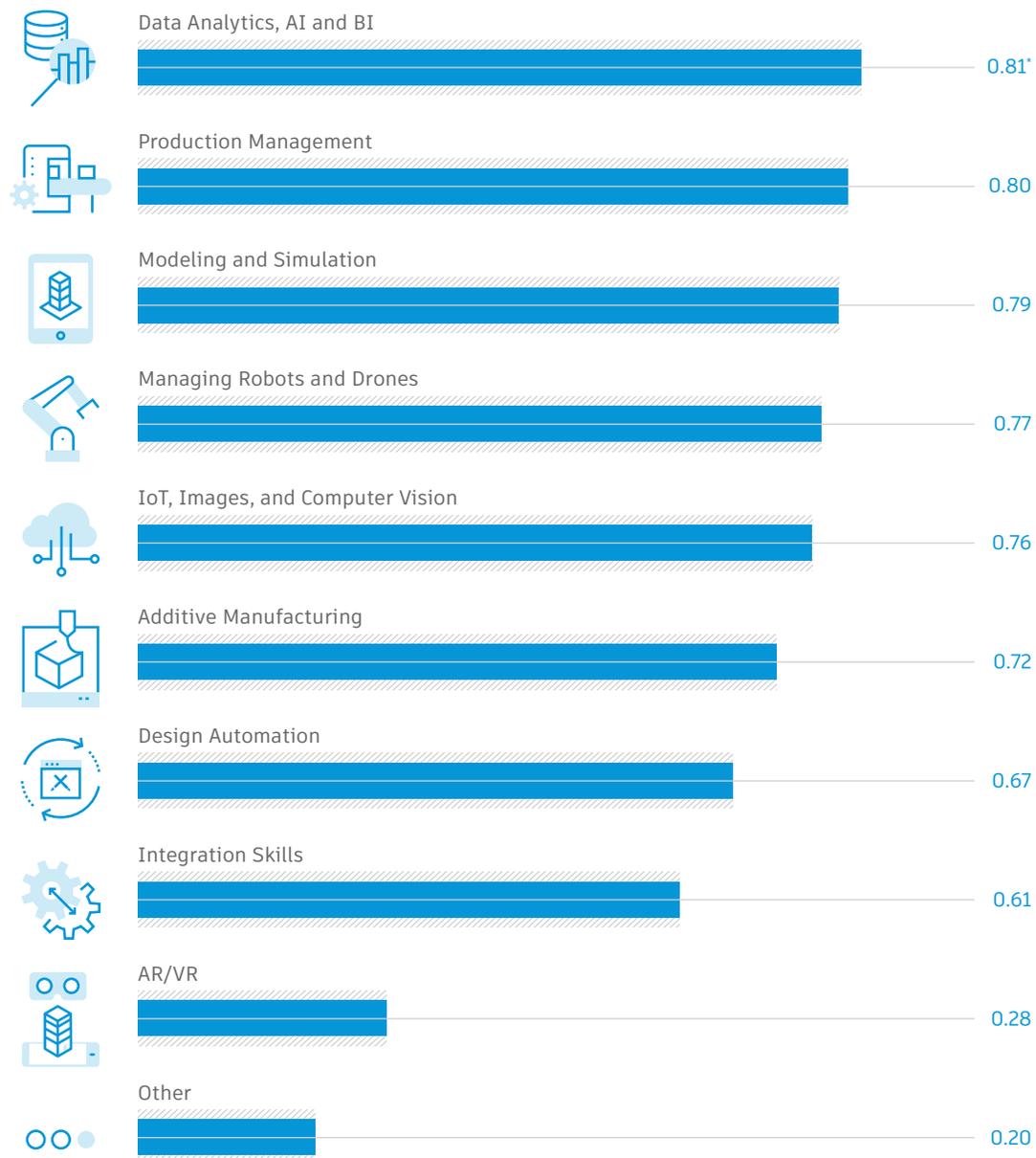
Maximilian Schutz, Head of BIM at GOLDBECK

