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Digital

Tech-enabled transformations

A CEO's guide to maximizing impact
in industrials

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Introduction

Last year's compendium highlighted that industrial companies could generate more than $1 trillion in value by applying digital technologies, analytics, and the Internet of Things to their operations.[1] We discussed why executives should focus on five business domains—innovating and developing products, making and delivering them, selling them, servicing them, and running the business—and outlined the levers that companies must pursue to unlock this value.

Over the past year, our work with clients has helped to refine the potential across industrial segments and deepened our understanding of how to achieve a tech-enabled transformation. The result is a comprehensive playbook that companies can use to chart their own course. In our experience, implementing this playbook can more than double the odds of maximizing a tech-enabled transformation's impact.

We developed the articles in this collection to provide additional detail on how to embark on this journey as well as the performance improvements that industrial players can achieve across business domains. Our hope is that this detailed, practical guidance will give industrial companies a concrete starting point to maximize the impact of technology investments on their organization.

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[1] *Tech-enabled transformations: The trillion-dollar opportunity for industrials*, September 2018, McKinsey.com.
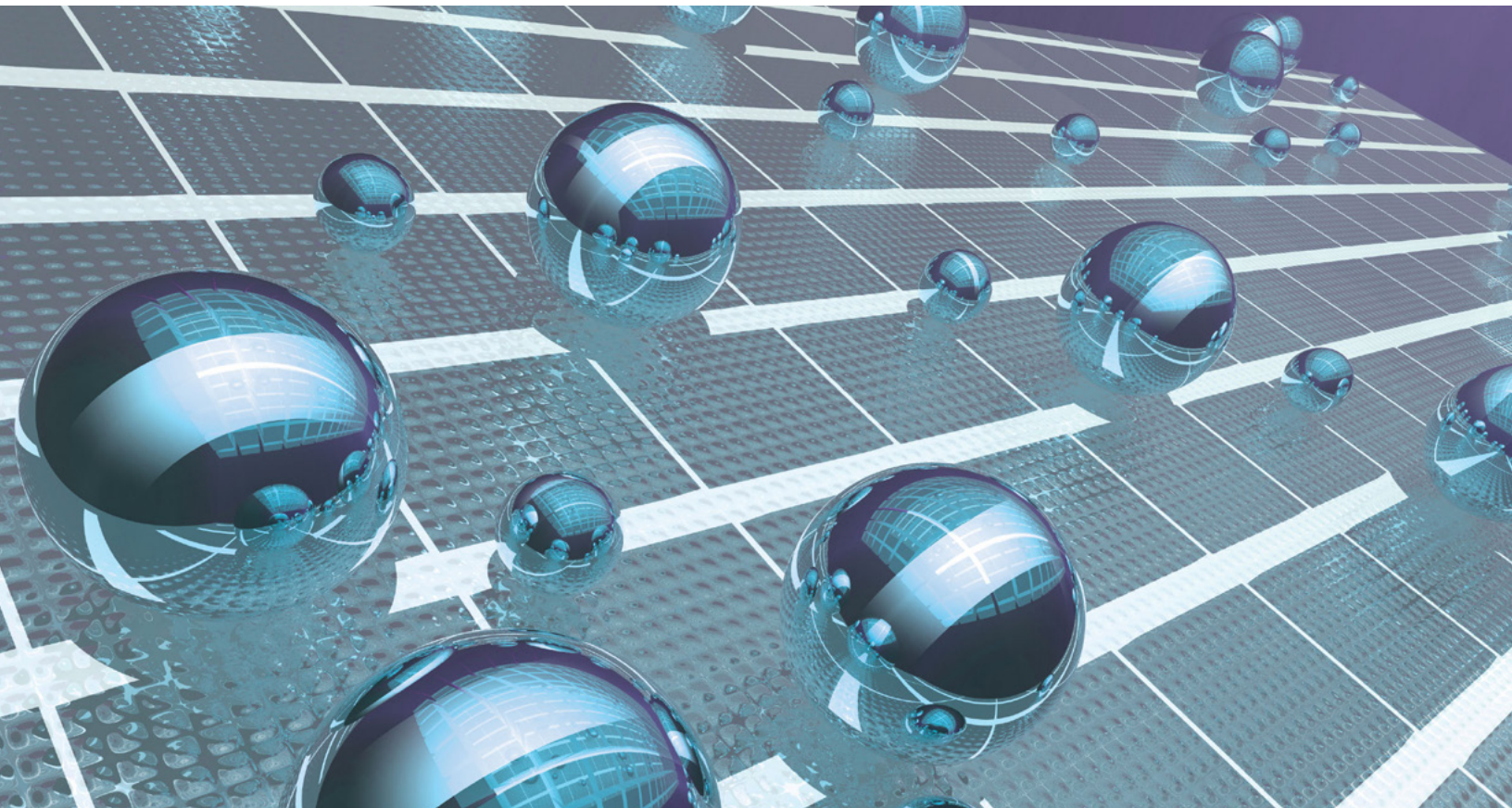
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Part 1:

Maximizing the impact of tech-enabled transformations in industrials

Why industrials should pursue a tech-enabled transformation now

Shifting market dynamics and rising competition compel industrial companies to overhaul their organizations to harness technology.

by Venkat Atluri, Aamer Baig, and Satya Rao

The most earth-shattering technological breakthroughs are rarely felt all at once. Individual products or innovations may gradually prove their value, spawn other applications, and eventually become part of a broader platform with the potential to reshape business models. As such, incremental progress can suddenly lead to sweeping change that leaves companies scrambling to catch up.

The same holds true for the rate at which entire sectors embrace technological advancements. Some industries incorporate cutting-edge technologies in response to disruption—think the digital transformation of entertainment and media. The FAANG (Facebook, Amazon, Apple, Netflix, and Google) and BAT (Baidu, Alibaba, and Tencent) companies, for example, are regularly resetting the bar for how businesses engage with their customers and suppliers. Their influence on the business landscape and consumers often carries over to other industries.

As these trends sweep across the business landscape, the industrial sector finds itself on the cusp of unprecedented upheaval. Periods of intense change often magnify the importance of placing the right strategic bets. A tech-enabled transformation can equip industrial companies to increase revenues, expand margins, and pursue new revenue streams with different business models. Organizations that move aggressively and develop comprehensive strategies for integrating technology into their operations will maximize their odds of capturing the value at stake. By contrast, companies that choose to sit on the sidelines are essentially ceding their competitive advantage.

Changing dynamics in industrials
Three factors—a changing workforce, faster-moving ecosystems of customers and suppliers,

and digital disrupters—are reshaping the industrial sector.

A changing workforce
Evolving workforce expectations and increased automation are changing not only the demographics of the workforce but also the ways in which industrial organizations must adjust their efforts in attracting, retaining, and developing talent.

