

Voices on Infrastructure

Workforce of the future

December 2019





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Introduction



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Welcome to the December issue of *Voices*, a collection of insights on the **workforce of the future**. Spending shortfalls—projected to total some [\\$5.5 trillion worldwide](#) when compared with the level needed to maintain current GDP growth—are already straining global infrastructure. But another threat looms as well. Infrastructure faces a labor shortage due to retirement, a working-age population with different workforce preferences, and increasing degrees of automation that leave workers worried about the sustainability of their jobs.

Modern infrastructure and capital projects demand new skill sets in every phase, by every actor involved. To develop the [workforce of the future](#), leaders must sharpen their focus on culture, organizational structures, and the incentives required to attract and retain top-tier talent. Ushering in the workforce of the future will require the integration of new talent and the retraining of existing talent, with fresh perspectives from a diverse workforce becoming much more critical for success. Both public- and private-sector leaders will need to create detailed plans focused on managing talent—enhancing capacities and skills while also advancing cultures of safety, innovation, and inclusion.

This issue emphasizes the essential qualities of the future workforce, as well as the leadership required to steer this transformation. We hope you find these outlooks insightful and welcome your thoughts on the topic. 

News from the Global Infrastructure Initiative



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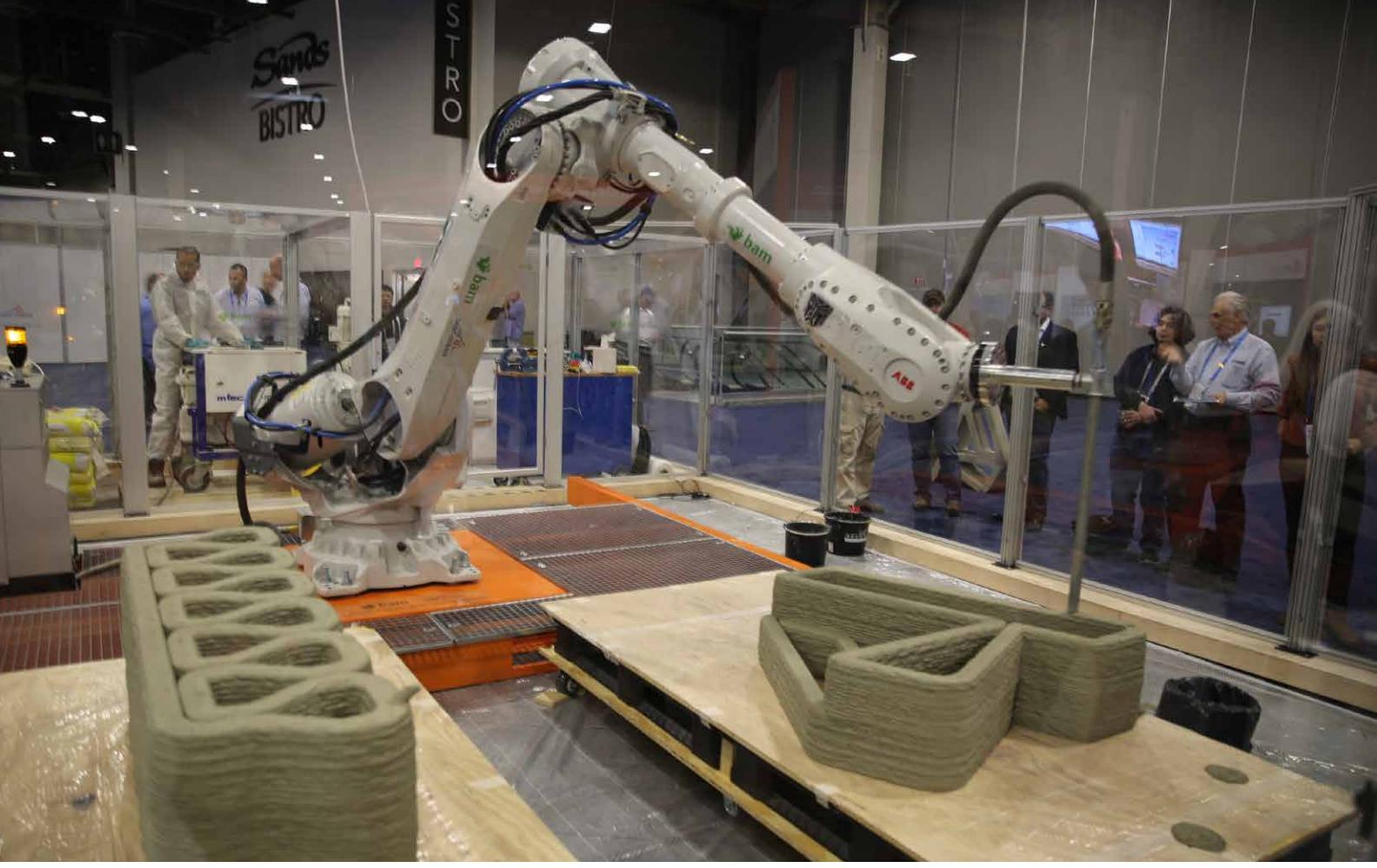
We are excited to publish the December 2019 edition of *Voices*, exploring the workforce of the future. Industry-wide shifts in digitization, industrialization, consolidation, and rising technology investment are changing the industry and will require a different mix of skills across the value chain. In this edition, we discuss what new skills and capabilities will be essential in a modern-day workforce tasked with shaping and delivering the projects of the future.

During the fourth quarter of 2019, we hosted five roundtables on a variety of topics. Our [San Francisco roundtable](#) convened over 80 leaders in the energy, infrastructure, and mobility sectors to discuss **managing the significant disruptions** resulting from environment, technology, and workforce changes. The [Johannesburg](#) and [Houston](#) roundtables focused on the **potential of collaborative contracting** to improve performance and predictability in major projects. **Future-proofing infrastructure** was the topic for our [Paris roundtable](#), while [Milan](#) focused on **unleashing the potential for advanced analytics** in infrastructure. Visit our [roundtable](#) and [innovation site visits](#) pages for details on past and future events.

Momentum continues to build for our [sixth GII Summit](#), taking place in Montréal on June 10–12, 2020. The theme will be the project of the future, and our program pillars will tackle fundamental industry challenges, including digital and analytics transformation, collaborative project delivery, leadership and workforce development, and future-proofing infrastructure. We are already more than 75-percent subscribed with global leaders and expect to reach capacity early in 2020. For more details, please visit our [Summit page](#).

Looking ahead, our April 2020 edition of *Voices* will focus on the **project of the future**, coinciding with the GII Summit theme. We hope you enjoy this edition of *Voices*, and we welcome your thoughts on any of our GII programs. If you have comments or would like to subscribe a colleague to *Voices*, please contact us at

info@giiconnect.com.



Courtesy of Autodesk: Royal BAM Group's BAM Infra and Saint-Gobain Weber Beamix demonstrate the use of a 3-D printing robot for offsite manufacturing for construction.

The impact and opportunities of automation in construction

The current labor shortage is just one reason why automation, if approached in the right way, could have a positive effect on the construction industry.



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While the word “automation” may conjure images of robots taking over jobs, the reality is much more nuanced. In construction, for instance, automation is less likely to diminish employment opportunities than it is to increase productivity. Indeed, automation—alongside the global need for new and updated infrastructure and better and more affordable housing—can help shape the direction of the industry. The key will be anticipating and preparing for the shift, in part by developing new skills in the current and future workforce.

Big picture: What does automation mean for construction?

In years past, productivity in construction increased slowly at best.¹ In the United States, for instance, from 1947 to 2010, productivity in construction barely changed at all. Meanwhile, productivity increased by more than a factor of eight in manufacturing and by more than a factor of 16 in agriculture²—both industries that have embraced automation. So, one major benefit of automation in construction is the potential for quite a large uptick in productivity.

There are three primary opportunities for automation in construction. The first is automation of what are considered traditional physical tasks on-site—for instance, robots laying bricks and machines paving roads. The second opportunity comes from the automation of modular construction—or rather production—in factories, including 3-D printing of components such as facades. And the third centers on digitization and the subsequent automation of design, planning, and management procedures, as well as the vast efficiencies those can create on-site. For example, building information modeling—which essentially brings together the designs of planners and general contractors to identify issues before they move to the site—makes the planning process more efficient. But more importantly, it makes the on-site execution more efficient, allowing project teams to eliminate mistakes and better coordinate the workforce.

What impact will automation have on work for builders?

A substantial shift to modular construction off-site could have a significant impact on the construction workforce, but the transition will take decades. Producing individual components, or modules, in factories lends itself to much more machine use than what can be done on-site. Some companies, such as Katerra, are already building such modules. A lot of the construction in these factories is still done manually, but over time, as scale increases, the process will become more automated. We estimate that about 15 to 20 percent of new building construction will be modular in the United States and Europe by 2030. So, while it’s an increasing share and a big market, it’s a slow process, and a lot of activities will remain on-site and relatively unpredictable for some time to come.

For those activities that do remain on-site, it’s unlikely that a company will fire a carpenter and bring in the latest robot to do everything the carpenter did. Rather, machines will take over individual activities within a role. What that means is workers will need to learn to work side by side—or in a hybrid role—with machines. For example, even the average construction worker will be expected to use a tablet to access building plans or operate a drone in place of doing a physical site walkthrough.

Will there be enough work in the future?

While there are substantial automation opportunities across industries, employment in construction will probably suffer less than in industries where activities are more repetitive, such as manufacturing. The easiest tasks to automate are repetitive, physical activities in predictable environments—but construction’s environment is usually unpredictable, except when modular-construction techniques are used. The unpredictability is twofold: not only do pieces move around but each construction site and project is tailored to specific customer demands, architectural designs, and geographical and site requirements.