Key skills for future roles include:

- Systems thinker
- Programming mindset
- Active learner
- Strong Science, Technology, Engineering and Mathematics (STEM) background
- Data-driven decision-making
- Complex problem-solving with excellent communication skills

The experts assume that the increasing technological expansion will lead to stronger adoption of new technologies, which include design automation, IoT, robotics, and additive manufacturing. Some share the opinion that the usage of IoT and machine learning could bring the construction process to a new level of self-optimization, leading to a knock-on effect that would bring other innovations into the construction industry. Others point to the fact that at present different materials are being increasingly explored, which opens a significant number of possibilities to use advanced materials in order to move the sector toward manufacturing type processes.

FIGURE 8 RANKING OF NEW SKILLS FOR EXISTING ROLES



* Relative Importance Index (RII) scale 0.0 to 1.0

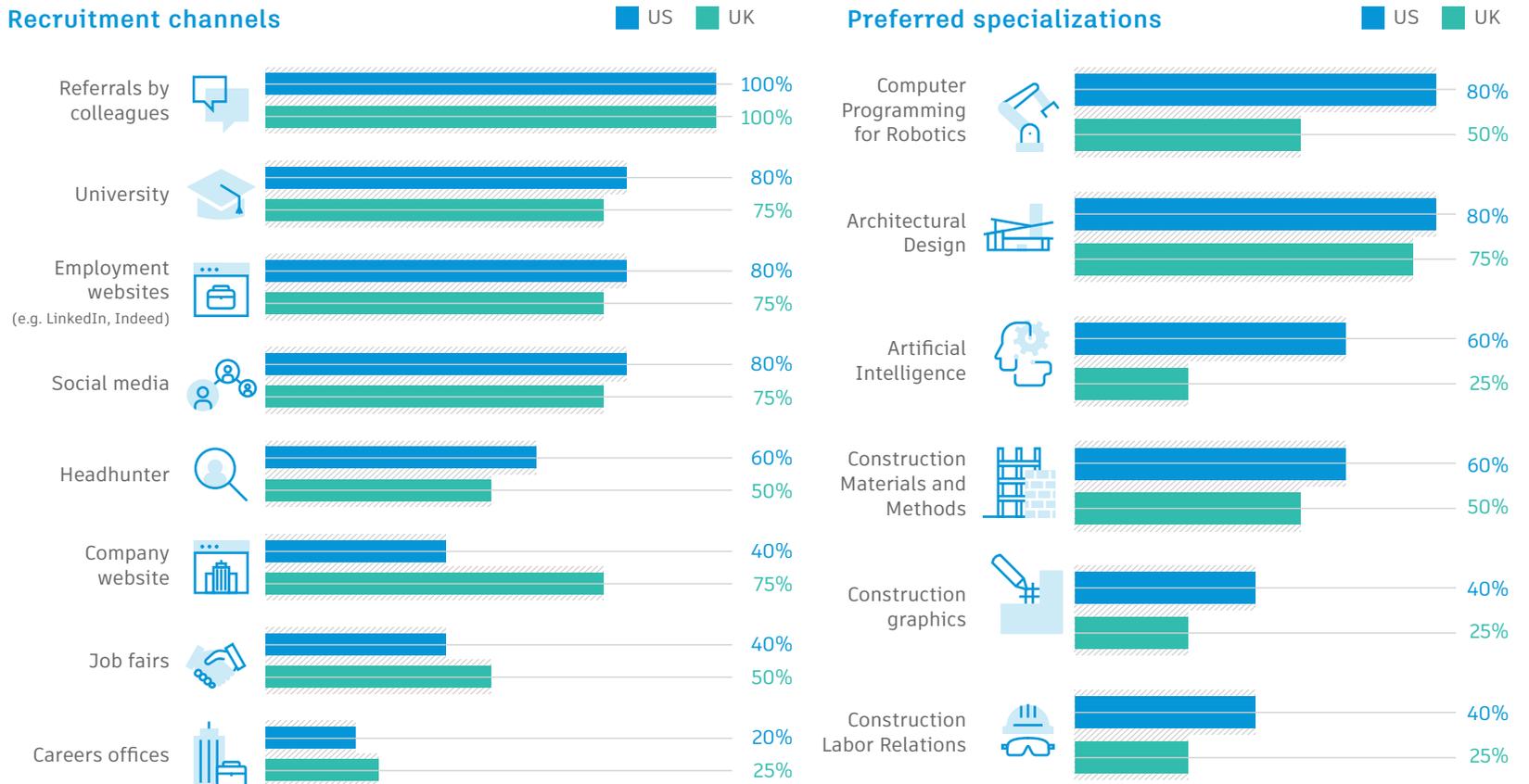
3.3 Role of Industry and Academia

Our study found that the most used recruitment channels for IC-related roles are referrals by colleagues, universities, employment websites, and social media. In the UK, the company website is a more important recruitment channel than in the US. The most preferred degrees and specializations included Computer Programming for Robotics, Architectural Design, and Artificial Intelligence.

The biggest challenge for recruitment into the new roles is the lack of candidates' practical experience in the construction sector. The experts point out that there is still a lack of exposure to new IC trends such as prefabrication. Here the experts pointed out the need for meaningful collaboration between industry and academia.

The competition with technology companies for the same tech-savvy talent pool is also challenging, due to comparatively larger salaries in the technology sector and poor perceptions of the construction industry as lagging in terms of processes and technology.

FIGURE 9 RECRUITMENT OF IC-RELATED ROLES & PREFERRED SPECIALIZATIONS



The top recommendations include offering new specializations in Prefabrication, Robotics, AR/VR, and Data Analytics and Machine Learning, which could be available at both the undergraduate or graduate level. In addition, multi-disciplinary specializations should be an important part of the future of academia, as these emerging IC roles require exposure to both main topics in construction alongside specialist topics such as artificial intelligence, virtual reality, data analytics, along with materials science.