By 2020, millennials will account for 50 percent of the US workforce, rising to 75 percent globally by 2025.[1] This generation of workers differs from previous cohorts in several ways. Millennials gravitate to jobs supported by digital tools rather than numerous manual tasks. They also actively seek to learn and grow on the job and aren't shy about jumping to a new company in search of advancement. According to Gallup, 21 percent of millennial workers have switched jobs in the past 12 months, and 60 percent are open to new job opportunities.[2]

To remain competitive with other sectors, industrial companies must embrace technology and replace manual tasks with more thought-provoking, challenging roles. Consider, for example, a financial controller in an industrial company. Today, the controller might spend 60 to 70 percent of the workday stitching together reports from different data sources for business partners. If these tasks were automated, the controller could evolve to become a strategic thought partner for the business.

At the same time, automation, data, and connectivity are changing the nature of work: McKinsey research found that a significant amount of retail activity can be automated using technology. And the total number of connected devices is predicted to rise from fewer than 27 billion in 2019 to more than 75 billion in 2025.[3] The volume of data generated by

[1] Peter Economy, "The (millennial) workplace of the future is almost here—these three things are about to change big time," *Inc.*, January 15, 2019, inc.com.
[2] *How millennials want to work and live*, Gallup, 2016, gallup.com.
[3] Statista, "Internet of things (IoT) connected devices installed base worldwide from 2015 to 2025 (in billions)," accessed on July 11, 2019, statista.com.

these devices, already exploding in recent years, will continue on this trajectory.

The impact of technology on all facets of the industrial sector, from the shop floor to distribution centers, means that most jobs will evolve and require more tech-savvy employees.

Faster-moving ecosystems of customers and suppliers

To date, industrials have lagged behind other sectors, such as retail and banking, in their ability to integrate digital technologies into operations. In retail, Walmart has invested in a range of technologies: from autonomous cleaning robots that free up workers' time to virtual-reality headsets used in training associates. And a number of retailers have at least partially digitalized their stores, increasing visibility and personalization.

Likewise, banking is undergoing its own transformation, fueled by the digitalization and integration of processes and tools to make employees more productive. One global bank developed a new digital onboarding tool for online customers, rolling out a modified version to more than 4,000 sales advisers in branches. The bank's investments in intensive coaching and frontline training supported frontline adoption, resulting in a 25 percent increase in the productivity of its sales advisers.

Even industrial-adjacent sectors have been quicker on the uptake. This pattern matters because as companies integrate digital technologies into their operations, they will prefer to engage and partner with innovative organizations. In the mining industry (a downstream customer of mining equipment), mines are increasingly conducting maintenance as needed rather than on a fixed schedule. One company used sensors and machine learning to implement predictive maintenance

in 20-ton heat exchangers. The model was able to predict when the exchangers would fail, so the frequency of repair visits adapted from once every 70 days to once every 160 to 200 days. And with dozens of heat exchangers across the operation, the cost savings have been substantial.[4]

In the logistics industry (a downstream customer of the commercial vehicle industry), leading shippers and carriers have incorporated digital and analytics into demand forecasts and route optimization. These technologies have enabled some shippers to trim inventories by up to 75 percent and warehousing costs by 15 to 30 percent—all while increasing labor efficiencies as much as 80 percent. Similarly, third-party logistics companies have deployed connectivity and analytics to enhance routing, resulting in efficiencies of up to 25 percent.[5]

These adjacent industries are the immediate customers of industrial players and expect a certain level of technological maturity in their transactions. For example, more sophisticated components (such as smart hydraulic valves) can increase the accuracy of predicting failures in large downstream equipment in mines and oil rigs. Or companies could innovate their transactions with industrials by engaging through online and e-commerce channels—even increasing traditional sales and distributor relationships. This trend increases the urgency for industrial companies to pursue a tech-enabled transformation.

Digital disrupters

Since the industrial sector is capital intensive and relies on R&D, companies may believe they are insulated from the incursion of digital attackers—that notion is misplaced. Amazon's B2B business, for example, reached $10 billion in revenues in 2018. The reason is that Amazon has one advantage over its competitors: an ability to offer a greater variety of products than incumbent B2B companies.

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[4] "Behind the mining productivity upswing: Technology-enabled transformation," September 2018, McKinsey.com.
[5] Aisha Chottani, Greg Hastings, John Murnane, and Florian Neuhaus, "Distraction or disruption? Autonomous trucks gain ground in US logistics," December 2018, McKinsey.com.

A tech-enabled transformation can equip industrial companies to increase revenues, expand margins, and pursue new revenue streams with different business models.

Fast-moving tech start-ups have also begun to enter advanced sectors such as logistics and pharmaceuticals, in some cases striking partnerships with established companies. For example, Fast Radius, which offers 3-D printing on demand, has teamed up with UPS on the global expansion of its production capabilities. The company's vision is to offer a 24-hour turnaround on the production and shipping of parts, allowing manufacturers to take advantage of a virtual inventory.[6]

As such experiments gain momentum, industrial customers expect an increasing level of customization and digital engagement, so companies must reimagine their existing operating models and supply chains. When done right, these efforts could lead to new-business creation. In automotive retail, for example, customer preferences are quickly shifting in the used-car purchasing journey: 64 percent of buyers want extensive vehicle data, online photos, and search tools; and 59 percent want end-to-end online purchase capabilities. In response, new market entrants such as Carvana, Fair, and Vroom are disrupting the market.[7]

Further complicating these three changing dynamics, industrial companies have seen their growth and profitability stagnate in recent years. McKinsey research found that the sector's performance largely flatlined from 2011 to 2015,

a trajectory that has held true in the subsequent years.[8] The likelihood of an economic slowdown could further ratchet up the urgency for industrials to embrace technology to achieve the next horizon of growth and profitability.

Tech enablement can change the trajectory of industrial companies

In "The trillion-dollar opportunity for the industrial sector: How to extract full value from technology," our research identified five domains where companies can apply technology to boost productivity and margins (Exhibit 1).[9] A well-coordinated, tech-enabled transformation in these domains could potentially generate $1 trillion in additional revenues and increase total returns to shareholders by 9 to 22 percent.

A transformation of these five domains generates value in two areas:

— *Revenue growth.* Industrial companies have typically lagged behind their peers in using technology to improve sales and customer engagement. A tech-enabled transformation provides functions with greater access to data, analytics, and digital tools—enhancements that can also open up opportunities for new business models that move beyond selling components and products. A tech-enabled transformation can help companies capture a greater share of

[6] Tia Vialva, "Interview: Fast Radius raises $48m to accelerate industrial AM in Series B led by UPS," *3D Printing Industry*, April 4, 2019, 3dprintingindustry.com.
[7] Ben Ellencweig, Sam Ezratty, Dan Fleming, and Itai Miller, "Used cars, new platforms: Accelerating sales in a digitally disrupted market," June 2019, McKinsey.com.
[8] Richard Jones, Felix Recht, Nick Santhanam, Xiaoran Tong, and Shekhar Varanasi, "What's ahead for industrials," March 2017, McKinsey.com.
[9] Venkat Atluri, Saloni Sahni, and Satya Rao, "The trillion-dollar opportunity for the industrial sector: How to extract full value from technology," November 2018, McKinsey.com.

Exhibit 1

A tech-enabled transformation in industrials can generate value across five domains.