We expect the overall number of jobs in construction to grow rather than shrink, with up to 200 million additional jobs by 2030 if countries fill global infrastructure gaps and boost affordable housing supply.³ Automating more of the construction process could also help deliver infrastructure and buildings faster—without needing to reduce headcount. Furthermore, there is a substantial need for infrastructure and housing in parts of Asia and Africa. This means there will be demand for construction work—and workers—for a long time to come.

Any slowdown in global growth, which would lower demand for infrastructure investment, might counter some of that upside. But, generally, there is—and we expect there to continue to be—enough work to do.

How will automation affect construction wages?

Despite everyone having enough work to do, we expect a larger spread in wages. In the long term, automation is likely to increase productivity and allow wages to rise for workers with advanced skills. At least during the transition time—which can take a decade or longer—those with advanced skills will command higher wages because they will be in higher demand, while those more exposed to predictable, repetitive tasks will be in less demand and may see a slowdown in their wage growth.

Overall, construction jobs tend to be in the middle-wage range, at least in the United States, and are not straightforward to automate. Therefore, the industry might contribute to filling in what otherwise looks likely to be a continued hollowing out of the middle class.

How can the industry manage the upcoming workforce skills transition?

As in all industries, automation will create an increasing skill mismatch in construction. Workers will still need a fair amount of physical skills: even if robots do the physical work of laying

bricks, workers will still need to drive and maneuver heavy equipment. But they will need to pair this work with more technological skills.

But where will they acquire those skills? Adjusting to automation in construction will require efforts from the public sector, the private sector, and industry associations to support workers in developing the skills to make the transition.

Historically, the public sector has had a predominant role in supplying baseline education and skills, and it will likely continue to do so. But curricula must shift to meet current and future needs, particularly for technological and socioemotional skills. There will also be a growing need to reskill and upskill workers who left formal schooling decades ago, requiring an evolution of the education system to provide lifelong learning opportunities.

The private sector, meanwhile, has a responsibility to address the more specialized skills needs of the workforce—and across sectors, a majority of executives recognize they have a strong role to play.⁴ But historically, construction has invested much less than other industries do in employees' skills. This is partially a result of the predominance of subcontractors and high shares of temporary labor. But as all firms face the same skills shift, it will become increasingly difficult to find qualified people on the market. Institutions must preempt the need and provide access to skill-development opportunities, investing in their current workforce so they are prepared for the job ahead.

Finally, collaborative efforts also abound. For instance, Germany's Technical University of Munich organizes a platform of industry players that trains participants in digital construction through boot camps, hackathons, immersion days, and peer exchanges. In the United Kingdom, Homes England, a nondepartmental government body, is working to launch a

research program on modular construction that will monitor and report on a couple dozen sites. The goal is to compare these projects with traditional build approaches, thus providing the industry with data on emerging technologies.⁴



The outlook for automation in construction is bright. That's not to say there won't be work to do across industries to prepare the workforce for shifting needs. But overall the industry will likely improve its productivity, see an increase in wages, and be better suited to meet the growing demand for infrastructure and real estate. ■

¹ Note that it is quite difficult to properly measure construction productivity, but nearly all industry executives we speak to believe that the development is nowhere near what it could or should be.

² For more information, see "Reinventing construction through a productivity revolution," McKinsey Global Institute, February 2017, on McKinsey.com.

³ For more information, see "Jobs lost, jobs gained: What the future of work will mean for jobs, skills, and wages," McKinsey Global Institute, November 2017, McKinsey.com.

⁴ For more, see "How organizations can address the future of work now," McKinsey Quarterly, December 2019, forthcoming on McKinsey.com.

⁵ Nick Walkley, "Working together to tackle the UK housing crisis," *Voices on Infrastructure*, November 2019, McKinsey.com.

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Image courtesy of Laurie Mahon

Forging the workforce that will transform the world

The next generation of workers see the world differently than their parents did. Laurie Mahon, vice chair of CIBC's global investment banking business, explains what this means for the infrastructure industry.



Laurie Mahon

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Futurists envision cities with driverless cars and speeding bullet trains zipping around gleaming zero-carbon buildings, all digitally connected and powered by clean, silent wind farms, and with their waste magically whisked away and reinvented into whimsical sculptures in the gorgeous green spaces they also fertilize and water. It's a world transformed from today's congestion and pollution into one of balance and harmony.

But by whom?

Two wonderful books by Greg Goldin and Sam Lubell, *Never Built New York* (2016) and *Never Built Los Angeles* (2013), describe dozens of never-built infrastructure and architectural projects that would have fundamentally changed the cities they were planned for. The books are full of fanciful drawings and exemplary visions, such as Frank Lloyd Wright's radical city plan for Ellis Island, William Zeckendorf's rooftop airport—which would have been built 200 feet above Manhattan—and a system of buses hoisted by helicopter to a downtown heliport in Los Angeles.

But what strikes me about these images is a single unifying factor: people. People who could not imagine, who would not compromise, who could not put the pieces together, who simply would not see the world as something different than it was then.

It is tempting to blame a failure of leadership, but what's more likely is a failure of both business and government leaders to understand that the people needed to implement these changes must themselves be different. Different, in challenging the status quo. Different, in thriving on change and adventure and tough challenges. Different, in knowing that doing good matters as much as doing well—maybe more.

We're contemplating a future of infrastructure built not on carbon and steel but on electrons and fiber and complex chemistry. At the same time, we stare into a future in which the skills of the old-economy infrastructure fade and the need for new

ones rises. Data analysts, coders, and modelers now take the place of draftsmen and accounting clerks. In the field, on-site 3-D printers produce bridge parts once made at foundries hundreds of miles off site. And the lasting consequence: the communities that housed those factories, and the people whose children found good work in them, empty out as their roles in the global economy diminish.

Cities that count themselves among the winners in this new economy are full, but whether employment is "full"—or, perhaps more importantly, "fulfilling"—is a much more open question. Gigging and consulting threaten to replace the 35-hour work week; new technologies and globalization can make workdays and workweeks seem longer than ever, with the 40-hour-a-week, nine-to-five life just a memory.

None of the old patterns make sense, so none of the old answers work. Children can hardly answer the question of, "What do you want to be when you grow up?" when many of the jobs they might be able to choose from don't even exist today.

Our kids—whether millennials (ages 23 to 38 in 2019) or Gen Z (ages 22 and under)—are more likely to think about what kind of a life they want to have. It looks a lot different than ours. More of them say that they want to make a difference, not just get a paycheck. They want to explore new ideas and new places. They'll bring passion, skepticism, and a desire to be part of something—but if they don't feel engaged emotionally and behaviorally, they may well move on.

The workplace must adjust to these seismic changes, and those who fail to adapt will quickly suffer the fate of the dinosaurs. But here's the rub: change won't be easy for 150-year-old banks and fifth-generation building contractors.

So how do engineering firms, investors, and public-sector agencies ensure they attract and retain this incoming talent?

First, inspire them. Tell stories of memorable projects, explaining how they came about and what part the team played in getting it done. Describing to law school recruits that they will be preparing bond indentures is incredibly boring and unimaginative, whereas demonstrating that they will be creating the legal framework for a new rail line linking two important cities is exciting.

Second, challenge them. Set the bar high, but provide the training, coaching, and mentoring to propel their success. This is the generation that has been in class since the age of two, has had more coaches than the Washington Redskins, and is used to constant feedback. Annual performance reviews and set-in-stone timelines for promotion will not cut it.

Third, reward them—but understand it is not all about money. Companies that offer flexible working hours, create out-of-office opportunities, and recognize nontraditional leadership roles (that are not in the chain of command but are nonetheless powerful and directive) are particularly attractive to young workers seeking a different tempo than their parents'.

Fourth, connect them. Accept that technology has changed the world. Forever. Understand that working remotely or at odd hours (in the middle of the night or before school) are the norm, not privileges. After all, a team that can communicate across continents seamlessly can do so from either the office or the nursery.

Fifth, empower them. Solicit feedback and then react to it. Ask them about what the team is missing (whether it's people, skills, or tools), and then get those resources. For example, involve young professionals in designing recruiting efforts—such as where to recruit, at what level, and how to tailor the job description—rather than just expecting them to welcome new team members they had no say in hiring. Encourage them to collaborate in designing new technology and reviewing hardware and software choices.

Redesign internal processes to be inclusive instead of exclusive and transparent instead of opaque.

Sixth, let them go. Seriously. Even today, many of the best careers are hardly linear, and that pattern seems likely only to intensify. So, understand that when those perfect associates join right out of business school, they'll probably move on to something different after four or five years. So the senior engineer hired to shape up the structural design team will leave to run a nonprofit that builds footbridges in Australia. What's underappreciated is that the company will likely be the better for it. Employees who have had a great experience at a firm make fantastic clients and advocates, and new employees who join in their place bring fresh insight and perspectives.

Finally, be a leader. It sounds trite, but people who want to make a difference and accomplish great things in life want to work for someone who does too. Lead with purpose.

That should be easy for an infrastructure leader since our purpose is to build a better world.



To make that shiny city and with projects that become real instead of never-built, we need a highly engaged cadre of engineers, planners, financial experts, and political leaders who take on the quest for a cleaner, safer, more harmonious world—and make it their own. ■

Voice highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.

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Image courtesy of Sunrun

Shifting the status quo in energy: An interview with Sunrun CEO Lynn Jurich

It's more important than ever for leaders to overcome fears and embrace the new energy landscape. Empowering consumers to make informed decisions can help.



Katy George

Senior Partner
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Lynn Jurich

CEO
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Increased market volatility due to climate change affects all industries related to the construction sector, including mobility, energy, and infrastructure. As a result, consumer preference is shifting to sustainability initiatives. Sunrun pioneered a business model that enables many more individual homeowners to pay for and install solar panels and batteries. Since its beginning in 2007, the company has grown from two graduate students in an attic to more than 4,000 employees.

In this interview, Sunrun CEO Lynn Jurich talks about the importance of creating win-win models with the utilities industry, the essential benefits of diversity and inclusion, and what it takes to lead in these disruptive times.

