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The cornerstones of large-scale technology transformation

A clear playbook is emerging for how to integrate and capitalize on advanced technologies—across an entire company, and in any industry.

by Michael Bender, Nicolaus Henke, and Eric Lamarre

How does your company use advanced technologies to create value? This has become the defining business challenge of our time. If you ignore it or get it wrong, then anything from your job to your entire organization could become vulnerable to rivals who get it right. The new technologies come with many labels—digital, analytics, automation, the Internet of Things, industrial internet, Industry 4.0, machine learning, artificial intelligence (AI), and so on. For incumbent companies, they support the creation of all-new, digitally enabled business models, while holding out the vital promise of improving customer experiences and boosting the productivity of legacy operations. Advanced technologies are essential to modern enterprises, and it's fair to say that every large company is working with them to some extent.

In private discussions over the past year, we've asked more than 500 CEOs whether they think technology can improve business growth and productivity sufficiently to lift profits and shareholder value by 30 to 50 percent; a great many have said yes. So far, though, that prize has remained elusive for a lot of companies. Consider, for example, McKinsey research highlighting the

large number of digital laggards, and the wide gap between them and leaders: digitally reinvented incumbents—those using digital to compete in new ways, and those making digital moves into new industries—are twice as likely as their traditional peers to experience exceptional financial growth.[1]

Most senior executives recognize the magnitude of the task before them. Although incumbents possess advantages such as hard assets, customer relationships, and valuable brands, those strengths—and the scale that accompanies them—also vastly increase the complexity of digital transformation. Some enterprise-wide technology transformations come up short simply because leaders have a difficult time creating coherent strategies that stitch together their digital priorities with other major business objectives.[2]

What's more, even companies that devise sound strategies are likely to encounter two formidable obstacles to using advanced technologies at a transformative scale. The first challenge is the sheer number and breadth of technology solutions required to truly transform an enterprise, often in the hundreds. The second one might be called the "last-mile" challenge: redesigning a company's processes to capture the value of new technologies, in line with its strategic goals. Both sound technical, but they play out far from the traditional IT organization and create headaches for the business leaders who will need to guide their people toward new patterns of thinking and operating.

A playbook for overcoming these challenges is starting to emerge across industries. In this article, we'll explore five cornerstone practices underpinning the progress of successful companies:

- Develop technology road maps that strategically focus investments needed to reinvent their legacy businesses and create new digital ones.
- Train managers to recognize new opportunities and build in-house capabilities to deliver technologies.
- Establish a modern technology environment to support rapid development of new solutions.

[1] See "How digital reinventors are pulling away from the pack," October 2017, McKinsey.com.

[2] For more on this problem, see Jacques Bughin, Tanguy Catlin, Martin Hirt, and Paul Willmott, "Why digital strategies fail," *McKinsey Quarterly*, January 2018, McKinsey.com.

- Overhaul data strategy and governance to ensure data are reliable, accessible, and continuously enriched to make them more valuable.

- Focus relentlessly on capturing the strategic value from technology by driving rapid changes in the operating model.

DISTRIBUTED OPPORTUNITIES

The first scaling challenge is rooted in the sheer number of solutions that a company typically needs to carry out its digital strategy successfully. Consider, for example, a global mining company seeking dramatic productivity improvement through technology. Boosting the productivity of a mine would typically involve deploying solutions in a half-dozen broad domains such as "better ore-body management through advanced analytics" or "predictive maintenance to reduce maintenance costs and increase uptime." Each domain, in turn, might contain dozens of more specific opportunities. Predictive maintenance, for instance, can be applied to drills, shovels, and heavy-hauling trucks. For hauling trucks, specific solutions might be needed to deal with operating conditions, drivers' behind-the-wheel behavior, and the reliability of truck components and systems. All told, we estimate that it takes more than 100 technology solutions to maximize the productivity of a mining operation (Exhibit 1). In industries as diverse as banking, electric power, and retail, we have found that the benefits of technology are distributed among a similarly large number of opportunities. Across the business landscape of AI alone, McKinsey has inventoried more than 400 meaningful use cases.