Innovating and developing products and services
- Extracting value from connected products
- Creating data-enabled business models
- Optimizing R&D processes

Running the corporation
- Modernizing the finance function
- Optimizing workforce deployment (HR)
- Building a scalable technology backbone (IT)

Making and delivering
- Optimizing procurement
- Enhancing forecasting and demand planning
- Digitizing manufacturing and assembling
- Streamlining distribution and delivery

Servicing
- Managing customer demand
- Optimizing field labor
- Managing parts
- Delivering superior customer experience

Selling
- Enhancing presales and discovery through digital marketing
- Transforming customer experience
- Optimizing pricing
- Enabling IoT at dealers and retailers

service revenue, which can raise profitability, particularly for industrials companies that are struggling with high labor costs.

— *Margin expansion.* Companies that harness technology can increase margins significantly through improved productivity in areas such as manufacturing, distribution, R&D, and back-office functions. For example, an analytics-based approach to pricing can inform pricing decisions and help companies apply more sophisticated pricing approaches.

The time to move is now
In pursuit of this $1 trillion opportunity, we believe three segments of companies will emerge: aggressive investors with comprehensive

strategies and playbooks; companies that invest in isolated or piecemeal projects, with no clear integrated strategy regarding technology; and passive participants.

Investments in technology will be needed to generate this value (for an examination of the impact of a tech-enabled transformation on the different segments of industrial companies, see sidebar, "Sector snapshot: Where the value lies"). In the past, industrial companies have often made expensive bets on technology projects that yielded limited payback and dampened the enthusiasm among executives for ambitious tech-based strategies. Companies will need to shed this mind-set to make progress.

Tech-enabled companies will be better positioned to lock in customers through improved products and
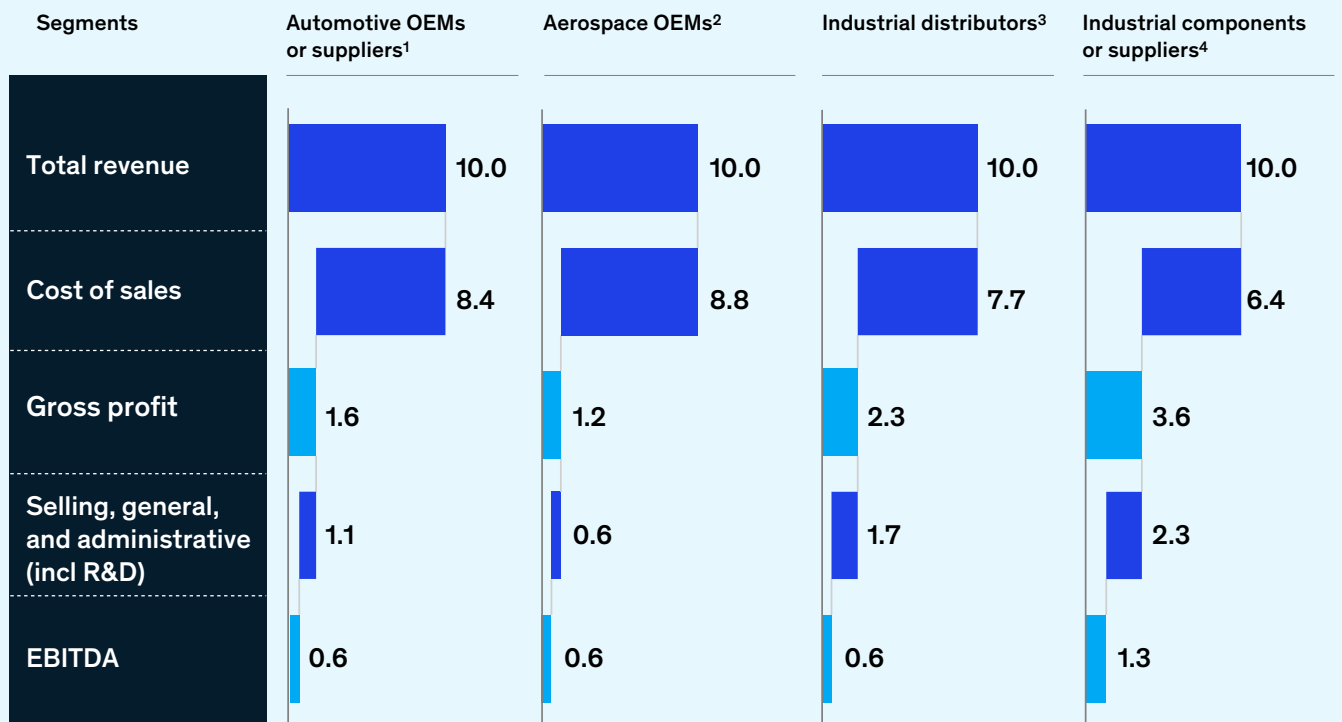
Sector snapshot: Where the value lies

The industrial sector consists of four segments, each with its own structure for revenues, costs, and potential value
(Exhibit A). The impact of a tech-enabled transformation and where value can be generated or destroyed will vary accordingly.

Exhibit A

Profitability and cost structure vary across four industrial archetypes.

Annual revenues and profit for representative $10 billion company across segments
$ billion

Segments	Automotive OEMs or suppliers[1]	Aerospace OEMs[2]	Industrial distributors[3]	Industrial components or suppliers[4]
Total revenue	10.0	10.0	10.0	10.0
Cost of sales	8.4	8.8	7.7	6.4
Gross profit	1.6	1.2	2.3	3.6
Selling, general, and administrative (incl R&D)	1.1	0.6	1.7	2.3
EBITDA	0.6	0.6	0.6	1.3

