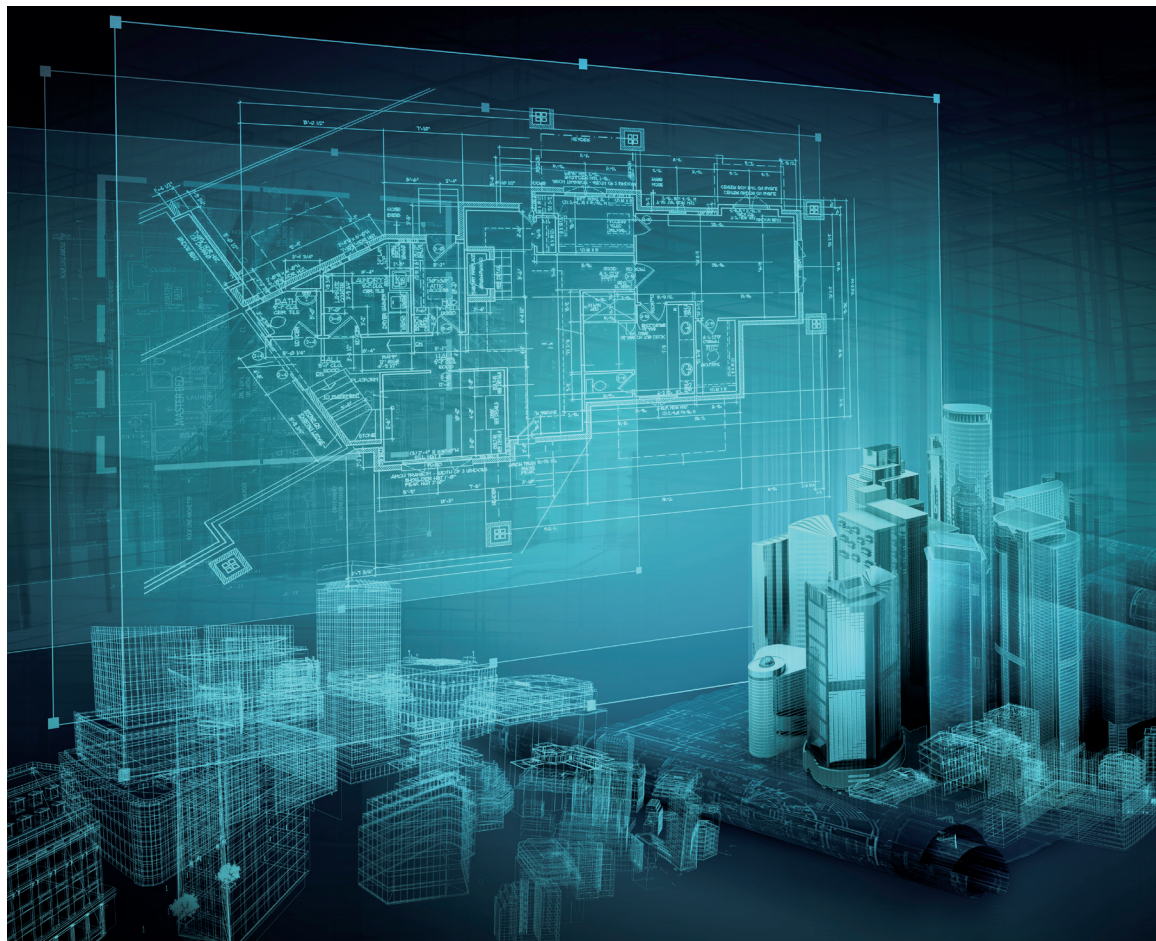# Navigating the digital future: The disruption of capital projects

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Navigating the digital future:
The disruption of capital projects

Digital technology is disrupting capital projects. Companies that want to emerge as leaders must transform their organizations now.

Productivity in the construction sector has stagnated for decades, with the average capital project reaching completion 20 months behind schedule and 80 percent over budget. Some overruns result from increased project complexity and scale, but another factor also looms large: all stakeholders in the capital-projects ecosystem—project owners, contractors, and subcontractors—have resisted adopting digital tools and platforms. These include advanced analytics, automation, robotics, 5-D building information modeling (BIM), and online document-management or data-collection systems. Meanwhile, companies in sectors ranging from government to manufacturing have significantly reduced costs and schedules by aggressively pursuing digital solutions.