Katy George: *The word disruptor is thrown around a lot, but it's certainly true of Sunrun. How did that happen?*

Lynn Jurich: It was clear to us from the start that solar was going to be the breakthrough renewable technology. We hypothesized that solar is disruptive because it can be distributed at a micro level. When a new technology emerges, people always try to force it into the way they already do things—and in the energy industry, that often looks like a hub-and-spoke model, where a centralized energy source is distributed elsewhere for consumption. But one of the disruptive things about solar is that it's more typically sited where the energy is actually consumed.

We wanted to go for the direct-to-consumer market, because we believed that's where you hit grid parity first. It cost a lot more money than we thought it would and posed many challenges along the way. But fast-forward 12 years: we've installed nearly \$4.6 billion worth of residential systems, and we have 255,000 customers across 22 states, Washington, DC, and Puerto Rico.

Katy George: *How did you build the capabilities and culture to be successful?*

Lynn Jurich: The business model has evolved over time. We've had to make significant changes in how we attack the market. Our original plan was to own scalable pieces of the value chain. We believed there were advantages to building up a financing capability and making it affordable for people to install solar. So that's the business model we invented—delivering solar as a service. That model gives you scale from finance, reach, distribution to end consumers, and brand.

In the beginning, we deliberately didn't handle any of the construction. That's a local business, so we partnered with local companies. It became clear, about six years in, that we needed to be involved in construction as well. That was a massive change for us. We needed to acquire a local solar installer and build that capability out. Furthermore, we were dealing with a completely different business, workforce, and set of challenges there. Not only that, but we had to convince them to take our equity before we were publicly traded.

We also had to make culture shifts—and our culture is still evolving. We had a primarily structured culture, full of people with deep backgrounds in finance and policy. Now execution is where all the action takes place. The front line is getting more efficient, and the people who talk to our customers are the same people who handle installations. I spend a lot of time in the field myself to better understand the challenges and opportunities. We're also figuring out how to orient the business so that decision making is done locally. People are smart and want to do the right thing. Give them the right context, and the people closest to the action are going to make the best decisions.

Katy George: You're competing with local, nimble installers, but you're also competing with utilities. How does this dynamic affect the customer?

Lynn Jurich: There are many longstanding incumbents in this industry. Their business model is big energy flowing one way and building all your assets for peak demand. Today, it's suddenly getting expensive to maintain that system. There are massive amounts of capital expenditure going into upgrading our utility system—and climate change is making it worse. I think the industry forecast for the next two years is \$250 billion in capex—meanwhile, sales are flat.

Now we're able to sell solar electricity as a service to our customers at a lower price than the utility. Our structural advantage is increasing because our costs are decreasing. What I want to do is work with the utilities—it's not a zero-sum game to me. Instead of having both us and the utilities build infrastructure, we strive for win-win models where we say to the utility, "You have peak demands for power. Instead of powering an expensive fossil-fuel plant, let us tap into thousands of our customers' batteries, coordinate, and dispatch them." We create a response to peak demands, and the customer doesn't need to change their behavior.

I often see people misunderstand risk. The status quo *feels* safer but is actually riskier. If you're a utility commissioner, it's riskier to keep relying on those 30-year-old gas plants than to incentivize a bunch of homes to help meet that demand. Yet this is how so many people react to disruption: with fear and a desire to protect the way things are.

Katy George: How would you describe the leadership team's culture? What's most important to you in terms of behavior?

Lynn Jurich: It's critical that our leadership start from a place of abundance and win-win scenarios;

even if those scenarios end up not being possible, it's important to get creative and think in that space. That's what it takes to move quickly and within the time frame necessary to address energy issues as urgent as climate change.

When operating from place of abundance, we can call each other out when we're getting too attached to our own ideas, and we have a facilitating coach to help us. We make it safe to think freely and say, "What if the opposite of that could be true? Let's be curious about this for a second." You make much better decisions that way.

Also, it's crucial for us to take care of our employees, particularly the ones on the front lines with customers. If your employees are passionate about the purpose, and the company takes care of them, they're going to take care of your customers. Your customer experience is everything in this world.

Katy George: Let's talk about diversity and inclusion. Women make up 50 percent of your leadership team.

Lynn Jurich: Yes, and diversity and inclusion is essential. One of the things we do is talk about the dynamics of unconscious bias. Because we've created this zone where we operate openly, there are women who say, "Hey, I feel like I'm being talked over." We make that a safe conversation to have.

Some more traditionally "feminine" traits, such as standing for community and thinking about the greater good, help us make better decisions than a more dominant, competitive, "I'm going to win" attitude. I say that even though I'm super competitive, I probably fit in the more "masculine" category, so I don't need to say that it's about the differences between men and women—it's just those traditionally gendered traits. You must value different perspectives.

I see a lot of women, including those within our company, who aren't in formal management roles. When you take a closer look, however, there usually *is* a woman doing all that management work—she's just not confident enough to own it. If you're going to do the work, you should step in and say, "I'm going to do this, but I want to be compensated for it. I want the title and authority." ■

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More diversity, more complexity: Is your culture evolving fast enough?

Infrastructure builds hard assets—but rising complexity and diversity mean that the soft skills will matter more for future success, say infrastructure experts Greg Stanmore and Bruce Williamson.



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As infrastructure companies embrace more collaborative approaches to working with clients and one another, mind-sets, skill sets, and processes will need to evolve for organizations to become more nimble and creative. Getting the mix of culture, organizational structures, and talent right will be a top priority for most infrastructure leaders—and a thorny one. And diversity in each area will be crucial for successful and sustainable change.

In this Q&A, Greg Stanmore and Bruce Williamson, infrastructure experts at leadership advisory firm Spencer Stuart, discuss the cultural shifts happening within infrastructure organizations, the challenges involved, and the leadership qualities that will be most prized.

McKinsey: *Do infrastructure leaders need persuading to put culture at the top of the agenda? What barriers to culture change do they face?*

Greg Stanmore: With infrastructure projects becoming larger and ever more complex, most infrastructure leaders do recognize the need to transform their organization's culture. Yet there are several persistent barriers, including the fact that many large infrastructure companies are heavily siloed by function and geography. The typical command-and-control management style can inhibit employees at all levels of the organization from contributing ideas and collaborating effectively. Such silos increase both the chances that unit leaders don't have the information they need, and the potential for miscommunication with governments and communities.

Also, the makeup of infrastructure company teams doesn't yet reflect the makeup and diversity of the communities they ultimately serve. Especially given that an increasing number

of urban regeneration projects are mixed-use developments, infrastructure firms risk missing important ideas when they don't bring together a diverse set of stakeholder perspectives. Until they have that diversity of thinking—by gender, age, career backgrounds, cultural backgrounds, and other angles—they won't find the sweet spot of delivering on the modern requirements for built environments and infrastructure assets.

Bruce Williamson: Infrastructure organizations need their business leaders to collaborate across functions and find solutions that are beneficial to the organization as a whole. Currently, a lack of such collaboration means that many companies are incapable of breaking free from doing what they've always done—embracing innovation—and having more proactive client conversations with a bias toward codesign.

Another barrier is that few infrastructure companies have the type of learning-oriented culture needed to deal with the rapid pace of change in their industry and really thrive. When organizations don't put a high priority on learning, it's difficult for them to engage with and understand their constituents' evolving needs. They fail to build empathy for their end users, and it's quite difficult to communicate long-term purpose and community benefits to a range of different stakeholders.

McKinsey: *What new skills and leadership traits are needed to meet these challenges?*

Greg Stanmore: Greater diversity is certainly one key. Our observation of global property group Lendlease, for example, is that they have hired or promoted executives with experience in disciplines such as risk management, strategy and business development, and investment management into senior line leadership roles. Previously, leaders

with traditional engineering and building backgrounds would have held all of these roles. And of course, organizations also benefit from increasing their geographic and gender diversity to more closely reflect infrastructure projects' end users.

Since technology plays a crucial role in enabling people from different functions to work together, leaders also must have the technical knowledge needed to manage dispersed teams and multistakeholder projects. Building information-management software, for example, provides a common language for design, and digital-twin technology helps multidisciplinary teams plan effectively, collaborate well, and manage risk.

Bruce Williamson: In a similar vein, the global engineering firm Aurecon created new roles to lead their digital, innovation, design-thinking, and advisory functions and adopted a new lens for hiring and promoting leaders. In assessing incoming leaders, passion for the work—especially for the impact that projects can have for people and society—and an individual's long-term potential were prioritized over past performance. Aurecon looked for traits such as client focus, intellectual curiosity, unconventional thinking, and courage. Although traditionally a very hierarchical organization, where senior—and mostly male—leaders dominated the debate, Aurecon began to prioritize gender, age, and geographic diversity in recruiting and hiring.

To aid in retention, Aurecon helped their engineers evolve from order takers to true partners in the design process. They did this by arming engineers with storytelling skills and new tools, such as additional training in design thinking, to improve their ability to articulate end-user needs. Engineers also were encouraged to embrace a new mind-set, recognizing their unique voice in the process and

their responsibility to speak up for the project's success.

McKinsey: *How can infrastructure organizations better promote diversity and inclusion?*

Bruce Williamson: The first step is for leaders to embrace the notion that diversity is a business-performance issue, not a compliance issue. The evidence continues to mount that diversity and inclusion not only unleash creativity and innovation, but also encourage strong learning cultures and position companies to outperform their peers.¹

Many organizations are recognizing how much diversity matters and are making progress in hiring and promoting a more diverse workforce. They are adopting talent-evaluation approaches that focus on the traits and capabilities that will be required for the business going forward. However, the big pitfall at the moment is that these approaches often don't set new people up for success; most companies need to do a better job addressing the challenges that people from diverse backgrounds face. The organization that gets this right will win in the pursuit of diversity and all the benefits that follow.