[1] Major automotive OEMs and component-supplier players ranging from $50 billion to $200 billion in revenue.
[2] Major aerospace OEM players ranging from $10 billion to $100 billion in revenue.
[3] Major industrial-distributor players ranging from $2 billion to $15 billion in revenue.
[4] Major component-supplier and manufacturing players ranging from $2 billion to $30 billion in revenue.
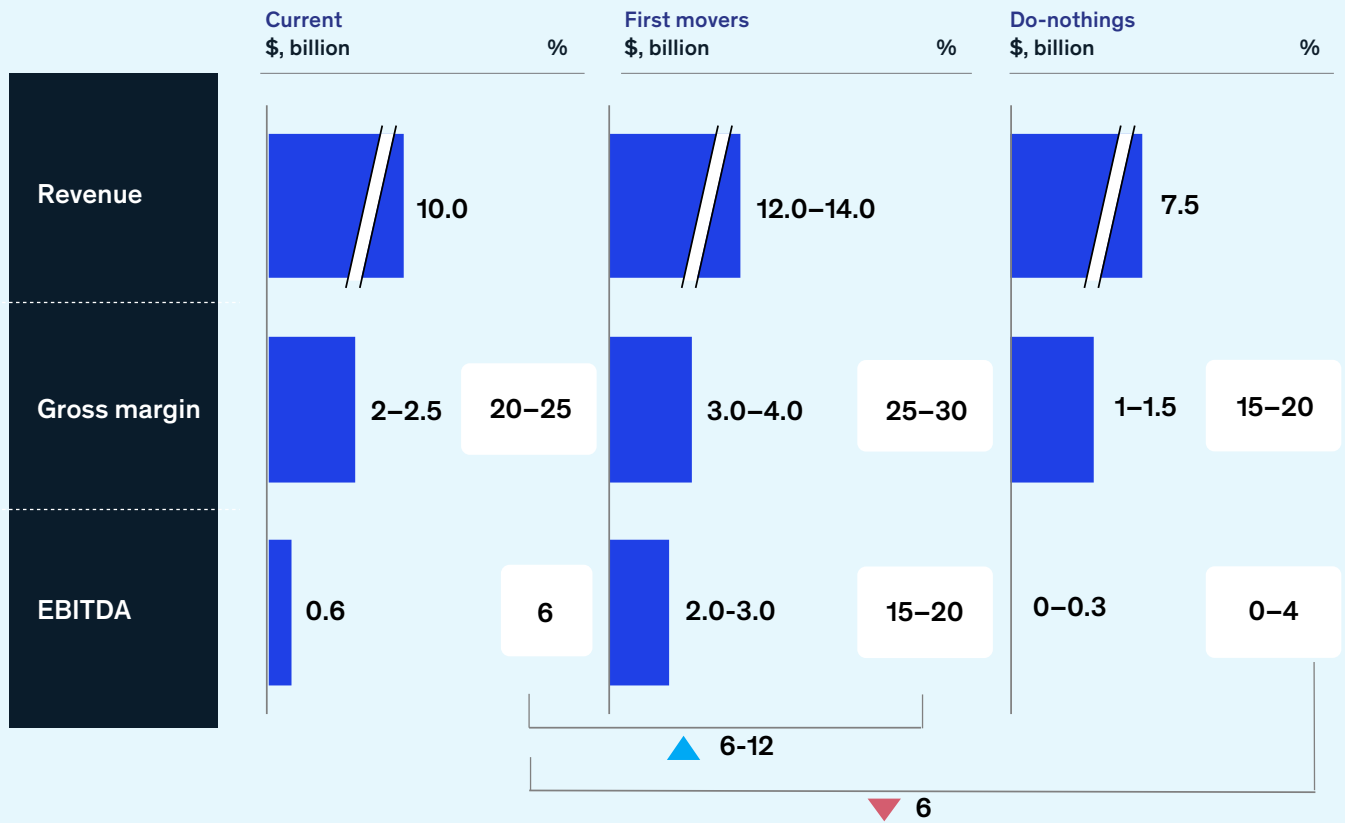
The divergent trajectories of companies that actively pursue a tech-enabled transformation—compared with those taking a wait-and-see approach—reinforce the need for bold action. Passive participants will see their productivity and competitiveness fall across the board, which we believe will lead to significant profitability loss in the long term. At industrial distribution companies, for example, technological first movers will see their revenues, margins, and profits improve significantly (Exhibit B). In contrast, companies that sit on the sidelines will see their profitability (and their competitiveness) eroded. The time to act is now.

Exhibit B

Analysis of industrial distribution companies highlights the impact of a tech-enabled transformation.

Potential five-year impact

▲ Expansion, %   ▼ Compression, %

	Current $, billion	%	First movers $, billion	%	Do-nothings $, billion	%
Revenue		10.0		12.0–14.0		7.5
Gross margin		2–2.5	20–25	3.0–4.0	25–30	1–1.5	15–20
EBITDA		0.6	6	2.0-3.0	15–20	0–0.3	0–4

▲ 6-12

▼ 6

services and could gain substantial advantages in their ability to attract talent and motivate their workforce. They might also have the option of partnering with disrupters and innovators in their industry.

Companies that implement a comprehensive approach will be well positioned to substantially increase revenues, margins, and profit (Exhibit 2). Although the opportunities to capture value will differ by segment, the overall impact will be dramatic. Companies in the broader industrials segment could raise revenues and margins by

as much as 4 and 7 percent, respectively. Such improvements would translate to an increase in earnings before interest, taxes, depreciation, and amortization of up to 9 percent.

Why companies need a comprehensive playbook

Although a tech-enabled transformation can generate tremendous value for industrial companies, it is also incredibly complex. New technologies are just one part of the equation. Companies must also change every facet of their operations—from their

Exhibit 2

Industrial companies that undertake a comprehensive tech-enabled transformation can reap significant value.

Representative impact for companies undergoing a comprehensive tech-enabled transformation across archetypes[1]
(% increase)

	Automotive OEMs or suppliers	Aerospace OEMs		Industrial distributors	Industrial components or suppliers
Revenue growth	0–1	0–1		10–35	1–4
Gross margin expansion	2–5	2–5		3–7	3–7
EBITDA expansion	2–5	2–5		6–12	5–9

[1] Impact shown is representative for each company archetype, based on McKinsey experience; actual impact will vary based on company financials and starting position.

processes to their people to their culture and mind-sets. Our research and firsthand experience in helping companies achieve tech-enabled transformations have led to the production of a standard playbook to guide the journey.

The transformation playbook consists of two phases—assess, then build and implement—supported by four enablers: capabilities and talent, technology and data, performance infrastructure, and organization mind-sets and behaviors.

By following the playbook in a coordinated way, companies can make rapid progress and sustain the improvements from a transformation.

The path forward will require industrial companies to reimagine their operations with tech at the center. Organizations that undertake a comprehensive tech-enabled transformation will be not only more profitable but also more efficient, responsive, and resilient. Now is the time to get started.

Accelerating the impact from a tech-enabled transformation

Industrial companies that follow a comprehensive playbook can capture more than twice as much value as organizations focused on technology alone.