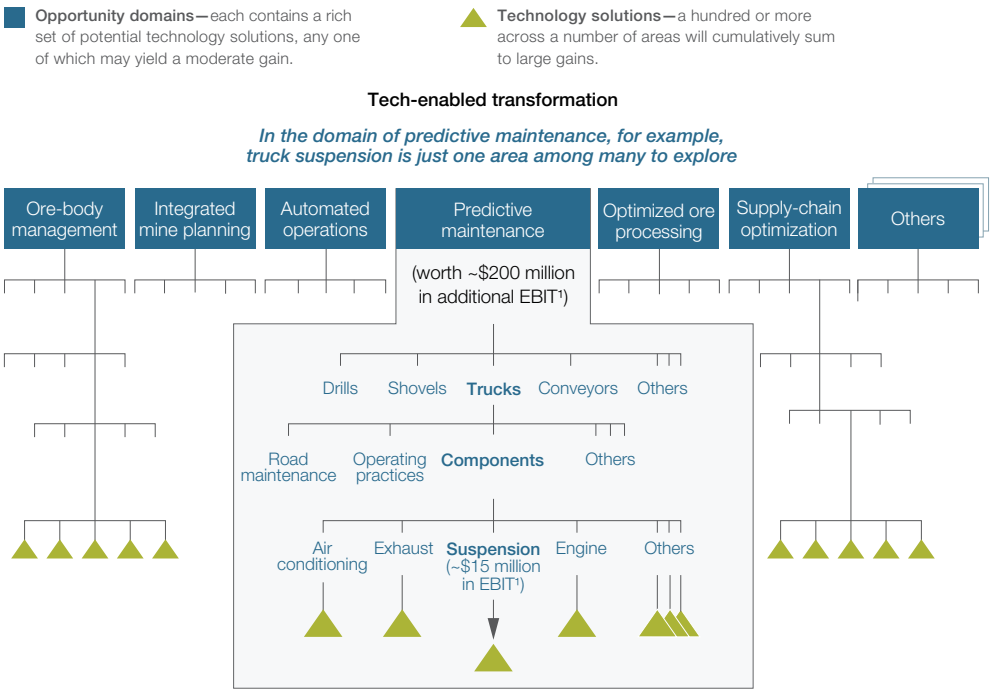
While some solutions deliver more bottom-line impact than others, none will typically be a "silver bullet" that makes a genuinely transformative impact on its own. And since many technology innovations can be replicated by rivals within a year or two, the advantages they confer seldom last for long. Enduring advantages are more likely to accrue to companies that can sustain a high rate of innovation, consistently introducing new solutions and improving them with proprietary data.

Creating a few pilot solutions is relatively straightforward, and many companies have done so. During an initial experimentation phase, it's normal to use technology contractors and vendors to create solutions. But relying on third parties becomes impractical once a company establishes a digital strategy that calls for building a hundred or more solutions. Technology solutions must be tightly aligned with business needs, and as users try them out, they're likely to discover shortcomings—necessitating progressive refinement. The many handoffs that take place with external

Exhibit 1

Deploying technology solutions in half a dozen or more broad domains can yield a significant gain in annual EBIT: potentially $1 billion or more for a global mining company.

Example: A global mining company explores opportunities in the domain of predictive maintenance



[1] Earnings before interest and taxes.

providers over multiple revision cycles make this iterative mode of collaboration expensive and inefficient. Scaling up effectively therefore requires ample in-house technology-development capabilities—capabilities that few companies possess.

THE 'LAST-MILE' CHALLENGE

The second challenge that arises in technology transformations is capturing the business value of new solutions. Consider the predictive-maintenance opportunity for the mining company described earlier: technology makes it possible to boost productivity by performing maintenance only when a truck's condition warrants it, rather than adhering to a schedule of preventive measures that are sometimes premature.

But the mining company won't spend any less on labor and parts or keep its trucks in service longer, unless it changes the work routines of many maintenance-related experts. The reliability engineer minimizes excess

effort by learning to triage predicted maintenance events. To prevent the downtime that can occur when trucks no longer come in on a known schedule, the maintenance-planning team creates a new scheduling procedure, and the inventory-management team finds a way of restocking that ensures the right parts are on hand when trucks are brought in. The maintenance team accelerates repair work based on new diagnostic information. And finally, the financial-planning team reallocates the money saved on maintenance to other activities or additional profits.