The situation is rapidly changing, however, since construction-technology firms have garnered $10 billion in investment funding from 2011 through early 2017. This surge has stimulated development of a wealth of tools and solutions for all project phases, from preconstruction through operations. The cost and productivity benefits that these innovations can offer are too large to ignore. While digital tools are not the only improvement lever available to construction stakeholders, and while they will not solve all productivity issues, they will spur the greatest performance improvement.

Construction has the benefit of learning from many other industries that have undergone significant digital transformations over the past five years. Experience in other industries shows that companies that have been quick to embrace emerging technologies and develop new platforms—the first movers—have gained a strong competitive advantage. We expect the construction sector will follow a similar pattern, giving industry stakeholders an imperative to launch digital transformations now. With thousands of tools on the market, however, many companies struggle to identify a portfolio of digital solutions that truly addresses their major pain points. Even more companies falter during implementation, often losing momentum after the pilot stage or finding it impossible to launch digital initiatives across multiple projects.

To overcome these problems, capital-project leaders must create a tailored digital strategy focused on business value and integrate it into their operating models. Equally important, they have to develop internal capabilities and organizational structures that support wide-scale innovation. These are daunting challenges for any organization, but even more so for those in the immensely fragmented, risk-averse construction sector, where companies begin every new project from the drawing board. A strategic new approach to digitization can help overcome them.

Digital transformation is essential in capital-project delivery

Builders have traditionally been at the forefront of innovation. Each generation of structures, from ancient pyramids to 20th-century skyscrapers, arises from more-sophisticated construction techniques. Over the past 20 years, however, the industry has fallen behind. In fact, a recent McKinsey Global Institute (MGI) analysis of 22 major industries showed that construction was second to last for overall digitization rates, ranking above only hunting and agriculture. With

construction clinging to manual processes as other industries advance, the sector's productivity is now about half that of the total economy (Exhibit 1).

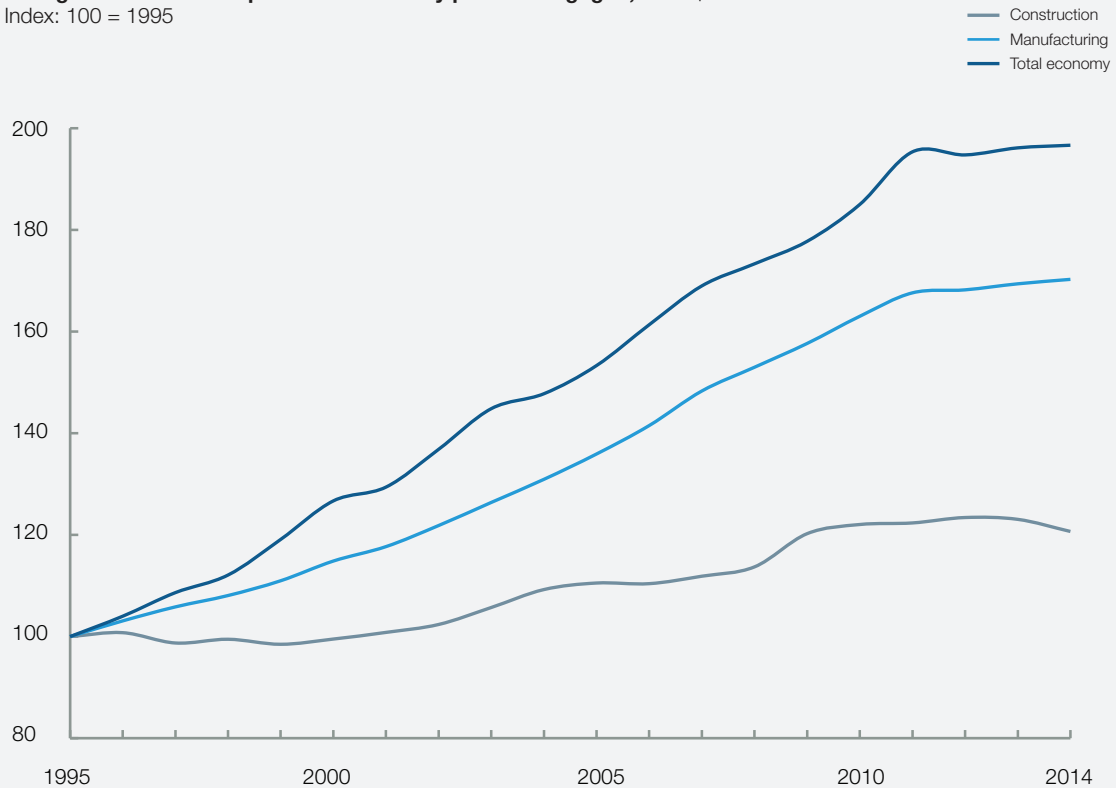Many organizations may hesitate to use digital tools because of the nature of the construction