by Venkat Atluri, Aamer Baig, and Satya Rao
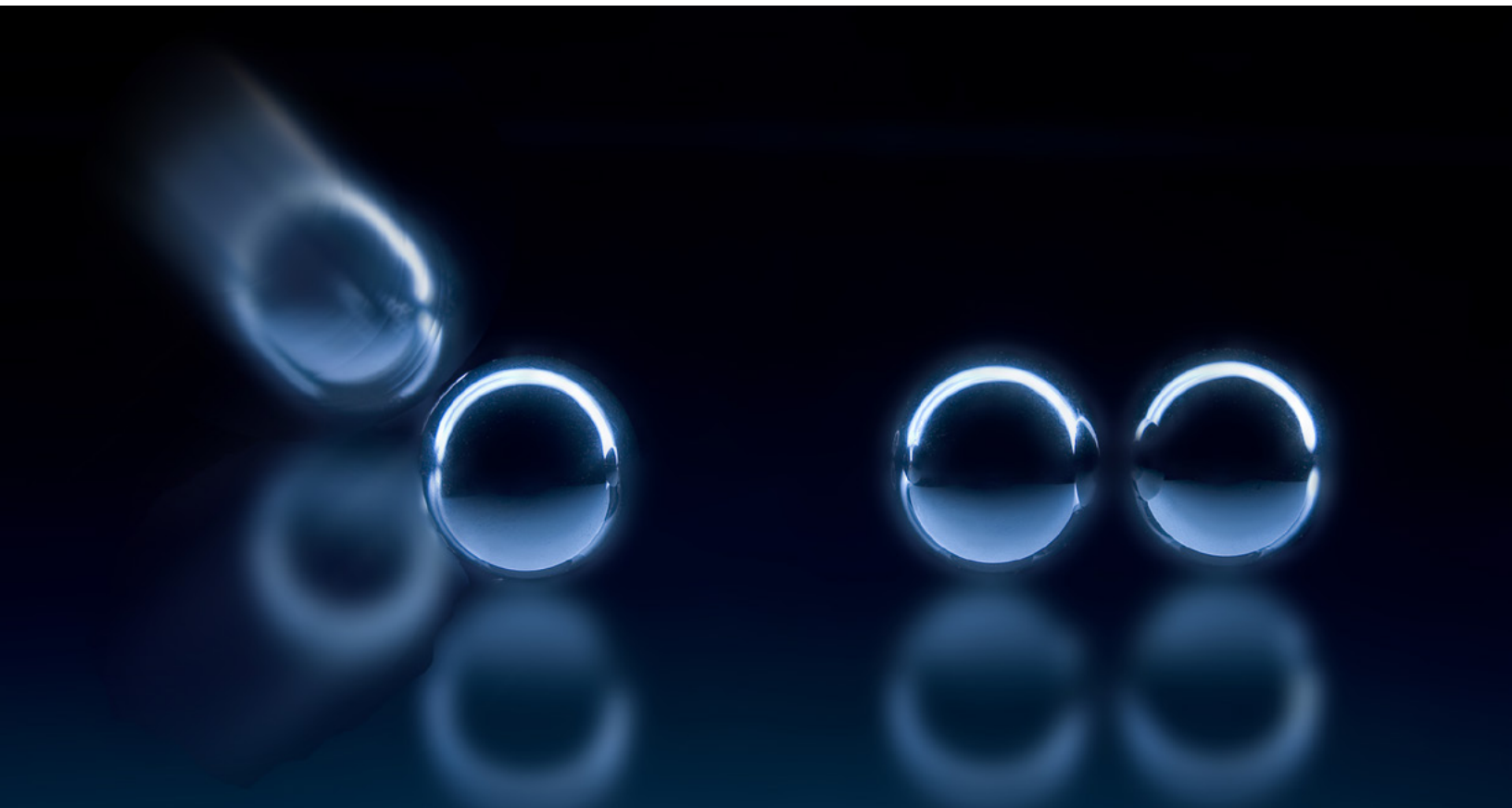
Technology continues to race ahead, bringing innovative applications seemingly bound only by the imagination. Automation, the industrial Internet of Things, and robotics, among others, are transforming the way companies approach the production and delivery of goods. The coming years could bring completely automated manufacturing floors, increasingly transparent supply chains, flexible operating models—even the emergence of "dark warehouses," which require no human workforce.[1] Such breakthroughs are closer to reality than ever before. Consider that Tesla has claimed the production of its Model 3 is already 95 percent automated.[2] Similarly, in late 2018, DHL launched an automated distribution center that boosted productivity by 60 percent over nonautomated facilities.[3]

Such innovations represent a tremendous opportunity. In 2018, McKinsey identified $1 trillion of potential value that industrial companies could capture by deploying a tech-enabled transformation (see sidebar, "Defining a tech-enabled transformation").[4] Yet arguably, the impact to date in industrials has barely scratched the surface. Indeed, most CEOs would admit they are in only the early stages of deploying technology at scale and achieving the promised impact. Tech-enabled and digital transformations are a top-of-mind issue for CEOs, but few companies currently sponsor digital initiatives, and even fewer are achieving the targets they have set.

The question of why industrial companies trail their peers is a complex one. Industrials do face some of the same challenges as organizations in other sectors—from outdated infrastructure to lack of necessary talent—but they must also grapple with systemic obstacles before beginning to capture potential value. Issues are as likely to emerge around people and execution as around technological complexity.

A successful tech-enabled transformation requires organizations to make progress on several paths simultaneously, a prospect that can seem overwhelming. Only by following a structured, comprehensive playbook can companies translate

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Sidebar

Defining a tech-enabled transformation

Digital technologies—including analytics, the Internet of Things, artificial intelligence, and machine learning—have tremendous potential to fundamentally change how industrial companies operate. Organizations will need to undertake an end-to-end transformation to harness these technologies and capture the next level of value. The term "tech-enabled transformation" reflects technology's role as a catalyst in this journey for industrial companies as well as its role in supporting and accelerating change throughout the organization.

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[1] Ben Ames, "It's lights out in the warehouse," *CAM's Industrial Corner*, August 2016, Volume 7, pp. 1–3, cohenasset.com.
[2] Tom Randall, "Inside Tesla's Model 3 factory," Bloomberg, June 8, 2018, Bloomberg.com; Fred Lambert, "Tesla says the Model 3 body line is now 95% automated," *electrek*, June 8, 2018, electrek.co.
[3] Michael Angell, "DHL Group wooing US e-commerce retailers with moves to automate distribution," *Freight Waves*, December 1, 2018, freightwaves.com.
[4] Venkat Atluri, Saloni Sahni, and Satya Rao, "The trillion-dollar opportunity for the industrial sector: How to extract full value from technology," November 2018, McKinsey.com.

their transformation priorities from strategy to action. A two-step methodology supported by several enablers can provide companies with the direction, priorities, and organizational capabilities to maximize the value of such investments. Indeed, companies that took a comprehensive approach to their transformation generated more than twice as much value as organizations focused solely on technology improvements.[5]

Where tech-enabled transformations flounder

Across sectors, achieving a successful tech-enabled transformation is a tall order. Industrial companies have a number of built-in obstacles that they must address—some the result of decades of strategic decisions. Historically, the C-suite has not been closely involved in digital transformations. This habit may stem from an aversion to using data and analytics to inform decision making or support functions such as operations, sales, and finance. Further, industrial companies often apply platforms or tools ad hoc or for specific use cases rather than rolling them out on an enterprise level across business domains.

The way that industrial companies have evolved can also create challenges. Many businesses grow through acquisition, so their IT infrastructure can be a patchwork of multiple platforms and systems that have never been properly integrated. Companies also commonly have manufacturing facilities and machinery from the 1940s and 1950s, making modernization efforts time-consuming and expensive. Still others lack the required in-depth understanding of digital technologies. For example, even if a company has adopted the cloud, its leaders might not have figured out how to link modernization efforts to value. We have also found cost to be a recurring obstacle: with lingering skepticism about the impact of technology investments, executives can pull the plug on projects the moment difficulties emerge.

A lack of sufficient talent and capabilities is not a challenge unique to industrials, but these companies must address it from several angles. Not only must they upskill existing talent to create a more technologically savvy workforce. They also need to attract top candidates to implement analytics-based solutions. And while industrial companies have the resources to hire qualified

50%

more value generated by companies that took a comprehensive approach to their transformation, as opposed to those that focused solely on technology improvements

[5] "Unlocking success in digital transformations," October 2018, McKinsey.com.

tech talent, their overall strategy and culture must ensure that analytics hires can make the desired impact—a considerably heavier lift.