This example illustrates a decisive, often overlooked fact about technology transformations: the value of advanced technologies largely comes from performance gains beyond the operating unit or process where a technology is applied. To realize this last-mile value, companies have to train people in R&D, procurement, operations, marketing, sales, support, and other areas to work in different ways. Incumbents routinely underestimate the effort required—if they think about it at all. And the last-mile journey may be even more challenging when the goal is to build entirely new businesses with advanced technologies.

When a business commits to transforming itself with technology, the cost of changing its operating model can easily exceed the cost of developing the technology solutions. McKinsey has learned that businesses with highly successful analytics programs, for example, are four times as likely as other companies to devote more than half of their analytics-related spending to embedding the use of analytics in their workflows and decision-making processes. A company must therefore look at the release of each technology solution not as the final act in a project but as a turning point that sets up a new phase of operational changes.

ACHIEVING SCALE AND CAPTURING BENEFITS

The need for a large number of technology solutions and the last-mile challenge may be familiar hurdles to readers who lived through the lean revolution some 25 years ago. Capturing value from lean initiatives involved driving each process change all the way through the operating model of the business. No single lean project could generate a major performance improvement, but a rich portfolio of lean projects could.

To make the transformation manageable, companies implemented lean projects in waves, tackling processes or units of roughly 200 people at a time. They first developed a vision for how each process or unit would be transformed. Then they built benches of lean experts (often called black belts) to manage change and ensure the new operating practices were adopted.

Even though lean methods were never proprietary, companies such as Toyota used them to ceaselessly pursue small performance improvements, and thereby build and protect an advantage over their competitors.

Our experience working with digitally reinvented incumbents suggests that a similar playbook is emerging in tech-enabled transformations encompassing five cornerstone practices described below.

Creating business-led technology road maps

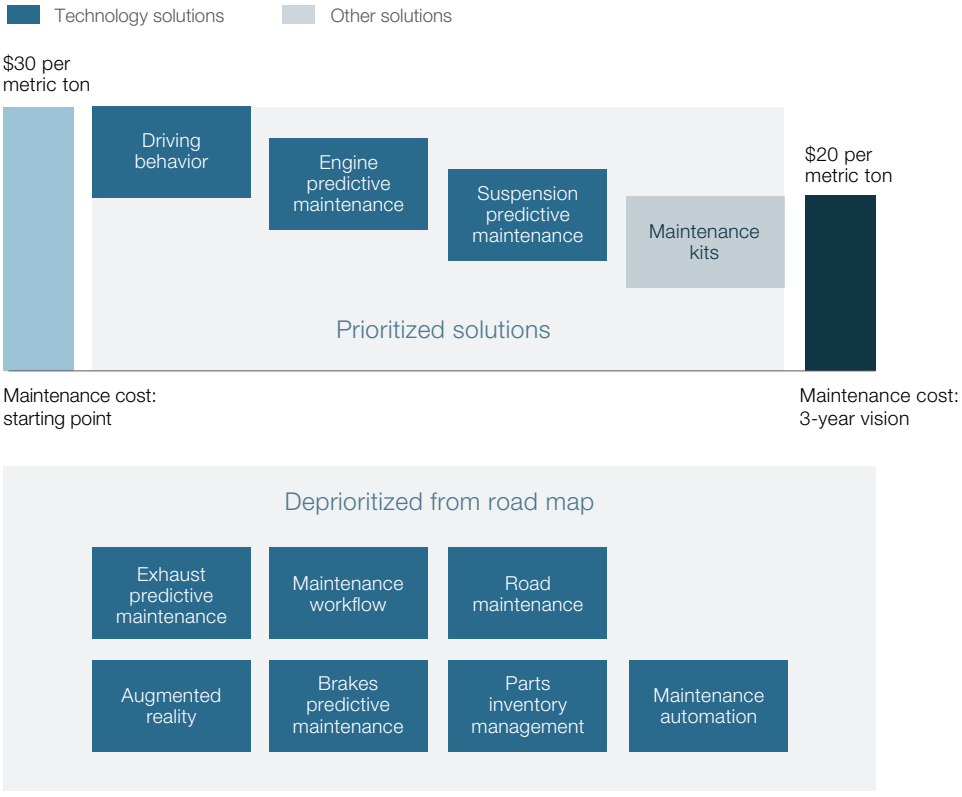
Large-scale technology transformations can begin once CEOs and top leaders have agreed on a bold, comprehensive digital strategy and an overarching vision for how technology can enhance their companies' performance. (For more on crafting a digital strategy, see "Digital strategy: The four fights you have to win," on McKinsey.com.) The critical next step, one that too few executive teams take with sufficient diligence, is to develop a road map of technology solutions that will achieve the transformation vision. The road map is a powerful tool because it aligns business and technology leaders on the sequence of solutions to be developed (and, likewise, on the solutions that should be deprioritized). It also articulates clear, ambitious objectives, whether for building a new digital business that taps large, nontraditional revenue pools or for steadily improving the productivity, quality, or customer satisfaction of the core business. The mining business described earlier, for example, devised a road map of solutions to help it deliver on a high-level vision for using technology to significantly reduce hauling costs (Exhibit 2).