McKinsey: *Where have you seen cultural transformations in infrastructure go wrong?*

Greg Stanmore: Many corporate leaders—in infrastructure and elsewhere—fail to articulate purpose. Ultimately, most people in the infrastructure business are driven by the desire to do meaningful work that has a positive societal impact. Organizations need to tap into that inspired purpose and invite everyone to participate in conversations about opportunities to innovate. This approach can build the confidence of people throughout the business whose voices are typically sidelined, encouraging them to be more engaged in problem solving.

Bruce Williamson: Another pitfall is failing to define the capabilities and styles that leaders need based on the target culture and business needs. For example, as firms expand further down the value chain into asset management, and further up the value chain into infrastructure policy and development advisory, it's common for them to simply enlist a high performer from the traditional business to lead these areas. If these leaders bring a hierarchical management style to the new ventures, their businesses fail to gain traction. The most successful organizations will be those that stay laser-focused on culture and establish processes for selecting and developing leaders with the capabilities and styles to thrive in these environments. ■

¹ Sundiatu Dixon-Fyle, Vivian Hunt, Sara Prince, and Lareina Yee, *Delivering through diversity*, January 2018, McKinsey.com.



Empowering talent: Women in energy, resources, and infrastructure

The energy, resources, and infrastructure sectors are low on a crucial source of talent: women. New data shed light on the size of the problem—and point to potential solutions.



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The energy, resources, and infrastructure (ER&I) sectors have a gender representation problem.¹ Our research finds that women are underrepresented at every level of ER&I employment, from entry-level positions to the C-suite—and at a wider margin than corporate America overall.

The reasons are varied and deeply ingrained, but several challenges rise to the fore. To start, women aren't getting into the employment pipeline from the beginning: just one-third of entry-level hires are women. Women in ER&I report more workplace incivility than women overall—and far more than men. And being the only woman in the room is still a common experience in ER&I.

Regardless of the challenges, women in ER&I have ambitions to reach the top—not only to contribute to the company's success but also to act as role models and influence workplace culture. But their efforts alone won't be enough. Helping more women enter and stay in ER&I will take a long-term commitment from individual companies and the industry at large. For companies willing to face the primary challenges head on, the path forward is clear: enlarge the entry-level candidate pool, ensure hiring and promotions are fair, make the "only" experience rare, and offer robust networks and support systems.

The current state of women in energy, resources, and infrastructure

With every step up the North American corporate ladder, men outnumber women by a progressively larger margin that by the C-suite reaches five men for one woman. The good news, according to McKinsey's annual *Women in the Workplace* report (conducted in partnership with LeanIn.org), is that companies across industries are making progress—whether it be promoting more women to the C-suite, offering flexible work options, or holding senior leaders accountable for gender diversity. These developments represent progress not only for gender parity but also for corporate performance; separate McKinsey research has found that gender-

diverse companies are 21 percent more likely to outperform the competition.²

We reviewed pipeline data from 30 companies and survey data from 6,000 respondents in the ER&I sectors, including oil and gas, utilities, engineering, and energy and basic materials—and the numbers confirm what many have anecdotally pointed to for years. Stated simply, women are underrepresented at every rung of the ER&I corporate ladder by a wider margin than industries overall (Exhibit 1). And like industries overall, the ER&I workforce loses disproportionate numbers of women early in the pipeline—specifically the first promotion to manager, during which the share of women promoted in ER&I is 28 percent versus 43 percent for women overall.

A bright spot, according to the data, is that the ER&I pipeline is less "leaky" than the overall pipeline. This means that although women are vastly outnumbered by men at all levels, a higher proportion of women in ER&I than women overall stick it out to the top. Moreover, our research finds that the share of promotions of women in ER&I from SVP to the C-suite is 42 percent, compared with 31 percent in other industries, and the share of hiring women at the C-suite level is higher as well (36 percent versus 31 percent in other industries). These findings point to the efforts of ER&I companies to improve the representation of women at the top as well as the ambition and perseverance of women in the industry.

Indeed, the survey found that women in ER&I are just as likely as women in other industries to say they want to reach the top (both at 33 percent). However, their reasons differ. Women in ER&I are slightly more likely than women overall to say they want to reach the top to be a role model (45 percent versus 42 percent), impact the success of the company (63 percent versus 59 percent), and have an opportunity to influence the culture of the workplace (52 percent versus 46 percent) (Exhibit 2).

Exhibit 1

Women are underrepresented across the pipeline in energy, resources, and infrastructure (ER&I) industries; however, the pipeline is less leaky than other industries.

% employees, 2018

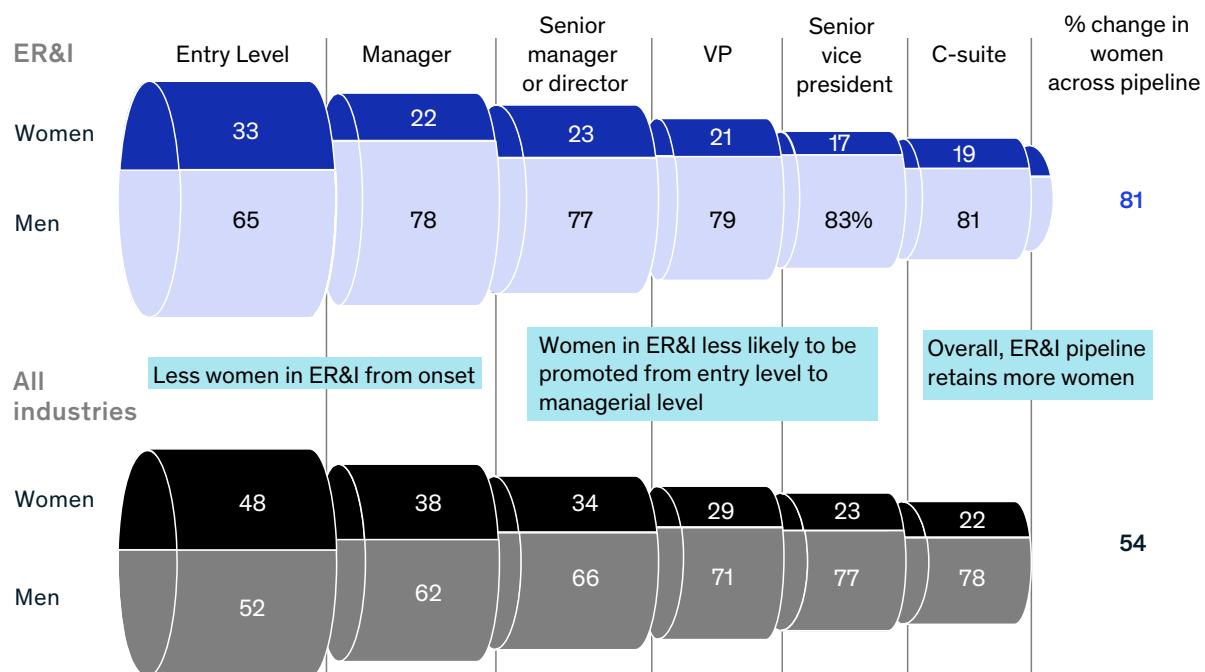
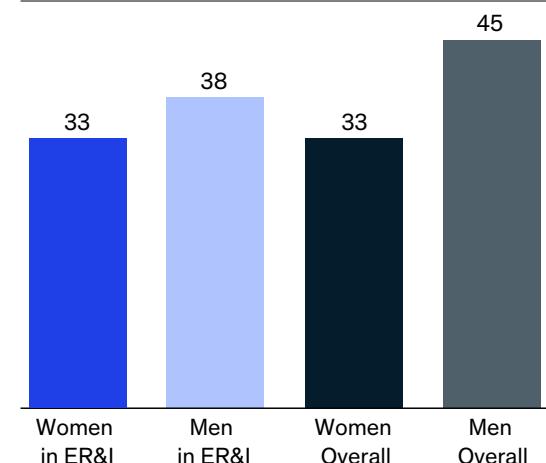


Exhibit 2

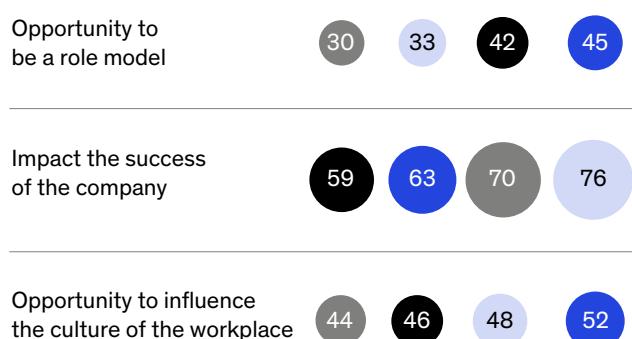
Women have ambition to reach the top despite—and even because of the challenges they face.

% employees who expressed ...

... desire to be a top executive



... reason for desire to be a top executive to be ...



Women face challenges specific to the energy, resources, and infrastructure sectors

The challenges start at the beginning of the pipeline, as just 35 percent of entry-level hires in ER&I are women (compared with 48 percent in corporate North America overall). An underlying cause could be that, according to the National Girls Collaborative Project, women make up just 28 percent of the science and engineering workforce³—fields that can be precursors to employment in ER&I sectors such as engineering, manufacturing, and construction. Many of the women that do study science, technology, engineering, and math (STEM) fields are drawn to other industries, such as healthcare.⁴ Furthermore, a lack of hiring practices that target women candidates as well as the perceived experience of women in ER&I based on existing representation may also affect the number of women entering the industry.

Once women are in the room, the challenges continue. According to the survey, women in ER&I report more incivility than women overall—and far more than men (Exhibit 3). Four in ten women in ER&I said they've felt pressure to provide more evidence of their competence than others do and

have had their judgment questioned in their area of expertise. These experiences, along with more blatant aggressions such as being addressed in a less-than-professional way, are indicative of company cultures that create barriers to women's advancement. Even more concerning, when asked if they've experienced any form of sexual harassment, 43 percent of women in ER&I responded in the affirmative versus 35 percent of women overall.