A comprehensive playbook for a tech-enabled transformation

A transformation playbook, consisting of two phases and four enablers, can help industrial companies break free of their legacy approaches to pursuing a tech-enabled transformation (Exhibit 1). While the guide may appear straightforward and intuitive, its impact depends on comprehensive and coordinated execution of all elements. Following the playbook for an ambitious transformation will maximize the chances of success, but companies must ensure they have leadership's buy-in and involvement as well as bottom-up engagement.
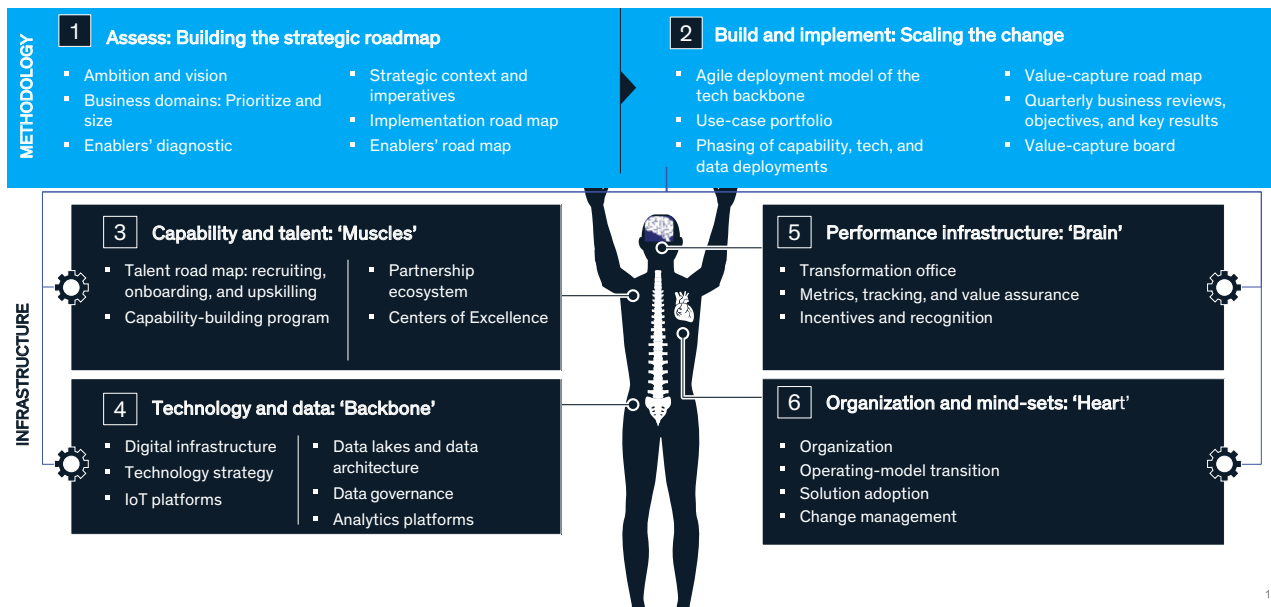
Phase 1: Assess

The tech-enabled transformation starts with a CEO's vision of the company's transformation. Too often,

conversations about how to apply technology end up focusing on specific use cases that get lost in a sea of business priorities. Instead, senior executives must envision a transformed business model across a set of domains. Our research identified five business domains with the greatest potential value in a tech-enabled transformation: making and delivering, selling, running the corporation, servicing, and innovating and developing products and services.[6]

The assessment of an organization's current state should quantify the value and feasibility of achieving targets on an accelerated timeline. A company can capture its aspirational value only by considering a portfolio of use cases within each business domain. Companies can then prioritize use cases based on their potential value and feasibility (Exhibit 2). In contrast, companies that start by focusing on targeted use cases instead of business domains undermine the impact of transformation. For example, the IT organization could work with

Exhibit 1

Industrial companies must follow a comprehensive transformation playbook to capture the value from technology.

METHODOLOGY

1 Assess: Building the strategic roadmap
- Ambition and vision
- Business domains: Prioritize and size
- Enablers' diagnostic
- Strategic context and imperatives
- Implementation road map
- Enablers' road map

2 Build and implement: Scaling the change
- Agile deployment model of the tech backbone
- Use-case portfolio
- Phasing of capability, tech, and data deployments
- Value-capture road map
- Quarterly business reviews, objectives, and key results
- Value-capture board

INFRASTRUCTURE

3 Capability and talent: 'Muscles'
- Talent road map: recruiting, onboarding, and upskilling
- Capability-building program
- Partnership ecosystem
- Centers of Excellence

4 Technology and data: 'Backbone'
- Digital infrastructure
- Technology strategy
- IoT platforms
- Data lakes and data architecture
- Data governance
- Analytics platforms

5 Performance infrastructure: 'Brain'
- Transformation office
- Metrics, tracking, and value assurance
- Incentives and recognition

6 Organization and mind-sets: 'Heart'
- Organization
- Operating-model transition
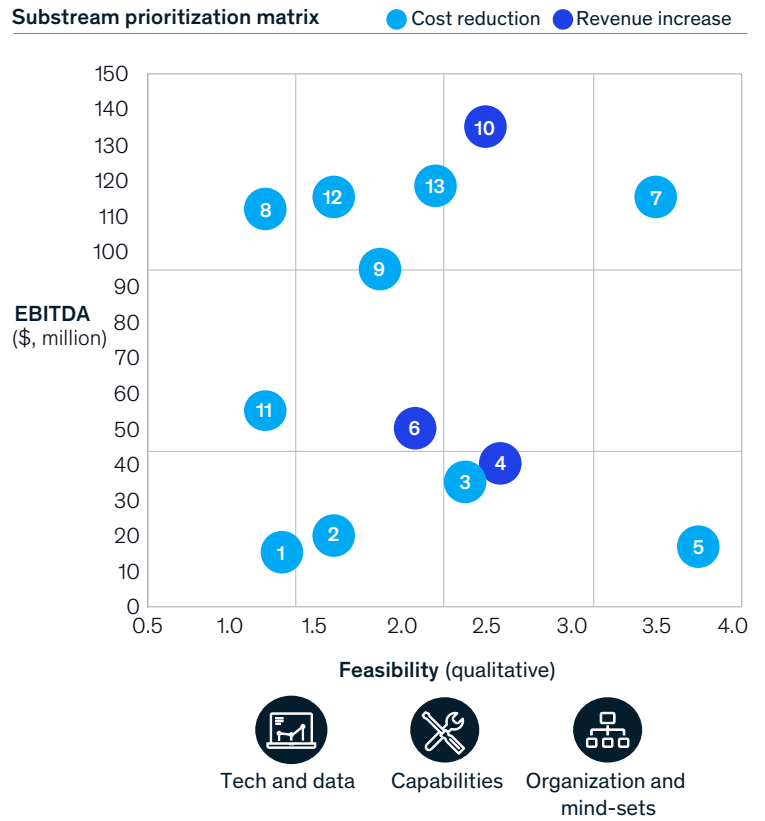- Solution adoption
- Change management

[6] For more on these domains, see Atluri, Sahni, and Rao, "The trillion-dollar opportunity for the industrial sector," McKinsey.com.

Exhibit 2

Domains should be prioritized by potential value and feasibility.