It's crucial for business leaders, in collaboration with technology specialists, to direct the creation of technology road maps for their units personally, because they are best positioned to know the unmet needs of customers and the sources of waste in their operations, and best able to target solutions accordingly. They also can be held accountable for ensuring the successful development and implementation of solutions, as well as the capture of their expected benefits.

One global designer and maker of electronics products demonstrated a sound approach to creating road maps when it plotted the transformation of its manufacturing operations, as part of a broader effort to continue leading the industry on cost, quality, and lead time. The leader of each major unit in its value chain—inbound supply and logistics, circuit-board fabrication, assembly, and outbound logistics—began by assembling a cross-functional team of people to analyze the unit's business processes from end to end, paying close attention to customer or user pain points and sources of waste.

Exhibit 2

A mining company created a road map that prioritized specific technology solutions to reach the targeted reduction in hauling costs.



Next, the team articulated potential improvements (such as greater output from circuit-board fabrication, lower assembly labor costs, and shorter production lead times) and identified suitable technology applications. In all, the teams defined more than 100 applications. Only 32 of those were selected for development, based on the maturity of the underlying technologies and the potential returns on investment.

Unit leaders grouped the 32 solutions into three waves to roll out over two years, starting with low-cost options. In inbound supply and logistics, for example, the first wave of solutions focused on using robots and AI to automate in-plant logistics or the movement of materials and components within factories. The second wave called for automating warehouses in a similar fashion, and the third wave anticipated the use of emerging technologies, such as augmented reality, that would improve the

accuracy and efficiency of manual labor. Each unit prepared its road map independently, making connections with other units where necessary. This way, each unit could focus on building and implementing the solutions it needed to transform its area of operations.

Building in-house capabilities

An essential component of achieving scale in a technology-enabled transformation is having sufficient in-house technology expertise and talent. One proven model for building a technology bench is the "technology factory." Such a factory is wholly at the service of the business and governed by the business. It provides the sort of work setting that is necessary to attract technology talent and achieve high-velocity development.

Scotiabank, a large international bank, set up such a factory in 2015. Headed by the bank's chief digital officer, the factory employs 700 technologists and functional specialists, who are grouped into small agile teams that share expertise, development tools and methods, and proprietary software and analytics. Scotiabank structured its factory as a network of five hubs, with one co-located in each of its five core geographic business units to promote close collaboration. Scotiabank's factory ordinarily develops 20 to 25 solutions at a time. Over the past two years, factory-built solutions have helped the bank to nearly double the share of sales made through online channels from 11 percent of revenues to 20 percent, on the way to a medium-term goal of 50 percent.