industry. The landscape is fragmented, with multiple public- and private-sector owners, investors, contractors, and subcontractors. These organizations often differ starkly in terms of capabilities and management approach. With each project following a bespoke model, it is difficult

Exhibit 1

The construction industry has lower productivity than other sectors, and the gap is growing.

Global productivity growth trends[1]

Real gross value added per hour worked by persons engaged, 2005 $
Index: 100 = 1995

Construction
Manufacturing
Total economy

[1] Based on a sample of 41 countries that generate 96% of global GDP.

Source: GGCD-10; national statistical agencies of Malaysia, Singapore, and Turkey; Organisation for Economic Co-operation and Development (OECD); Rosstat; US Bureau of Economic Analysis (BEA); US Bureau of Labor Statistics (BLS); World Bank; World Input-Output Database (WIOD); McKinsey Global Institute analysis

to establish universal standards and processes. Industry fragmentation also makes it difficult for stakeholders to share information for data analysis.

Another problem is that the current contract model burdens some companies with a disproportionate share of risk. Such players have little incentive to introduce untested tools or processes, fearing that they might delay timelines or otherwise jeopardize their ability to fulfill their contractual obligations. They do not think about the many benefits they could lose by holding back. Digital tools may also decrease the frequency of change orders and claims—often a major component of engineering and construction (E&C) companies' profitability— by providing real-time performance insights, improving planning, and minimizing project alterations. If E&C stakeholders focus only on this shift, they may have difficulty thinking about the other ways that digital solutions can help them increase profits.

For capital projects in the public sector, regulatory issues may also discourage digitization. Government agencies have long required companies to follow standard procedures when responding to a request for a proposal, and these leave little room to introduce innovative strategies.

Several leading E&C companies have begun to digitize, but their efforts are often limited to pilots or become bogged down in complexity, especially when dealing with the vast stores of information that digital tools provide.

With great value at stake, companies must transform rapidly

As construction-technology solutions begin to disrupt project management, companies that do not innovate will find themselves at a disadvantage. A recent McKinsey analysis suggests that existing digital technologies, when applied comprehensively and efficiently, can reduce overall project costs by as much as 45 percent. Although this will not entirely eliminate construction's productivity gap with other industries, digital solutions will produce more improvement than will any other lever. For E&C companies, the stakes are particularly high, since these cost reductions will soon determine whether they capture solid margins or experience financial struggles as competition intensifies. For owners, digital cost savings will be essential to completing projects more rapidly and within or below budget.

For incumbents in the E&C industry, rapid transformation is critical to stay ahead. These firms are facing increased competition from technology companies, both established ones and start-ups, that have recently expressed interest in infrastructure projects, viewing them as ripe for disruption and a logical extension of their existing portfolios. Although incumbents have the advantages of market share and brand recognition, they could lose ground to digital natives unless they move now.

There may be even bigger gains for companies that are first to market with new platforms, such as those for project management or material supply. Just as Amazon changed retail, Netflix changed entertainment, and Tesla is changing the auto sector, the digital leaders in construction could put the industry on a new path and set the standards to which others aspire. The real question is not if this will occur, but when.