Domains	Subdomains
Making or delivering	1 Equipment and maintenance
	2 Plant management and quality
	3 Forecasting and demand planning
	4 Material management
	5 Supply-chain network
Selling	6 Presales and discovery
	7 Sales and pricing
Running the corporation	8 Finance
	9 HR
Servicing	10 Field force productivity
Innovating and developing products and services	11 R&D
	12 Data-enabled business models

Substream prioritization matrix — ● Cost reduction ● Revenue increase

EBITDA ($, million) vs Feasibility (qualitative)

Tech and data — Capabilities — Organization and mind-sets

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the sales operations team to deploy dynamic pricing, but without a broader vision and ambitious transformation in mind, the value is likely to be limited.

When selecting use cases, industrial companies should ensure that the value at stake is measurable and meaningful such that it has the potential to change the organization's trajectory. A well-executed tech-enabled transformation will have direct impact on revenue growth, margins, and new revenue streams from new business models or services. As part of the assessment phase, companies should set clear goals for each use case (based on the domains affected by the transformation).

Reimagining a business domain typically requires not just inspiration but also an ambitious goal. At one industrial company, a CEO sought to increase the margin profile by 200 basis points within a year by harnessing technology. This goal was clearly tied to profit and loss, so the entire organization was affected. One of its biggest business domains was selling, which had more than 1,000 staff using legacy or ad hoc relationships, tools, and methodologies. Leadership decided to digitalize the sales process by using data-driven insights in every area, from lead generation and pricing to the expansion of share of wallet with customers.

Once the CEO was convinced of the potential value from the business domain and the leaders

A well-executed tech-enabled transformation will have direct impact on revenue growth, margins, and new revenue streams from new business models or services.

bought into the ambitious goals, the company made technology investments across a range of use cases that directly supported the business domain transformation. The decision-making process also clarified the path to build capabilities and transform the organization. Upon deployment, the company saw margins increase by 50 basis points in the first three months—a quick result that built momentum and engagement.

Phase 2: Build and implement
The second phase is critical because it involves developing the internal capabilities and infra-structure to execute on the road map. As with any transformation, speed and acceleration are critical, but consistent follow-through and continuous improvement are also vital. When these programs are launched at scale, companies often report an initial uptick in productivity created by employee excitement in capability building and new tools. However, this progress can quickly plateau without a robust and closed-loop performance-management process.

Too often we see performance management and value assurance undermined by the challenges of reaching employees at multiple locations. In such instances, the best performers improve and some go-getters participate, but a large chunk of the organization sees marginal or no gains. Organizations that link standardized metrics to technology solutions can provide executives with the information they need to encourage participation and gauge progress.

Four enablers can equip industrial companies with the infrastructure and capabilities to execute a tech-enabled transformation.

Enabler: Capability and talent ('muscles')
Companies often greatly underestimate the investment in the capabilities needed to support a tech-enabled transformation. These capabilities can be broken into two categories: workers with the skills and agile mind-set to develop and scale digital and analytical solutions; and leaders and employees—including those within sales and frontline manufacturing—that harness data-driven insights for the greatest impact.

Scaling the talent to design digital and analytical solutions usually requires a different approach to talent attraction and development. In addition to seeking candidates outside the usual sources, organizations will need to manage new hires differently from how they manage legacy talent. In many cases, the incentives and management processes must be significantly revised to motivate this new wave of hires.

One of the greatest challenges in building capabilities is variability in leadership. To overcome it, industrial companies should continue investing in capable leaders to manage performance centrally and lead change across the organization. With this level of change, companies must also typically address mind-sets, as additional scrutiny into operations can be met with fear and suspicion.

Enhancing leadership and workforce capabilities requires a combination of standard and tailored training programs across every level of the organization. This effort must be ongoing and requires the right content, tools, and reinforcement. In the industrial company noted previously, it was essential to build the capabilities of the sales staff, which had not been exposed to data-driven sales approaches.

As a first step, companies must evaluate individuals to prioritize skills gaps and development needs. A blend of formal training, applied and social learning, and coaching supported by systems and processes can help organizations build the desired skills and behaviors at all levels. A common pitfall in capability building is a "one-and-done" model, in which companies undergo large-scale rollouts across their front lines—without a reinforcement model.[8] In reality, fundamentally changing capabilities requires a continuous-learning approach.

Enabler: Technology and data ('backbone')
It is essential for companies to address technology infrastructure at all levels of the organization. For the back end, a next-generation data platform that can aggregate data from a broad set of sources and empower high-speed software development is foundational to a tech-enabled transformation. This platform then supports front-end solutions that draw on data and analytics to support better business operations (Exhibit 3).

Exhibit 3

The data platform—which includes unstructured data storage, advanced analytics, and easy-to-use tools—supports modern analytics capabilities.
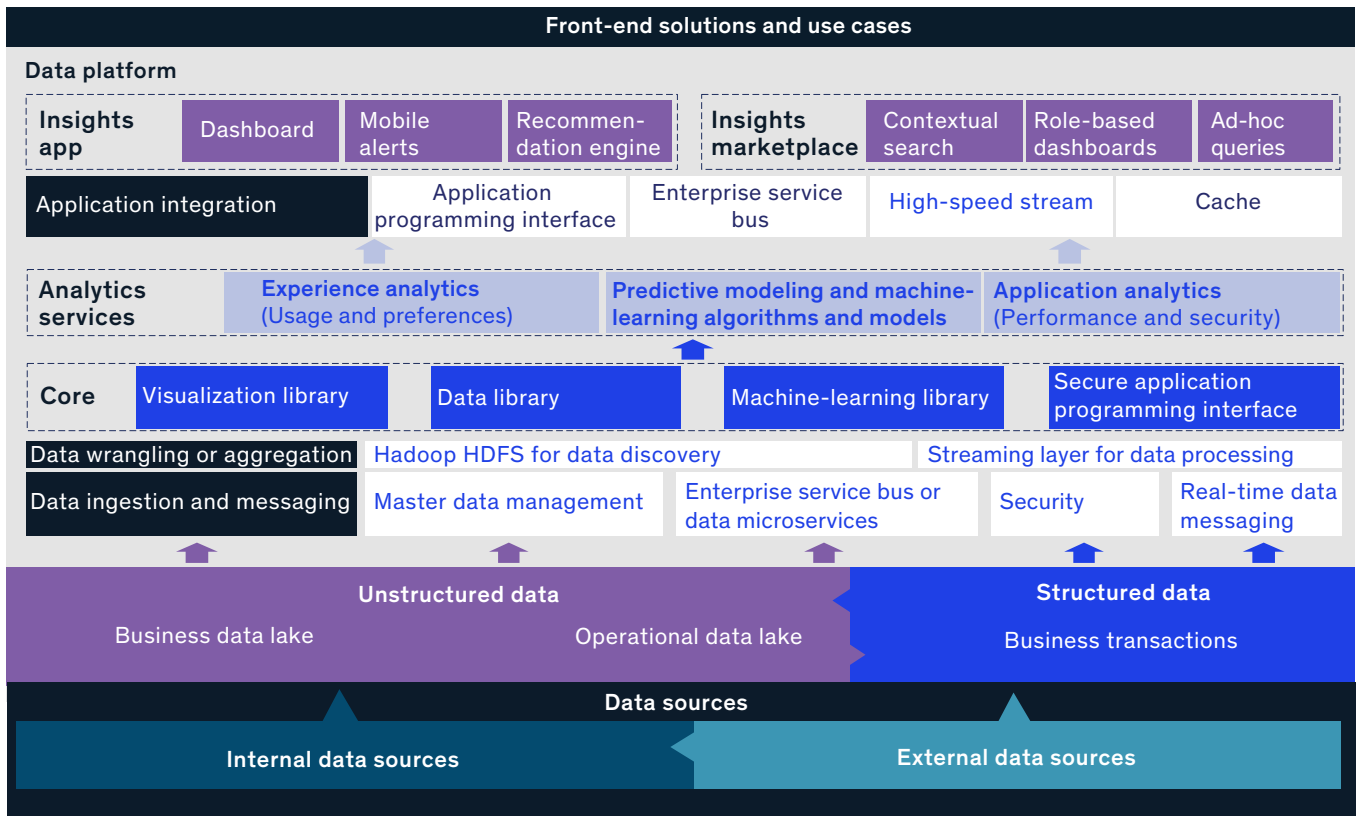
[8] Martin Reeves and Kevin Whitaker, "Digital transformation: Disruptions, delusions and defenses," BCG Henderson Institute, April 30, 2019, bcghendersoninstitute.com.