Scotiabank's factory, like other successful ones we've seen, exhibits several distinguishing features. Depending on the size of the company, a technology factory typically employs between 50 and 1,000 technology specialists: designers, software developers, data scientists, data engineers, platform architects, AI experts, automation engineers, analytics translators, product owners, and digital marketers, among others. The composition, scale, and skill set of the factory's workforce reflect the portfolio of solutions and the development pace specified in business units' technology road maps. With road maps focused on optimizing customer journeys, Scotiabank initially skewed its technology bench toward designers and software developers.[3]

To fill out a factory's roster, companies usually have to search far and wide. In our experience, it's not unusual for half of a factory's staff, particularly in technical domains, to be recruited externally, which is partly why it

[3] Each technology factory will have particular staffing needs. For example, a steel company seeking to maximize yields might need a main contingent of data scientists and analytics translators who can effectively bridge the worlds of steel operations and analytics.

can take 12 to 18 months to set up a well-functioning factory. A staffing campaign of this scale will falter if it is not directed by a leader with a proven ability to recruit and retain digital talent. At Scotiabank's factory, external hires make up about 60 percent of the workforce, and the remainder hail from the bank's IT department and other business units. Scotiabank also provided training to help the factory's workforce establish a common working style and set of methods. Internally hired business and technology experts, for example, received coaching in agile development if they weren't already familiar with it.

Arguably, it's even more important to spread knowledge of advanced technologies and their uses throughout the business. Interventions to effect cultural change and skill building can take any number of forms. At DBS Bank, CEO Piyush Gupta has noted, "One of the big things we focused on was how to get the company technology literate." After it learned that "classroom sessions didn't work," DBS staged a series of 72-hour hackathons in which its employees teamed up with people from tech start-ups to build apps. Coming out of the hackathons, Gupta said, "The renewed confidence and self-belief among employees was astounding."[4]

By contrast, one of the world's leading steel plants, the Tata Steel IJmuiden plant, in the Netherlands, offered on-the-job technology training with a "field and forum" approach. The company provided some 200 operations managers and engineers with enough training in advanced analytics that they could serve as analytics "translators," capable of spotting potential new opportunities to use sophisticated techniques and then deploying them or acting as business champions. Tata achieved this by cycling cohorts of managers through classroom training forums while having them perform hands-on projects in the field. The training curriculum left managers with a shared vocabulary and understanding of concepts such as agile, technology stacks, data governance, and data management. This common understanding of technology enables senior executives and managers to quickly align in the pursuit of new opportunities and to "pull" for the services and support of technology specialists (versus having IT "push" solutions).

Modernizing the technology environment

Two features define the core of a modern technology environment: a data platform and a development environment for producing software and

[4] See "The digital reinvention of an Asian bank," *McKinsey Quarterly*, March 2017, McKinsey.com.

analytics code.[5] Without these, a company's tech-enabled transformation quickly stalls and becomes mired in complexity. The good news is that technological tools have evolved rapidly over the past two to three years, and it is now possible to deploy these cloud-based solutions quickly and at relatively low cost.

Nutrien, a global supplier of agricultural inputs, built a data platform—a cloud-based middle layer—that centralizes information from 13 different in-house systems, as well as from external data sources. The platform makes the data readily available to a range of newly built employee- and customer-facing applications, such as online commercial transactions and agronomic services for farmers. Technology architects linked both legacy systems and new digital applications to the data platform through application programming interfaces (APIs). Whenever a core system or a digital application is upgraded or added, architects unhitch the old program from the data platform and hook up the new one—with minimal disruption. Introducing a data platform made Nutrien's enterprise architecture modular and flexible, creating a so-called two-speed architecture that easily integrates fast-evolving customer- and user-facing solutions with slow-evolving legacy systems.

In addition, Nutrien set up a modern software-development environment. The environment enables multiple developers to work on the same application in parallel and automates software testing and in-production release of new applications, reducing cycle times from months to hours. This new way of working is key to developing and improving software at a swift pace, especially once a company moves beyond the pilot phase of its transformation.

Data platforms and code-development environments should be among the first investments that companies make to facilitate the expansion of their technology programs. Although the cost and complexity of such efforts increase with the number of legacy systems and external data sources, as well as with the volume, sensitivity, and real-time nature of data in play, these additions are now easier to make with modern, cloud-based tools. The Nutrien business unit described above went from concept to live operations in less than six months, using off-the-shelf tools, and spent less than $10 million.