Furthermore, 33 percent of women in ER&I report often being the only person of their gender in the room—compared with 19 percent of women overall and less than 10 percent of men (Exhibit 4). According to *Women in the Workplace* research, being an “only” can compound the negative experiences of feeling on guard and an increased pressure to perform.

Finally, climbing the corporate ladder can involve a level of politics that some women find off-putting. Women in ER&I who do not want to be top executives say that “too much politics” and a need to “act in ways that are not consistent with who they are” are the top reasons (34 percent of women in ER&I versus 30 percent women overall

Exhibit 3

Women face more systemic challenges and microaggressions at work.

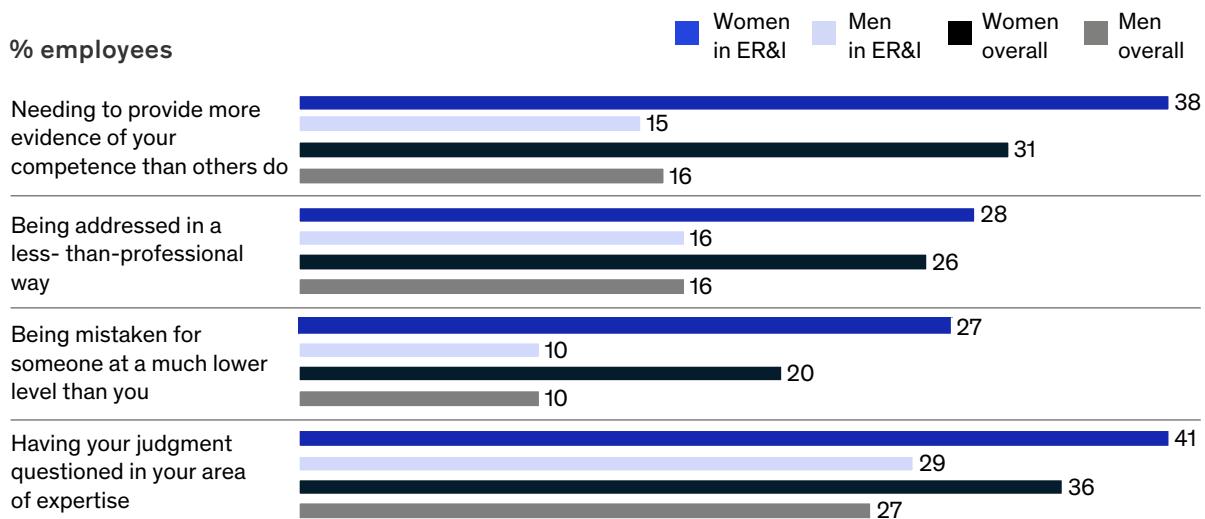
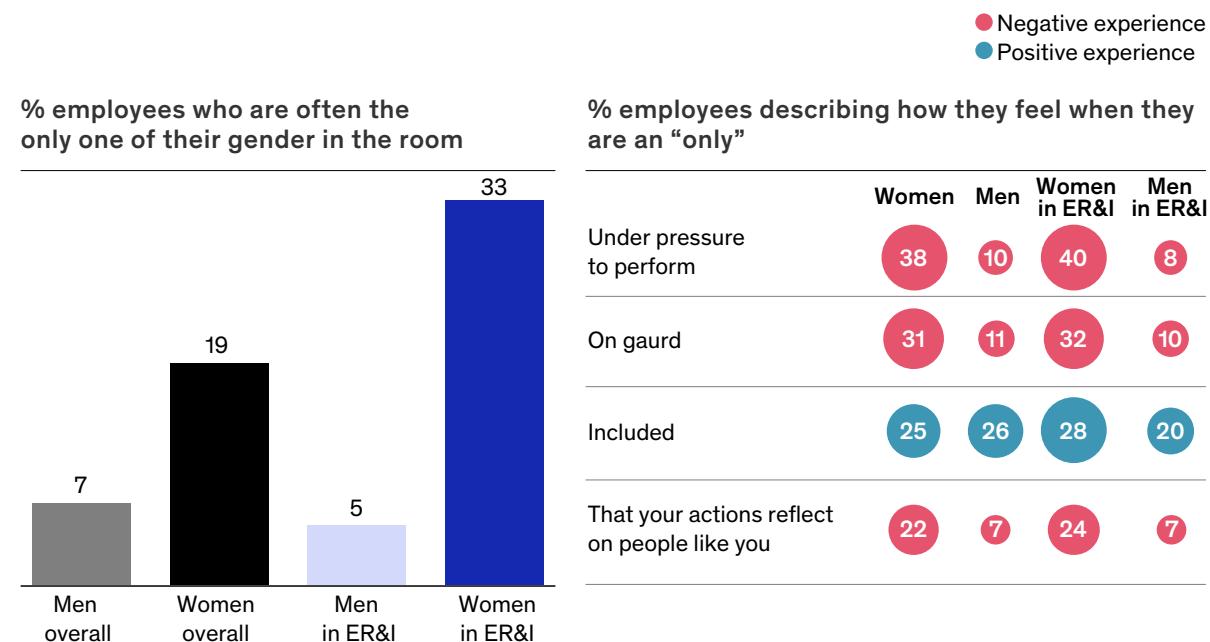


Exhibit 4

Women in energy, infrastructure, and mobility are more likely to be the only minority, which makes facing challenges more difficult.



and 17 percent of women in ER&I versus 14 percent of women overall, respectively). According to the survey, 30 percent of women in ER&I (and 24 percent of women overall) believe their gender has played a role in missing out on a raise, a promotion, or a chance to get ahead, compared with 10 percent of men in ER&I (8 percent overall). When women see their workplace as less fair, they are understandably more likely to leave the industry—or the workplace altogether. Furthermore, women of color feel these challenges to an even higher degree (see sidebar, “Women of color face even greater barriers”).

Making change in energy, resources, and infrastructure

As noted in the 2018 Woman in the Workplace report, “To achieve equality, companies must turn good intentions into concrete actions.”⁵ In ER&I, two priorities emerge that directly address the challenges that are heightened for women in the industry.

Revamp the approach to recruiting and promoting women

A minority of companies overall, and very few in ER&I, employ best practices in recruiting and hiring for gender diversity. Case in point: at the manager level, 24 percent of ER&I hires are women, compared with 39 percent of hires in industries overall; at the senior manager or director level, 22 percent of hires in ER&I are women compared with 33 percent of hires in industries overall. What’s missing?

To start, just 18 percent of women in ER&I said their company requires unconscious-bias training for employees who screen or interview candidates (slightly worse than the 22 percent of women overall who reported such training). And while a few more women in ER&I say their company provides hiring programs for underrepresented groups (12 percent, compared with 10 percent of women overall), clearly there

Women of color face even greater barriers

Women of color face even greater barriers than white women in the energy, resources, and infrastructure sectors. According to the survey, 55 percent of women of color in energy, resources, and infrastructure think they have equal opportunity for growth as their peers, compared with 64 percent of white women in ER&I. Women of color are also less likely to think promotions are based on fair and objective criteria (33 percent of women of color in ER&I versus 44 percent of white women in ER&I) and that the best opportunities go to the most deserving employees (32 percent versus 44 percent, respectively). Alarmingly, 42 percent of women of color in ER&I believe they missed out on a promotion because of their race (compared with just 3 percent of white women in ER&I). Increasing the racial and ethnic diversity of the ER&I industry will require getting to the root causes of these inequalities and implementing structured solutions to increase diversity and inclusion.

is real space to improve in both ER&I and corporate America in general.

According to the women surveyed, the ER&I companies they work for are also less likely to set diversity targets (24 percent claimed by women in ER&I versus 17 percent women overall), track hiring outcomes to check for bias (29 percent versus 22 percent), require a diverse set of candidates to be considered for open positions (39 percent versus 33 percent), and have someone who isn't directly part of the decision-making process sit in on interviews and discussions about candidate qualifications (30 percent versus 25 percent). These practices, as well as efforts that require candidates to opt out rather than opt in (for example, in determining which candidates will undergo interview coaching), would help ER&I companies increase the representation of women at all levels.

ER&I companies are also less likely than other industries overall to provide unconscious bias training for evaluators or to use consistent evaluation criteria to make assessments across employees. In addition to implementing these two practices, promotion decisions should be made with input from an unbiased third party, and promotions should only be offered once a diverse slate of candidates is identified. An important consideration in ER&I in particular is to ensure that promotions aren't invariably tied to job requirements, such as moving abroad for a period of time, that can't be

reconciled with stability at home when women are disproportionately the primary caregiver.

At the front of the pipeline, ER&I companies can also play a more active role further upstream by promoting initiatives and efforts that get women and girls to study and pursue careers in STEM fields. They can also appeal to those already in STEM by highlighting the diversity of roles as well as the impact that a career in ER&I could provide.

Support women through networks and advocacy
The incivility data suggest that ER&I companies must do more to support women, change behavior standards, and make the “only” experience rare. The upside is that women in ER&I are more likely to feel included while the “only” in the room, compared with both men and women in all industries, but there is still much to be improved upon. Companies can directly combat the “only” experience by hiring and promoting women in cohorts. They can also cluster women on teams and create structured opportunities for women to work with other women.

Finally, it's important for men to be a part of dismantling the barriers for their women colleagues. As allies, they can play a vital role in ensuring an inclusive environment is fostered across genders. Proactive endorsements of women colleagues can lessen the need for women to defend their own competence and head off unjust

criticism based on gender. The industry should continue to push for men to scale up their efforts to offer sponsorship, coaching, and mentorship, as well as advocate for women by helping build networks, balance slate promotion decisions, and offer flexible career paths. The evidence suggests that these actions can have an outsize impact on attraction and retention of women in ER&I.



The virtues of a more diverse workforce are clear, and ER&I is making progress—but more focused changes are needed to achieve gender parity. ■

The latest *Women in the Workplace* report offers a complete set of solutions for companies in ER&I and other industries.

The authors wish to thank Irina Starikova, Tijana Trkulja, Matt Rogers, Margaret Swink, Amy Wagner, Delia Zanoschi, and the rest of the Women in the Workplace team for their contributions to this research.