From the interviews, it became clear that universities in the US and UK are preparing students to enter a changing construction

world by relying on current and traditional construction approaches. Many institutions are attempting to expose students to the basics of IC through a wide variety of mechanisms, but no consistent and holistic approach exists. On their part, the industry has not been able to articulate and orchestrate formal IC career pathways. This current lack of career pathways makes recruitment more difficult. Experts pointed to the need for new qualifications and specializations, while some said in addition to specialties, IC needs to be integrated into undergraduate construction programs as soon as possible. There is a need for industry and academia to work with accreditation agencies to modernize the curriculum and associated competencies.

“Construction Management programs are behind. Industrialized Construction is here now: workforce shortage, increasing age of construction professionals, the increasing cost of construction and the market need for construction is pressurizing an already strained market. CM programs are training the workforce for what the industry needs for the next 20 years and not just the next 2 years. The industry needs skilled leaders in offsite and onsite construction with design, manufacturing and construction (DMC) as the core curriculum.”

Raghi Iyengar, Founder & CEO of Manufacton

“The key issue is a lack of a formal career path in IC. Construction is set up to recruit and train and get people qualified into very rigid roles. We need a new qualification structure, new professional qualifications, technical qualifications, that actually reflect the IC roles that we have been talking about.”

Mark Farmer, UK Government Champion for Modern Methods of Construction in Homebuilding, CEO at Cast Consultancy

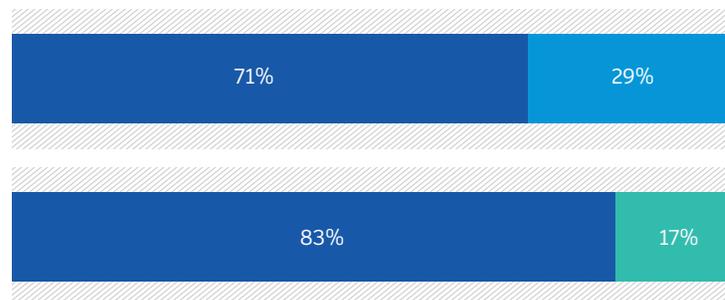
“Construction has a poor reputation, so if tech-enabled people have the chance to work in a tech business or in construction, it's most likely they'll choose tech. Incentivising these people to come into our sector is a huge challenge that we have to address.”