[5] There are other aspects of a modern technology environment not addressed here such as bandwidth, computing power, connectivity, real-time processing, storage, and virtualization.

Overhauling data strategy and governance

Every executive understands that data are a source of competitive advantage, but surprisingly few have put in place the business practices to capitalize on the value of data. As companies move beyond piloting solutions, they find that their data are messy, hard to access, and undifferentiated from their competitors'. Scaling beyond a few solutions becomes complex and slow for them, and often yields unimpressive results because the underlying data are poor.

It doesn't have to be this way. The value of data is directly related to the technology solutions that the data enable. Data strategies therefore should start with the technology road map described earlier and, for each tech solution, articulate the data needed. If you want to automate insurance underwriting by relying solely on the customer's name (rather than using medical tests and customer form filling), you need a vast array of external data—and a permissive regulator. If you seek instead to automate claims management, your data requirements may be very different. Prioritizing the data domains that support the initial set of solutions on the technology road map is a critical first step.

Next, the prioritized data domains should guide the data ingestion efforts, be it from legacy systems or external data sources. Value in data is often unlocked by linking data from very diverse sources. For example, Aston Martin substantially reduced the development time of new luxury cars by linking data from around 30 different sources, ranging from team composition and product drawings to parts features. In parallel, the chief data officer should be developing the appropriate data-management processes, such as establishing conventions (a "master data model") for defining data down to the syntax of customer names and assigning, to explicit data owners, responsibility for maintaining high-quality data. Data management has become an essential capability to any successful technology transformation.

Many leading players regard their data strategies and models as a long-term, multiperiod chess game. Ping An, a leading Chinese financial institution, started with data in banking and insurance and over time developed a customer-data ecosystem across nine industries ranging from automotive to healthcare. (For more, see "Building a tech-enabled ecosystem: An interview with Ping An's Jessica Tan," on McKiney.com.) Some companies obtain data assets through M&A. IBM's acquisitions of Explorys and Phytel,

for example, were healthcare-data plays. Many innovative companies, not satisfied with the data "exhaust" they can collect or buy, strive to create new data that are directly relevant to their anticipated use cases. An energy-trading business, for instance, is deploying webcams next to power-generation sites to understand the volume and mix of fossil fuels being burned and to better predict future regional demand. Examples such as these speak to the iterative nature of data-strategy efforts and to the importance of continually enriching your data assets. We strive for the same at McKinsey, by conducting an annual strategic process to consider which data sources and partnerships, among nearly 200 functional and industry data domains, should be expanded in the following year.

Changing the operating model to capture technology's value

Scotiabank's road map for enhancing its online credit-card application highlighted an array of technology solutions: digital marketing tools to find, target, and attract customers on the web; a streamlined application process that would cut the rate at which customers abandoned partly completed applications; and advanced analytics to improve pre-approvals, for example. While these solutions stood to improve customer satisfaction and reduce unit costs, Scotiabank could only capture the benefits by making corresponding operating-model changes across many different areas such as rebalancing online and offline marketing investments, and reducing staffing levels in the back- and mid-offices. These changes, some of which are still underway, are helping the bank to increase online card sales substantially while cutting acquisition costs compared with in-branch applications.

Time and again, though, we have seen companies succumb to the last-mile challenge, deploying new technologies in one area of the business but failing to make value-creating adjustments to its operating model in other areas. Last-mile value capture must begin with understanding how technology will change the business model and its underlying economics. By tracking the expected impact of technology systematically across many organizational units, companies can learn to work across silos and capture the full benefit (see sidebar, "The big roadblock to digital implementation"). Reconciling competing incentives across organizational units is a classic example of this. A plan to sell more credit cards online, for instance, might go over badly with the head of the retail-branch network who is rewarded for in-branch revenue increases.