Digital innovation within capital projects can take many forms

With change inevitable, stakeholders should focus on capturing value from digitization and the extent of their possible gains. Although capital-projects leaders may be tempted to implement any tool that appears promising, this blanket approach falls short because each company has unique needs. A better and more systematic method for determining
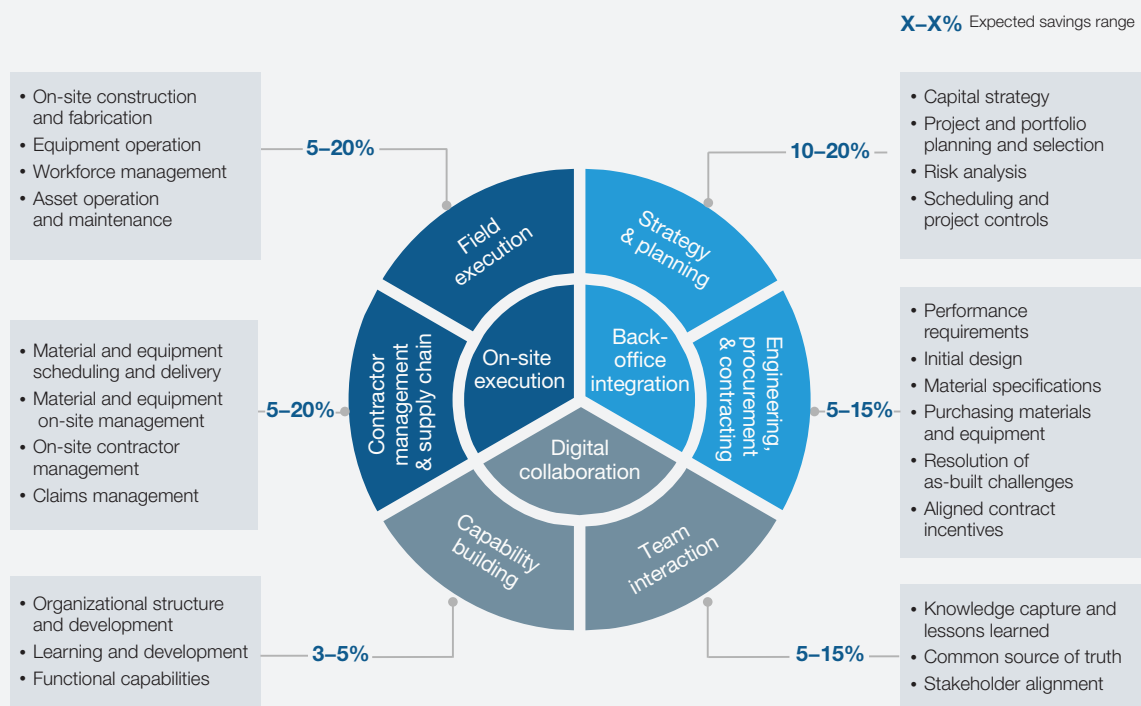
the right solutions involves first identifying a company's most acute pain points, as well as the opportunities it would like to pursue. Managers can then evaluate which digital tools will help them achieve their objectives, following an approach that classifies them on two levels (Exhibit 2):

- *Clusters.* Most digital tools fall into one of three clusters: on-site execution, back-office integration, or digital collaboration. As their cluster names suggest, tools within on-site execution and back-office integration are used to add value and create opportunities in these

settings. Digital-collaboration tools can be used in any setting, provided that they facilitate communication and interaction among members.

- *Tasks.* Within each cluster, companies should take the categorization a step further by classifying tools based on the specific improvements that they facilitate. Again, tools will fall into major groups. Within on-site execution, for example, most tools assist either with execution in the field or with tasks related to contractor management or supply-chain management.

Exhibit 2 **Companies should adopt a two-level system for classifying digital tools.**

X–X% Expected savings range

- On-site construction and fabrication
- Equipment operation
- Workforce management
- Asset operation and maintenance

5–20% — Field execution

- Capital strategy
- Project and portfolio planning and selection
- Risk analysis
- Scheduling and project controls

10–20% — Strategy & planning

On-site execution — Contractor management & supply chain

Back-office integration — Engineering, procurement & contracting

Digital collaboration

- Material and equipment scheduling and delivery
- Material and equipment on-site management
- On-site contractor management
- Claims management

5–20%

- Performance requirements
- Initial design
- Material specifications
- Purchasing materials and equipment
- Resolution of as-built challenges
- Aligned contract incentives

5–15%

- Organizational structure and development
- Learning and development
- Functional capabilities

3–5% — Capability building

Team interaction

- Knowledge capture and lessons learned
- Common source of truth
- Stakeholder alignment

5–15%

Source: McKinsey's Capital Projects & Infrastructure Practice's digital and innovation service line

This two-step categorization can help companies identify the right tools to address long-standing problems and estimate potential savings. For instance, tools within on-site execution may help increase productivity, eliminate cost overruns, and create more transparency about performance. An analysis of construction projects across industries shows that these tools can produce savings of up to 20 percent, but the gains may be much higher. With information like this, companies can make informed decisions about the investments that will bring the greatest business value, allowing them to build a portfolio of solutions that can be integrated seamlessly into their operating models.