Jamie Johnston, Director & Head of Global Systems at Bryden Wood

FIGURE 10 SPECIALIZATIONS IN PREFABRICATION, ROBOTICS, AR/VR, MACHINE LEARNING AND DATA ANALYTICS

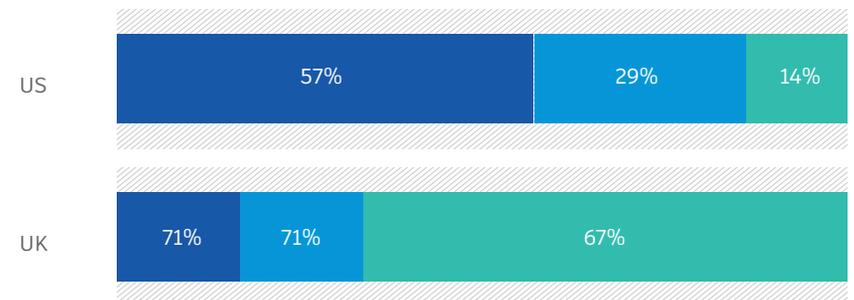
Availability at graduate and undergraduate level

■ Available at both levels ■ Available at the graduate level
■ Available at the undergraduate level



Electives or mandatory specializations

■ Should be electives ■ Should be mandatory
■ Should be mandatory, some electives



4 Final Recommendations

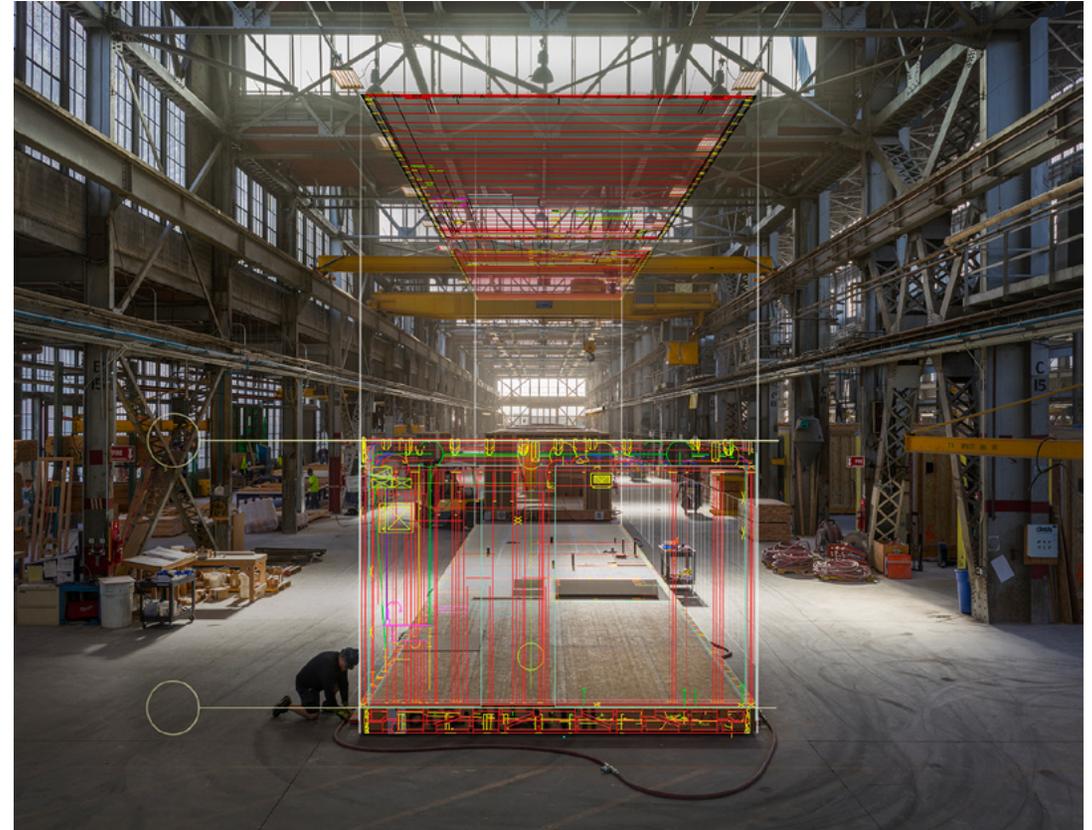
This report is a call to action for industry, government and academia to join forces to ensure the adoption of industrialized construction for transformational change in our industry. Each stakeholder: academia, the private sector, and the government has a part to play in this shift of thinking, behaviors, and process in order to facilitate change.