¹ For the purposes of this research, these sectors include oil and gas, utilities, basic materials, and engineering and construction.

² For more, see Vivian Hunt, Lareina Yee, Sara Prince, and Sundiatu Dixon-Fyle, “Delivering through diversity,” January 2018, McKinsey.com.

³ “Statistics,” National Girls Collaborative Project, ngcproject.org.

⁴ “Women in science, technology, engineering, and mathematics (STEM): Quick take,” Catalyst, June 14, 2019, catalyst.org.

⁴ For more, see Alexis Krivkovich, Marie-Claude Nadeau, Kelsey Robinson, Nicole Robinson, Irina Starikova, and Lareina Yee, “Women in the workplace 2018,” October 2018, McKinsey.com.



Image courtesy of Bentley Systems

Developing the digital construction workforce: A Q&A with Greg Bentley

New skills and new entrants are needed in infrastructure-project delivery. Fortunately, the workforce of the future might be closer to home than expected.



Greg Bentley

CEO
Bentley Systems

Much of the infrastructure in which we live—our roads, our bridges, our buildings—is now designed and tested with increasingly sophisticated technology. Software-development company Bentley Systems has provided digital tools and services for some of the world's most complex developments, including the Abu Dhabi International Airport and the Shard in London.

As a result, the company understands the challenges facing the infrastructure industry—from its engineers and architects, to IT managers and owners and operators—as it embraces and grows into the digital age. In this interview, Greg Bentley, CEO of Bentley Systems, discusses the skills the industry needs, the new technologies (such as digital twins, 4-D surveying, and cloud services) it can apply, and the role executive teams should play in improving digital literacy.

McKinsey: *What is the construction workforce like today?*

Greg Bentley: Demographic circumstances are understandably creating anxiety throughout infrastructure-project delivery. One estimate suggests that after 2008's capital-markets tumult, the resulting austerity and waning number of projects reduced the construction workforce by 40 percent.¹ Workers clearly wanted to escape the chronic cyclical nature that characterizes much of construction.

There's also been a secular demographic trend: failing to attract younger workers. In construction trades, less than 10 percent of the workforce today is under the age of 25—a figure much lower than in previous years.² This demographic problem is already starting to constrain capacity, and I think everyone realizes it will get worse if the industry doesn't change.

But there is a silver lining. The compelling solution to the quantitative and qualitative skills deficits in the infrastructure-project-delivery workforce is “going digital.” This offers the dual benefits of helping today's limited supply of infrastructure and construction professionals become more productive, while at the same time attracting new young talent—digital natives—by changing the character and appeal of the work. In this way, going digital leads to a virtuous cycle.

McKinsey: *What does going digital mean for the industry's skills needs?*

Greg Bentley: Going digital is the key to industrializing infrastructure delivery. It will help the industry catch up to manufacturing in turning formerly analog process into automated, digital workflows—templated, replicated, scaled, and progressively connected through information mobility that spans the project life cycle and across disciplines. To signify this, we use the terminology of a “4-D project digital twin,” which, for example, facilitates “constructioneering.” Here, the work of engineers and constructors is iterative, immersive, and interactive, rather than being discretely separated and sequenced. They need to be modeling and simulating projects together to take full advantage of modularization and automation.

Infrastructure project delivery, and especially construction, is fundamentally a 4-D endeavor. The needed new skills are dexterity with models, data, and digital dashboards. You're collaborating virtually through cloud services for 4-D surveying with drones and digital imagery, and then machine learning from the progressive comparison at each stage between the physical twin and the engineer's virtual twin.

Engineers and constructors are mechanically inclined and naturally adaptive. So they will find themselves becoming increasingly proficient in applying machine learning as their previously “dark” data is opened up—through intuitive immersive visualization—for analytics. By virtue of this anticipated skills-transition process, I tend to be bullish on generalists, more so than on narrow specialists, playing a greater role on future project-delivery teams. But all will benefit from comfort with at least some degree of coding and of business-intelligence virtuosity.

McKinsey: *How can the industry find or develop the skills necessary for constructioneering?*

Greg Bentley: My hunch is that, fortunately, the skills to work with 4-D modeling already exist in our emerging workforce, but we may need to find them among the many young people who are currently attracted to computer gaming or who create animated environments for other industries’ purposes. We need only to entice them to work on our physical infrastructure, rather than their virtual worlds. Think about the type of digital visualization that the computer gamer takes for granted. Several years ago, Microsoft’s first HoloLens was primarily regarded as a gaming device; today, the HoloLens 2 is recognized as an industrial-grade tool with industrial-scale potential for infrastructure digital twins.

We need to ensure that the infrastructure professions are increasingly known and attractive to young people who have these generalist skills, these visualization skills, quantitative dispositions, and purposeful energy. Construction and engineering are far from routine; they are interesting and challenging, and they are rewardingly well suited for individuals with natural propensities for analytics, for imagining creative ways to use data, and for crafting with (machine-learned!) tools of the trade.

When a sector like ours talks about attracting workers, we can anticipate the fair questioning about whether current jobs will be lost to future robots. I would point out that robotics are used in heavy civil construction already. The first autonomous vehicles on many new roads are the machine-controlled excavators and graders driven by the constructioneers’ 4-D models. The results are better conditions, predictability, and safety of work, as well as greatly improved efficiency and economics of projects, which can lead to more work. Automation will not make the jobs of engineering and construction professionals scarcer, but rather safer and more rewarding.

McKinsey: *What do executive teams need to do to help improve digital literacy?*

Greg Bentley: Infrastructure-project executive teams should have an awareness and a zeal for these improvements. To me, the telling indicator is whether they regard technology as incremental overhead in producing their traditional deliverables, or whether they see it as the answer to minimizing scarce or unsafe labor, to improving work quality, to making more projects feasible, and to winning more lucrative and enduring work. In my experience, infrastructure CEOs generally recognize the compelling opportunities in going digital, but their vision is often thwarted by inflexible operating structures in their organizations.

I believe it’s preferable for executive teams to think about going digital not as an intimidating onetime “transformation,” but rather as a progressive process of increasingly connecting and automating workflows by useful (and ultimately self-financing) degrees. Infrastructure engineering leadership should enthusiastically and confidently embrace the potential improvement to their conventional business models—and the lessened vulnerability

to the skills shortage we've talked about here—enabled by digital twins.

For me, a litmus test for whether an infrastructure-project-delivery organization is working to digitally future-proof itself is its commitment, or lack thereof, to explicitly investing in R&D. I don't mean that engineers and constructors should be getting into the software business. Rather, they should create and capitalize intellectual property that advances their work toward valuable "infrastructure as a service" outcomes.

McKinsey: *What are some specific actions that public- or private-sector groups can take to fuel going digital at an industry level?*

Greg Bentley: I think that advocacy and full adoption for apprenticeship programs are a good start. Over the past few years, the United Kingdom (as a leader in joining private with public initiatives) created a high-speed rail college that offers hands-on instruction for digital advancement. Bentley Systems is one of the companies supporting this program, with hope that these students will graduate and bring knowledge of 4-D surveying and other digital tools and workflows to future projects.

From the software side, we can expand our contributions by providing not only the tools for infrastructure professionals but also the behind-the-scenes machine-learning environment to help each unique individual continuously improve in going digital. Together we can make up for the currently worsening infrastructure-project-delivery skills gap by attracting and empowering the right digital natives. In the end, if we get it right, perhaps a sustainable skills advantage will be our generation's legacy. ■

¹ Jeffrey Sparshott, "Where did all the construction workers go?" *Wall Street Journal*, June 9, 2015, blogs.wsj.com.

² Emily Peiffer, "The construction industry's top workforce challenge — and 3 potential solutions," *Construction Dive*, October 12, 2016, constructiondive.com.

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Expert insights: What are three essential qualities of the workforce of the future that will distinguish it from the workforce of today?

As modular construction gains traction, industry leaders weigh in to identify common patterns and obstacles to overcome.



Tam Nguyen

Global Head of Sustainability
Bechtel



David Wilson

Chief Innovation Officer
Bechtel

With the increasing adoption of artificial intelligence (AI) and other technologies in the workplace, tomorrow's engineering, procurement, and construction workforce will be leaner, greener, smarter, and more agile. The workforce of the future will have the following three essential qualities.

Adaptability. Workers will be receptive to change, able to quickly adopt better methods, and adept at doing more with a smaller environmental footprint. In recent years, the rate of drone adoption has significantly increased across the industry;¹ rapidly adopting other new technologies will continue to be necessary.

Digital proficiency. The construction workforce will be capable of adopting, understanding, troubleshooting, and developing new digital workflows and solutions, as well as managing data more securely, efficiently, and effectively. The future worker will no longer sort through piles of paper drawings and instructions. Instead, they will navigate and create instructions using AI-enhanced wearables, smart devices, and workstations.

Machine mastery. Workers will have the ability to augment their own work using bots, robots, autonomous vehicles, machine control, and neural interfaces. Repetitive activities, such as data processing, material transport, and rebar tying will be performed by cobots—collaborative robots. These cobots will assist workers who prompt, direct, and oversee the work.

A workforce with these skills will use fewer physical and natural resources to deliver safer, quality products more quickly.



Romilly Madew

CEO
Infrastructure
Australia

Australia faces a period of unprecedented uncertainty spurred by changing demographics, rapid technological advancement, and shifting consumer demands. These trends will create a workforce of the future that looks different in three crucial ways.

More women. The Australian Infrastructure Audit 2019 found Australia's rates of workforce participation are high and stable.² However, participation rates for women—64 percent—remain lower than those for men—75 percent—and lower still than several other countries. The construction industry, the nation's third-largest employer, currently maintains the lowest level of female workplace participation of all industries.

However, women's representation in the workforce is growing, and this upward trajectory is expected to continue. Such increased participation could help relieve the construction industry's current labor and skills shortages.