Some digital solutions provide universal benefits

Although owners and E&C companies face unique challenges that will influence tool selection, certain ideas and solutions benefit virtually all organizations. We recently published another article, "Imagining construction's digital future," that describes some of the most important technologies that can increase value in major projects. Building upon that work, we have identified five basic areas where all companies must add solid digital capabilities to catch up to industry leaders:

- *Digital-project controls and work-front management.* Companies may experience delays and cost overruns because stakeholders look at different data sources when monitoring performance, resulting in conflicting progress reports. A cloud control tower helps eliminate these issues by providing real-time information about critical activities in a central database that all employees can access. For instance, the capital-projects unit of an electric-power company wanted to improve portfolio management and reduce costs across a pipeline of more than ten projects. It developed a control tower that provided real-time information on key performance indicators. The tower

also created performance visualizations by consolidating data not available at the site level (such as cost reports) and information from all E&C companies across locations. The company then used the control tower to identify issues related to cost, schedule, and quality as soon as possible, allowing it to take immediate mitigation actions. The control tower helped reduce costs by over 20 percent and decreased labor hours required for installation by over 15 percent.

- *Capital-portfolio management.* Construction stakeholders, particularly project owners, often struggle to manage diversified capital portfolios. Many widely available software programs can help, including those that track total portfolio expenditures, monitor progress, and flag potential issues that could raise costs or extend timelines. Some software programs also help with decision making, such as those that compare the projected results for two potential portfolios. In one portfolio of small- to mid-size projects, a company determined it could achieve potential savings of 20 to 30 percent through restructuring.

- *Next generation 5-D building information modeling (BIM).* Contractor management is difficult because documentation and project data tend to be scattered among different sources. 5-D BIM—the combination of 3-D physical models of buildings with cost, design, and scheduling data—can improve execution. While this technology is still developing, it is now sophisticated enough to be applied to most projects. In an extremely complex project, users may limit the use of 5-D BIM to specific subsections. Our experience shows that 5-D BIM can help companies in numerous ways. For instance, it can produce savings of up to 10 percent of the contract value through clash detection and reduce project life span and

material costs by about 20 percent. During a project at an airport, 5-D BIM reduced construction time by about three to five months by providing faster clash detection and better visualization of the proposed structure, reducing rework.

- *Advanced analytics.* Using machine learning, data-ingestion engines, and innovative pattern recognition, managers can now rapidly sort through millions of data points. With this capability, companies can compare the impact of hundreds of performance drivers on project or business outcomes. They can also identify the obstacles that raise costs and timelines. In some areas, advanced analytics may produce savings of up to 25 percent. The capital-projects unit of an oil and gas engineering organization used advanced analytics to identify drivers of efficiency loss, create benchmarks, and assess other factors that could affect performance. The analyses identified 15 to 25 percent productivity improvements for ongoing projects and 10 percent engineering savings across the organization.

- *Next-generation surveying and prefabrication analysis.* Virtual-reality tools help users view designs and prototypes, allowing them to interact with them as if they had already been constructed. That means they can see the exact size of various components before physical assets are fabricated. Similarly, advanced surveying tools help users understand as-built conditions and compare them with designs. For instance, one tool uses a drone and 3-D imaging to create a regular cadence of precise, millimeter-level surveys of construction progress.

While these five capabilities will provide many benefits, companies may not capture maximum cost reductions from digitization until they implement complex solutions that require greater digital skills, including those that rely on autonomous vehicles, automated construction processes, and 3-D printing. All these technologies are already creating significant value at some companies, although their use is still limited.

Capital-planning stakeholders must take action now to become digital leaders

Although many companies have implemented digital programs, most have not been able to quantify the benefits, making it difficult to gain more widespread support and buy-in across their organizations. But with potential cost reductions of up to 45 percent on each project, both owners and E&C companies must now build a clear business case for digital investments by implementing top-down initiatives to identify opportunities, measure progress, and share successes.