Academia – The future of the industry is highly dependent on the competence of graduates entering the workforce. In the face of troubling skilled labor shortages, new employees must enter the industry with the abilities and exposure to technologies to drive digital construction and the IC processes and higher levels of precision in construction.

Deans and members of the faculty in AEC related programs should evaluate their curriculum to expose students to the five megatrends in IC and future construction technologies that will enable knowledge of interdisciplinary skills required to fully embrace the digital age.

The **Private Sector** – The ecosystem of owners, architects, engineers, and contractors must work together to modify their operations, processes, regulations, and business model appropriately to thrive and remain competitive in the technology-driven world. By enabling the five megatrends in IC, the industry will increase overall productivity and be agile enough to adapt to the challenges and changing environments of our world.

The **Government** – In order to transform the industry, the government must incentivize, shape regulation, promote standards



and establish productive collaboration environments to enable IC. This can include funded research centers, requirements for digitization and prefabrication, and potential changes in procurement methodologies.

Together these stakeholders must make investments not just in technology but also in teams, their skills, and a digital-ready workforce. For industry professionals staying relevant will mean investing in themselves by staying engaged and current with IC developments. Every entity in the ecosystem has a role to play. For example, client

organizations can instill trust in the project teams by enabling the innovation environment ripe for IC adoption from the inception stage itself. It is equally important to bring along partners in the supply chain on the journey to embrace IC so that the whole-of-industry will be in a stronger position to compete in changing conditions.

If all these stakeholders work together in a collaborative ecosystem, the adoption of IC will ensure a more productive environment and produce a skilled labor force that will sustain the future of the construction industry.

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Limitations of the study

This study is based on published reports and semi-structured interviews of select experts listed above from the US and UK. This study is for informational and educational purposes only. Autodesk, RICS and the authors disclaim all responsibility or liability for any loss or damage resulting to any person or entity acting or refraining to take action based on any material included in this publication.

Further Reading

Autodesk IC in Academic paper

<https://damassets.autodesk.net/content/dam/autodesk/www/pdfs/autodesk-industrialized-construction-report.pdf>

RICS The Futures Report 2020

<https://www.rics.org/globalassets/rics-website/media/news/news--opinion/rics-future-report-2.pdf>

Innovation 2050 - A Digital Future for the Infrastructure Industry

<https://www.balfourbeatty.com/how-we-work/public-policy/innovation-2050-a-digital-future-for-the-infrastructure-industry/>

Shaping the Future of Construction: Future Scenarios and Implications for the Industry

http://www3.weforum.org/docs/Future_Scenarios_Implications_Industry_report_2018.pdf

The Potential Economic Consequences of a Highly Automated Construction Industry: What If Construction Becomes the Next Manufacturing?

<https://midwestpi.files.wordpress.com/2018/01/the-economic-consequences-of-a-highly-automated-construction-industry-final.pdf>

McKinsey & Company (June 2019). Modular construction: From projects to products

<https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/modular-construction-from-projects-to-products>

McKinsey Global Institute (November 2017). Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages

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