More senior—and senior-care—workers. The 2019 audit revealed that Australians are living and working longer. The number of workers over the age of 55 has increased significantly and is expected to continue rising. By 2042, the number of Australians over the age of 85 is expected to double, which will place increased pressure on social services and infrastructure, particularly the health and senior-care sectors.

More nontraditional work arrangements. Rapid technological change and shifting consumer demands continue to disrupt existing markets. Increasing demand on the past decade's sharing markets, such as ridesharing and skillsharing, can help meet future infrastructure challenges, including delivering quality transport to the outer suburbs of growing cities. While independent contractors now make up around 12 percent of Australia's workforce, this number is likely to increase alongside these growing labor categories.



Michael Della Rocca

Partner
McKinsey & Company

Across the construction ecosystem, the workforce of the future will be more digitally literate, diverse, and decentralized.

Digital literacy. Construction has reemerged, after generations of low productivity, at the start of a digital transformation. The sector is using virtual-reality tools, AI-based design algorithms, remote operation of construction equipment, digital-site safety tools, and a host of other technologies to transform its way of building. The future workforce will be trained and knowledgeable in such digital applications, and the most competitive talent will choose employers using these digital technologies across the value chain.

Diversity. Technology will open doors for a more diverse workforce equipped to contribute in a fundamentally different construction environment. Consider that it could be commonplace to see a young worker use an iPad to operate a bulldozer potentially hundreds of miles away at a future construction site. Even more innovative: a 24/7 workforce deploying advanced technologies to construct a commercial building module in a manufacturing environment.

The latter is happening now, but not at scale. As the industry successfully deploys technology, the traditional, hands-on, physically demanding construction roles—often filled by workers in hard hats—will dwindle, making room for more diverse workers. These workers will apply different skills, harness new platforms and tools, and work more flexible schedules as the construction ecosystem evolves.

Decentralization. Design, project management, and the supply chain will be managed and executed by a digitally enabled, diverse pool of practitioners worldwide. There will always be a need for some on-site activity. However, the ability to use virtual reality to test different design and construction scenarios, create digital twins to capture and monitor progress, deploy modular construction for project components, and use virtual project-management tools for team discussions will limit the need to relocate large teams across jobsites.

Taken together, the synergies across digitization, diversification, and decentralization are accelerating the industry toward a new kind of workforce. Future generations will see construction careers as fast-paced, high-tech, gender-neutral, lucrative, and worthy of the world's best talent—wherever it is found.



Prakash Parbhoo

Partner
McKinsey & Company

Our experience finds recurring patterns in the characteristics, mind-sets, and behaviors of large capital-project teams and frontline laborers that predict the project's success. Three critical capabilities stand out for the workforce of the future. And project teams can be selected and hired for all three of these characteristics today.

Collaborate through the good and bad. The most successful teams take a collaborative approach to resolving issues at all levels and between all stakeholders. They bring cross-functional stakeholders together to resolve issues and foster an environment in which all parties help each other do

their best work. Rather than engage in endless blame games, they agree to evaluate problems objectively, as a team, and to apply preset rules detailing accountability for underperformance. It's not just about collaboration in good times—the great teams distinguish themselves by collaborating even more closely when projects face challenges.

Solve problems in real time using data. The most efficient teams start by using common wisdom, such as by noting patterns, to predict where issues may arise—but they use data to focus their problem-solving efforts. For example, one team building a greenfield mine used advanced analytics techniques to provide early warning if tasks were at risk of delay. The data scientist and data-science translator are increasingly important in helping project teams by bringing new insights grounded in the constraints and complexities of the project environment.

Embrace new technologies. Engineering and construction are working through their own digital disruptions. While the long-term implications of this shift are still unknown, it is clear that a workforce able to adapt and embrace new technologies is essential. One team of unskilled frontline laborers improved their productivity by more than 100 percent with the aid of a smartphone app. Other efforts involve getting engineers comfortable coengineering with an AI assistant. Regardless of approach, being able to embrace new technologies in day-to-day work is essential for the future workforce.

¹ Mike Juang, "How drone photography is carving a niche in construction," CNBC, July 8, 2018, cnbc.com.

² Australian infrastructure audit 2019: an assessment of Australia's future infrastructure needs, Infrastructure Australia, June 2019, infrastructureaustralia.gov.au.

Voice highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.

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Image courtesy of Tideway

Transforming health, safety, and well-being in construction

Improving the well-being of construction workers is a key component of successful major projects and an ethical imperative. Tideway's chief technical officer, Roger Bailey, shares his perspective.



Roger Bailey

Chief Technical Officer
Tideway London

When accountants, postal workers, and bus drivers leave their homes for work each morning, they fully expect to come home in the same physical shape as when they left. Why can't it be the same for construction workers?

When it comes to health and safety in construction, today's best practices may not be good enough. Consider the historically "good" standards of health and safety performance on major infrastructure projects in the United Kingdom, for example. Based on these standards, a project involving 10,000 person years of input may require around 1,500 people to need first aid, either on-site or at a hospital. Of those, more than 105 may suffer significant occupational health impacts (such as hearing, vision, respiratory, or musculoskeletal impairment); 80 people may suffer a serious, life-changing injury; and one person may suffer fatal injuries.

The leaders of the Thames Tideway Tunnel Project, also known as the Super Sewer—a 25-kilometer tunnel under London's Thames River—wanted to do better than good. But creating better outcomes for workers is often less straightforward than it seems. Intense pressure to stay on schedule and on budget can lead to a culture that deters workers from reporting health- and safety-related issues. Poor communication between site workers who speak different languages may further hamper safety. And, demographically speaking, construction workers are at higher risk of poor health and well-being, which is often due to the need to or commute long distances or their relatively low income.

To address these problems and help keep our workers safer and healthier, Tideway focused on four elements: better onboarding; a hands-on approach to health, safety, and well-being; easy access to health services; and a risk-based approach to design. We believe that our model can serve as a guide for how major infrastructure projects can pioneer change to better protect the construction workforce of the future.

Protecting the workforce of the future

London's sewer system was designed in the 1850s to accommodate around 4 million people. But as the population moves towards 9 million, just a few millimeters of rainfall can strain the system. Such overflows are becoming more frequent, in part because of greater rainfall due to climate change. This means that nearly 40 million metric tons of raw sewage spills into the River Thames in a typical year. The Super Sewer will intercept and divert those spills away from the river. To manage the project and operate the completed tunnel, a consortium of investors created Bazalgette Tunnel Limited, known as Tideway. Construction started in 2016 and will be completed in 2022—the system will be fully operational in 2024.

At the project's peak, up to 4,000 people will be working on it. When construction is complete, Tideway—together with its program manager and contractors—will have expended around 19,000 person years of direct employment through the combined effort of about 30,000 individuals. That's a lot of opportunities to shape the infrastructure workforce experience.

Better onboarding

Poor communication between site workers with different first languages was defined early in the project as an unacceptable health and safety risk. English was set as the project language—and as part of onboarding, every prospective worker must complete a health and safety communications test to confirm their understanding of spoken and written English. The standard required is basic, but anyone who fails it would not be certified to work on site without additional language training and retesting.

Onboarding also includes a full day of interactive learning for the entire workforce, with no exceptions. Whether working on-site for a few days or a few years, everyone attends a purpose-built multimedia facility; here, with the help of actors and facilitators, the participants work through a hypothetical fatality of a colleague on site. The

exercise is designed to give people who have not experienced a serious accident or the fatality of a colleague a real understanding of the terrible consequences of these events—discussion of the impact on the worker’s family, workmates, supervisor, and senior managers are particularly emphasized. Further, additional training improves workers’ confidence to intervene themselves to enhance safety.

Two annual surveys of around 1,400 site workers have shown that the training has changed people’s attitudes, beliefs, and behaviors. In addition, perceptions of fairness and equality of opportunity have improved, and attitudes and approval of safety management have moved in a positive direction.

A hands-on approach to health, safety, and well-being

All Super Sewer workers are encouraged to report and engage with matters of health and safety with their colleagues, supervisors, and bosses in an open and timely manner. This encouragement starts with a face-to-face interaction with one of Tideway’s most senior leaders during onboarding, and continues at a person-to-person level throughout their tenure. This means that each member of the executive team will each have met and shaken the hands of possibly 2,500 people by the time the project is complete. Workers who feel inhibited from raising issues openly can call a 24-hour, 7-day a week confidential help line. Since 2016, more than 150 calls have been received by this number, of which around 40 have been found to be relevant and material and were investigated, then acted upon at CEO and board level.

Easy access to health services

Super Sewer site workers have easy access to health services, with the goal of not just staying safe but also leaving healthier than when they arrived on the project. To start, workers are given access to occupational health providers, including occupational health nurses and technicians,

physiotherapists, general practitioners, dentists, and occupational hygienists. Workers are also offered the opportunity to improve their general well-being, through voluntary health checks during onboarding and every two years thereafter. Most accept the offer. In a few cases, these screenings identified life-threatening conditions for which the worker could then seek treatment.

The health program also addresses aspects distinct to the construction industry workforce. These including the higher proportion of individuals who may be living away from home or commuting long distances, and those with higher risk of poor health—including mental health—due to low income. Sadly, the suicide rate among men working in construction is three times higher than the national average of men.¹ To improve and promote mental health, the Super Sewer project became a pilot site for the Mates in Mind mental health program, which offers access to mental health professionals as well as interventions, such as training on how to recognize potential issues and provide support to colleagues, on main work sites.

Risk-proof design

The focus on workforce health and safety must begin in the planning and feasibility phase of a project—well ahead of the construction phase—and then continue into detailed design and construction. For the past 25 years, this early focus has been enshrined in UK construction, design, and management (CDM) regulations—but these practices are not widespread.

Super Sewer designers receive training in CDM to boost skills and encourage them to identify and design out health and safety risks. A “Healthy by Design” guide gives designers and preconstruction planners specific examples of highly hazardous activities and how to design them out. Typical results have included, for example, the elimination of

potentially hazardous activities by using mechanical connections, rather than welded ones for completing stainless-steel fabrication work in a drop shaft. For above-ground structures, design leaders have used a safer composite alternative in place of red-cedar cladding, since red-cedar dust is a known carcinogen.