A review of past digital initiatives suggests that many fail because project leaders in the field are reluctant to implement new technologies, believing that they will increase costs and risks while conveying few benefits. To counter this perception, a company's CEO and board members must take ownership of the digital transformation from the outset, focusing on three building blocks: strategy (linked to business value), project enablement, and enterprise transformation (Exhibit 3).

Strategic direction and control

As a first step, CEOs and board members should create a comprehensive strategy, communicate it throughout the organization, and develop a transformation road map with tangible objectives. They should also install a transformation management team, providing it with decision-making authority and the full support of senior leadership.

When evaluating potential solutions, a company should prioritize investments based on their ability to address its greatest needs. It should rigorously

Exhibit 3 **In a digital transformation, leaders should focus on three building blocks.**

1 **Strategic direction & control**
- Develop overall strategy innovations
- Set clear objectives
- Develop transformation road map
- Shape story and communicate
- Install transformation management

2 **Project enablement**
- Define digital-project selection criteria and scope
- Identify suitable projects
  - fully digital projects
  - injection of digital applications (use cases)
- Run projects in waves
- Adapt based on learnings

3 **Enterprise transformation**
- Develop implementation plan
- Install digital-project unit
- Assess IT infrastructure

assess value using a systematic approach that helps estimate potential cost savings. The two-step assessment described in the previous section, which calls for tools to be classified based on the cluster in which they fall and the activities that they facilitate, is one option.

As leaders set their strategy, they must also realistically assess their company's digital capabilities—an analysis that will prevent them from selecting tools that grab headlines but are too complex for their organization to implement. Generally, the assessment will show that a company falls into one of three categories—digitally nascent, emerging, or capable—based on its digital investment levels and experience (Exhibit 4).

A company's digital maturity level will help determine near-term digital priorities. Consider field tools. A digitally nascent company might simply deploy basic tools that increase collaboration and transparency about a project's progress. At the other end of the spectrum, digitally mature companies might focus on field tools that fundamentally change operations, such as on-site 3-D printing or autonomous vehicles.

Communication is also critical during the strategy phase, since leaders must build support from all staff, including project managers in the field, to ensure that they use the proposed solutions.

Project enablement
Even the most capable companies should be careful to avoid overburdening staff or budgets during the early wave of a digital transformation. They should include a limited number of projects in the first wave of implementation, using clear selection criteria. Managers should also define and manage the scope of each digital initiative, noting the exact areas where it should generate improvement. After the first projects have launched, companies can embark on additional implementation waves that encompass more projects and generate greater impact. As leaders gather feedback from staff, clients, and other stakeholders, they can adjust their strategy as needed.

Enterprise transformation
Comprehensive digital transformations—those that reach all business units and levels within a company—are difficult to launch and maintain across project teams, which tend to have different

Exhibit 4 **Companies must understand their current digital capabilities to identify appropriate solutions.**

Digitally nascent	Digitally emerging	Digitally capable
• Limited investment in digital and innovative industrial solutions • Lack of digital-management appointments and clear digital strategy	• Some investment in one-off digital solutions for common challenges • Basic technological capabilities established	• Large investments in scalable digital solutions across projects and project phases • Advanced technological capabilities well rooted in the organization

Most companies are digitally nascent, some are emerging, and a few are digitally capable.

processes and goals. To generate value without disrupting the core business, companies should consider establishing a "Newco"—a business unit with the specific skills and resources to facilitate digital change across multiple projects. Newcos typically ensure that agile and lean processes are in place to support the tools, and they can scale up innovative programs more quickly than can traditional business units. As other groups see the value that Newcos generate, they will be more likely to appreciate and accept digitization.

Companies in many other industries have created Newcos to assist with digitization, often consecutively migrating service lines to them. For instance, the banking and finance industry made the transition to digital by creating Newcos. Within construction, stakeholders could take a similar strategy, migrating projects rather than service lines. As one example, the Newco might specify that all projects under its mandate must use 5-D BIM, adjusting timelines, organizational structures, and work processes to accommodate this shift.

Of course, strong management will be essential for any digital initiative, but companies may choose

different approaches. Some may appoint a chief innovation officer to handle all initiatives, while others may delegate responsibility for different tasks to business-unit leaders.