THE BIG ROADBLOCK TO DIGITAL IMPLEMENTATION

Rallying the organization around technology change beyond early sprints is as difficult as it is critical. It takes new mind-sets, coaching—and a commitment to work across organizational boundaries.

by Bruce Delteil, Blake Lindsay, and Khoon Tee Tan

A defining characteristic of major technology transformations is their cross-cutting nature: in a McKinsey survey, 75 percent of the executives responding said that such transformations affect multiple business units and functions.[1] Indeed, a technology transformation is likely to generate major financial benefits only when it changes most (if not all) parts of a company. Working across organizational boundaries, however, is a perennial challenge that many companies still struggle with. That contributes to the low success rate—just 37 percent, according to survey respondents—of digital implementation efforts.

What we have seen, over and over, is that some of the core practices associated with strong implementation—planning beyond sprints, keeping teams mobilized over time, and adapting performance management to the new demands on the organization—are difficult to drive across functional and business borders. Consider, for example, the "common cause" problem executives often cite: employees sometimes balk at working together across internal boundaries until they have developed a shared sense of where the company is heading and a willingness to help solve thorny institutional problems. Slowdowns and setbacks also occur as companies implement new cross-cutting processes that may not mesh with siloed, legacy ones but are critical to capturing last-mile value. Teams need a lot of coaching before they will adopt cross-functional ways of doing things. And if coaching doesn't continue and performance-assessment criteria aren't updated, the organization can start to regress as soon as the first wave of the transformation effort concludes.

For evidence that long-standing companies can implement digital-age changes, look at the accomplishments of Lloyds Bank, founded more than 250 years ago. In a first step toward digital transformation, Lloyds began building the in-house technology capabilities it would need to reinvent customer journeys from end to end. Crucially, the bank could push the implementation of advanced technology solutions across functional lines. A key to unlocking the value of the investments was coaching the cross-functional teams that support these journeys to work together and use technology assets to their fullest. The result: a "return on digital" amounting to several multiples of the bank's investment and a position as one of the United Kingdom's largest digital banks.

[1] "How the implementation of organizational change is evolving," February 2018, McKinsey.com.

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We've seen several CEOs accelerate their companies' technology transformations by appointing a senior executive to a multifaceted leadership role that includes driving cross-unit collaboration, mapping where technology benefits are expected, holding leaders accountable for capturing those benefits, resolving conflicting incentives, and removing impediments to value-capture efforts. Once issues such as these are clarified for business-unit and functional leaders, it's easier to lock in their value-capture commitments, to link that value to real-world performance improvements, and to help them recognize the necessary, supporting changes to their operating model. For example, asking a bank's head of back-office operations to reduce her staff by one full-time equivalent for every 1,000 credit cards sold online (rather than through the branch network) helps the bank progressively capture the benefits of its online credit-card application.

Ultimately, a technology-enabled transformation calls for a continuous, enterprise-wide effort to improve the operating model. It is no longer a one-time, big-bang, IT system deployment. As customers and internal users adopt technology solutions, every business area that is affected adjusts its processes accordingly. That can happen rapidly when the technology is disruptive or a new digital business is being created, but more often, the change unfolds progressively.

At many large traditional companies, a moment of reckoning has arrived. Not only is it difficult to scale up technology transformations beyond a handful of pilot projects, but broad-based efforts to apply and integrate advanced technologies are placing new demands on senior leaders. They must define technology road maps to drive strategic use of resources, invest in technology-development capabilities while training their managers, build a modern technology environment that can support multiple, fast-evolving solutions, ensure a strategic evolution of data assets across the enterprise, and reinforce a commitment to operating-model changes that will capture the business value of new technology solutions.

These enterprise-wide changes are critical to seizing today's technology opportunities, and tomorrow's. After all, the real competitive edge comes from repeatedly being first to market with innovative technological solutions and integrating them deeply into the operating model of the

enterprise. This is a final lesson from the lean-management revolution. Lean methods were widely known, yet Toyota and other companies still developed competitive advantages by using lean to orient their organizations comprehensively—from the CEO to the shop floor—toward the achievement of world-class performance. The information-technology revolution is playing out in a similar way. The companies that derive a true competitive advantage from technology will be those that make tech-enabled transformation a permanent business discipline. Q

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