Enabling the workforce of the future necessarily starts with ensuring individuals' safety and well-being. In every industry, including dangerous ones, workers have a right to expect to start and end their workday in the same shape; all stakeholders, from owners and operators to contractors, need to set higher standards. A culture in which people feel safe—physically, emotionally, and mentally—enables the workforce to flourish. ■

¹ "Suicide by occupation, England: 2011 to 2015," Office for National Statistics, March 17, 2017, ons.gov.uk.

Voices highlights a range of perspectives by infrastructure and capital project leaders from across geographies and value chains. McKinsey & Company does not endorse the organizations who contribute to Voices or their views.

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Building Change: Opportunities in disruption

Industry leaders convened to address environmental and technological disruptions, their impacts on the infrastructure industry, and paths for moving forward.



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Our built environment is contending with a wave of disruptive forces. Climate change is causing infrastructure owners to rethink where and how they build and power assets. Migration and urbanization are generating tectonic shifts in our transportation and infrastructure needs. And technology is altering the way we both live and work—especially as automation gains speed. On October 2 and 3, 2019, the Global Infrastructure Initiative convened more than 80 sector leaders at Building Change, a roundtable in San Francisco, to chart a path through these choppy waters.

Many conferences center on a single industry. However, we decided to orient Building Change on the increasingly interconnected and interdependent energy, infrastructure, and transportation industries. In periods of technological disruption, cross-industry conversations are crucial; in fact, organizations and leaders that succeed in breaking down functional and industry silos are most likely to thrive under these conditions.¹

Our roundtable focused on three crosscutting disruptions: environmental, technological, and workforce. Bringing a diverse group of recognized experts together to bounce ideas off one another revealed that—while the challenges these industries are facing are great—leaders are devoting no shortage of innovation, creativity, and effort to attempting to solve them. Although it would be impossible to recap every conversation, this overview highlights some of the most prominent points of discussion from the conference.

Environmental disruptions

Within just the past ten years, climate events have been estimated to cost the world nearly \$2 trillion in damage and directly affect nearly four billion people.² Conducting business as usual could risk triggering irreversible climate feedbacks. Roundtable participants were loud and clear: we must act now and decisively to address climate change and limit its impact to the extent that we still can. There is, however, room for optimism.

The climate crisis has made its way to the center of almost every corporation’s agenda, as investors, employees, customers, governments, and students increasingly demand action. The companies represented at Building Change are stepping up to the challenge. Human nature seeks to innovate and solve problems, and infrastructure players aim to be part of the solution in limiting global warming.

Executives discussed how to manage decarbonization and physical climate risk to their assets, both of which require fundamental change to business models as well as entire industries.³ To cope, relationships and interdependencies across sectors should be rewritten—and therein lie opportunities for new partnerships and business models. Energy and mobility were at the forefront of the discussion.

Managing the energy transition

The need to increase investments to future-proof existing infrastructure assets and to ensure new infrastructure is built with sustainability and resilience in mind echoed throughout the roundtable. Participants affiliated with the power sector noted dual priorities: reducing emissions from existing assets while preparing the grid for inevitable climate impacts, such as from flooding or fires. All agreed that reducing energy demand would help achieve these goals.

Achieving zero-emission power

Although the road to zero-emission power is well lit, it is still very long. For example, as of 2018, renewables contributed less than one-quarter of generation capacity in the United States.⁴ While declining costs and regulation continue to be major drivers of renewable adoption, one participant raised the point that at-scale renewables would require rethinking how power markets are structured and how to accommodate for capacity and flexibility.

More broadly, the participants discussed technology’s role in advancing toward a zero-emission future. Companies innovating in offshore

wind, hydrogen, and long-term storage are attracting increasing investments. Direct air-capture technologies (which remove emitted carbon directly from the atmosphere), though still nascent, were met with excitement. Participants noted that decarbonization innovations are not emerging solely from fringe start-ups. Traditional industry incumbents that face significant disruptions to their own business are also starting to invest more, both in their own R&D and in smaller innovators' efforts by initiating dialogue, collaborating, and helping them scale.

Moving to zero-emission mobility

Given transportation's contribution to greenhouse-gas emissions, electrification of mobility and ridesharing featured prominently in the discussion. While investment in charging infrastructure for personal vehicles is important, participants highlighted that achieving zero-emission mobility might require not only adopting electric and fuel-cell vehicles but also reconsidering how we integrate micromobility into the fabric of our cities at a scale and pace greater than what we see today.

Addressing equity head-on

As companies chart their paths through the environmental disruption, one consideration remains at the top of roundtable participants' minds: equity. The most vulnerable in society are often facing the greatest consequences of climate change and potentially face the greatest challenges in adapting. Participants shared many ideas about how to ensure an equitable transition. For example, donated or subsidized solar panels and batteries in low-income neighborhoods could provide electricity at no cost to residents while also storing and distributing power, thereby enhancing the local grid's resilience.

Technological disruptions

Data and analytics continue to represent some of the greatest opportunities to optimize asset operations and break down decision-making silos. In infrastructure, as in other industries, the use of advanced analytics can reduce the need

for new capital while raising returns on existing investments. For example, the rail industry uses analytics to increase its resilience by making predictive-maintenance decisions that help avert breakdowns and major accidents. Other assets, such as roads and solar power, can learn from this experience and apply similar models.

Disruptive technologies are also enablers. Not only do they facilitate collaboration and break down internal barriers but they also allow for real-time decision making and free up more resources for creative tasks.

Linking agility and empowerment

To reap the biggest benefits of technology and analytics, companies should internalize that risk stems from ignoring change, not from change itself. It may sound cliché, but many teams operate under a false sense of agility.⁵ Truly agile collaboration—that is, committed partnership and reciprocity rather than a flat structure of authority—is particularly critical during times of disruption.⁶ Those that take leaps of faith, act and fail fast, and pursue agile business models are better equipped to overcome disruption, even when the rug is pulled out from under them.

One executive noted the importance of “empowered doers,” people in the field who provide bottom-up feedback and have the authority to make decisions. In practice, that means facilitating agile collaboration between the business leaders and the engineers and operators. Indeed, technical employees cannot make decisions or build quality models without first understanding industry operations; likewise, business leaders will need enough digital literacy to ensure that the strategies they create are robust and well-resourced from a technical perspective. Another participant shared a success story of a construction and operations company that consistently engages their frontline workforce to select hardware and software before it is deployed enterprise-wide—thereby taking full advantage of operational expertise at every level of the organization.

Workforce disruptions

Participants recognized that to create and attract top talent, the industry will need a combination of serious efforts to retool its workforce and a more compelling vision for its culture and aspirations. In both cases, leadership is responsible for navigating these forces.

Revamping skills training

The workforce is shifting as cognitive computing, artificial intelligence, and automation replace repetitive tasks. Indeed, there is a significant gap between the skills workers have and the skills companies require to take advantage of new technologies.⁷ As the need for new talent surges, construction, utilities, and energy organizations might deliberate on ways to bridge the growing skills gap and address upcoming waves of retirement. Participants agreed that reallocating, reskilling, and upskilling employees will be critical to remain competitive.

Collaborations between the public and private sectors, as well as businesses and schools, can play a key role in reskilling the workforce, designing more flexible ways of working, and aligning talent supply and demand. One executive cited how San José State University became one of the greatest contributors of entry-level engineering roles in California after it identified the growing need—and gap—among the state’s many technology companies.

Reframing the employee experience

Many participants remarked that infrastructure is not necessarily seen as a prime destination for top talent. The infrastructure industry can compete with traditional technology companies for talent by creating an inspiring corporate culture and mission, one that will leave a tangible legacy of purpose and loyalty. And in the face of disruption, companies that provide the next generation of executives with a voice today—through management training or similar programs—can maintain their competitive edge.

In addition, we can rethink where people work—for example, by promoting collaborative technology

across offices and geographies. For cities with high costs of living, companies can establish satellite offices in nearby, more affordable communities to help attract diverse talent and mitigate the financial burden for entry-level team members.



Only a few organizations and cities are currently taking the necessary steps that could combat climate change and the related risks. This was at the heart of the roundtable—not only what changes are needed, but also how we can act quickly and decisively.

Building Change reiterated the value of bringing numerous industry perspectives together for a common aim. Every industry has its own stake in the risks posed by climate change, all of which are interconnected and interdependent. Thus, the best hope we have for generating change is wholehearted collaboration and a willingness to reinvent industries to meet the needs of the future rather than heeding those of the past. ■

¹ For more on how organizations and leaders successfully break down industry silos, see *Leadership & Organization Blog*, “Activate agility: the five avenues to success,” blog entry by Christopher Handscomb and Shail Thaker, February 1, 2018, McKinsey.com.

² *Introducing infrastructure resilience*, United Kingdom Department for International Development, July 2016, gov.uk.

³ Dickon Pinner and Kevin Sneader, “Earth to CEO: Your company is already at risk from climate change,” September 2019, McKinsey.com.

⁴ Evan Polymeneas, Humayun Tai, and Amy Wagner, “Less carbon means more flexibility: Recognizing the rise of new resources in the electricity mix,” October 2018, McKinsey.com.

⁵ Sam Bourton, Johanne Lavoie, and Tiffany Vogel, “Leading with inner agility,” *McKinsey Quarterly*, March 2018, McKinsey.com.

⁶ *Leadership & Organization Blog*, “Agility: mindset makeovers are critical,” blog entry by Carolyn Dewar, Sherina Ebrahim, and Michael Lurie, April 30, 2018, McKinsey.com.

⁷ For more information, see “The future of work in America: People and places, today and tomorrow,” McKinsey Global Institute, July 2019; “The future of women at work: Transitions in the age of automation,” McKinsey Global Institute, June 2019.



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