Another crucial prelaunch step involves the creation of implementation plans that describe how the first few digitized projects should proceed. To help keep teams focused on appropriate digital goals, the plans should specify all major performance indicators and milestones. While developing their implementation plans, companies should reassess their technology infrastructure and determine if it will support their desired goals—not all legacy systems are compatible with advanced tools.

Finally, companies must consider revising their pricing strategies. They may need to emphasize the benefits of digital solutions and innovative approaches to customers at the project-proposal stage. Without buy-in from all major stakeholders on the client side, it will be difficult to drive adoption. (See sidebar, "How does digital transformation work?" for a hypothetical example of a project that has successfully progressed from the strategic-planning stage through implementation.)

How does digital transformation work?

When designing a digital strategy, companies must focus on change in three areas: people, processes, and tools. Consider a hypothetical example involving the capital-projects unit of a North American chemical company that is building a $1 billion petrochemical complex. The unit has a long history of running over budget on such projects and wants to investigate digital solutions that can improve productivity.

While past projects may have been unsuccessful, they provide the capital-projects unit with robust data about costs, timelines, and productivity. Top managers examine this information to identify the major pain points, as well as undiscovered opportunities. They discover numerous issues with on-site execution, including difficulties deploying staff to the right locations when needed. There is also significant downtime after new crews arrive on site as they await directives from management. All too often, management does not know what is happening in the field because of communication breakdowns. Quality problems are also common, with many fittings needing to be resized after fabrication.

The company's CEO and board members then create a strategic plan and assess the capital-projects unit's digital maturity—an analysis that reveals that its capabilities are nascent in most areas and emerging in a few. After considering its maturity in combination with the information on pain points and opportunities, they create a road map that describes how the unit will build digital solutions into several projects in its pipeline,

including automated-workforce-planning software and a cloud control tower. The plan also discusses how processes and organizational structures will need to change. Since the capital-projects unit has mostly emerging capabilities within its engineering and design functions, it decides to introduce a more advanced tool there—5-D BIM.

The CEO communicates information about the plan throughout the unit, personally speaking with a few project managers to gain their support. To avoid overwhelming staff, the first wave of digital implementation involves rolling out the selected tools on two projects. On each project, select team members are asked to compile information about best practices and lessons learned. The next wave of implementation will include four projects.

The chemical company creates a Newco to launch the selected projects and hires a chief technology officer to lead it. The Newco also recruits more digital talent and helps existing staff members build their capabilities. Managers incorporate digital solutions into existing processes, revising timelines as needed. For instance, they add several weeks to the planning phase, before construction begins, to ensure that the control tower is ready to process information in real time. They then reduce some of the buffer they had put into the execution timeline, recognizing that the new solutions will facilitate efficiencies. Also—and perhaps most crucial—they are careful to show staff the benefits of the new tools, generating excitement even among those who were reluctant to abandon traditional processes.

Tips for maintaining momentum

Even though many companies are firmly committed to digitization, their initiatives often lose momentum, with staff returning to traditional processes after a few months. Capital-projects leaders can avoid this problem by creating new organizational structures and processes that promote innovation—either within a Newco or within the existing business. Leaders should assign responsibility for developing and coordinating execution of the digital strategy to specific groups or individuals. In tandem, they must shift performance-management and capability-building processes to place more emphasis on digital skills.

Outside hires may be essential to fill some talent gaps. For instance, Newcos should be free to recruit new staff with the skills needed for large-scale implementation. They often begin by hiring a chief technology officer and later add data scientists to support analytics and project-controls personnel who are experienced with digital-project management.

Many businesses will also need to revise their long-standing processes and timelines. Take project planning. Most companies complete this phase relatively quickly, but they may now need more time to get cloud control towers and other tools up and running before a project begins.

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With the capital-projects industry on the brink of digital disruption, stakeholders must transform their companies. Although digital tools will not eliminate all productivity issues, they represent the greatest improvement lever available. Companies that are slow to digitize, or that lack a bold, well-structured transformation plan, will lose ground. To make the big shifts that digitization requires, leaders must become less risk averse and adopt an aspirational mind-set. Sophisticated, groundbreaking tools, including those that use artificial intelligence, should be given full consideration, rather than dismissed as risky. While each organization may pursue different digital priorities, they must all share a commitment to large-scale change to succeed—and that means altering business and operational models to support innovation. Bold leaders and fast movers who aggressively support digital programs will likely reap the greatest rewards. ■

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