Companies must also adopt a broader perspective regarding decisions on their tech stack—for example, finding ways to aggregate and consolidate data sources in a centralized data lake. Although the prospect of consolidating data from multiple distributed sources can be intimidating, companies can still make iterative progress. Many industrial companies that partner with cloud players assume their work is done,[9] but that couldn't be further from the truth. Building a data bed on top of a cloud platform and developing the analytics tools to turn data into actionable insights is a major undertaking. In addition, data-visualization tools are needed to track key performance indicators linked to outcomes so that executives can monitor progress.

Since getting out of the starting gate quickly can help companies establish momentum, they should adopt an agile approach to technology deployment.[10] Emphasizing quick iterative cycles can not only focus an organization's energy and resources but also increase engagement and accountability. Too often we see companies stretch technology development out unnecessarily (a year, for instance, is far too long).

The industrial company that embarked on the tech-enabled transformation for its sales staff developed a data lake as a key asset.[11] Since building a production-ready tool would typically take eight to ten months, the company pursued an alternative short-term data bed that could be launched in a two-month sprint. This project gave the sales team early insights into how to pursue low-hanging fruit and short-term opportunities for immediate results. Thinking creatively and in an agile manner gave the sales team the tools it needed to sustain the impact.

Enabler: Performance infrastructure ('brain')

In many ways, the success of a tech-enabled transformation comes down to the effectiveness of a company's performance infrastructure. Indeed, so much value in technology projects can be lost

without it. For example, half of enterprise-resource-planning implementations fail on the first attempt, and most cost three to four times as much as the original budget.[12] A mature, robust performance infrastructure can help keep such initiatives on track by promoting accountability, coordination, and visibility into progress.

Performance infrastructure has three primary components:

— *A transformation office.* Dedicating high-profile resources is a critical factor in a successful transformation. The best candidates will be missed in their current jobs, so leaders must be discerning in their selections. These people are well respected, come from diverse business units, and do not hesitate to challenge the organization, escalate issues, and use data to increase accountability. A good transformation office also builds sustainable capabilities and incorporates data-driven decision making.

— *A war room.* Successful companies also invest in a war room to serve as a nerve center for the transformation. Daily check-ins can help to identify the hot spots where the organization should focus its attention. The war room helps establish a disciplined cadence of meetings with business leaders to ensure they are on track to achieve their targets. A chemicals company, for example, created a war room that oversaw principal targets, milestones, and real-time tracking (Exhibit 4). It then used weekly check-ins to get updates on such actions as data and customer relationship management integration and training programs.

— *Incentives and recognition.* Companies should base incentives on the tech-enabled transformation's tangible outcomes, especially its financial goals. For example, if the outcome is margin expansion through digitalization of the

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[9] Thomas Barrabi, "Volkswagen, Amazon partner on cloud network to boost production," *Fox Business*, March 27, 2019, foxbusiness.com; Eva Yoo, "Alibaba Cloud's partnership with Hitachi shows how much traditional companies need the cloud," *technode*, July 4, 2017, technode.com.
[10] For more on agile, see Wouter Aghina, Karin Ahlback, Aaron De Smet, Gerald Lackey, Michael Lurie, Monica Murarka, and Christopher Handscomb, "The five trademarks of agile organizations," January 2018, McKinsey.com.
[11] A data lake is a standardized data bed that houses data from different sources in one common area.
[12] Technology Evaluation Centers, "ERP software facts and stats—and lessons learned," blog entry by TEC team, June 5, 2018, technologyevaluation.com.

Exhibit 4
A transformation office and war room promote collaboration, monitor progress, and ensure accountability.

Four weeks to complete visual transparency	**New functionality every two weeks**	**Real-time tracking against targets**	**100,000 actions individually tracked**
Full frontline deployment and training	**Weekly execution cadence**	**Full integration of data and customer relationship management**	**Central nerve center installed at HQ**

front line, sales leaders and staff need to have clear motivations to pursue these goals. In one company, this task entailed changing the evaluation process of frontline employees to include rewards for exhibiting new behaviors.

Enabler: Organization and mind-set ('heart')
A tech-enabled transformation can be successful only if it is applied directly to the core organization—not piloted in a parallel organization. For the operating model to change, executives must alter the way they manage the business. For example, many companies have monthly operational or business reviews, in which the CEO and CFO talk to the business leaders. Using digital tools and dashboards in these reviews and establishing KPIs will reinforce the new approach throughout the rest of the business.

Transformations of this magnitude will not happen without visible and regular senior leadership involvement. Therefore, the CEO, CFO, and heads of business units must model the desired change. When they use the same technology and tools and are visible in plants, slow-adopting employees may gain extra motivation to embrace new ways of working.

Generating outsize value from tech-enabled transformations
Any transformation faces long odds of succeeding: McKinsey research has found that around 70 percent of all attempts (both digital and nondigital) fail.[13] Of the 30 percent that produce the expected value, a majority follow a structured process that focuses on several playbook elements.

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[13] Brent Gleeson, "1 reason why most change management efforts fail," *Forbes*, July 25, 2017, forbes.com; Boris Ewenstein, Wesley Smith, and Ashvin Sologar, "Changing change management," July 2015, McKinsey.com.

Our experience managing more than ten tech-enabled deployments in the industrial sector and a survey of more than 20 B2B companies (a combination of industrial, oil and gas, utilities, agriculture, and hardware organizations) that underwent significant tech-enabled transformations reinforce these findings. When companies concentrate on all aspects of infrastructure and execution in a coordinated fashion, they are significantly more likely to capture a greater share of a transformation's potential value.

All of the companies in our sample set ambitious objectives (such as to increase earnings before interest, taxes, depreciation, and amortization by at least 10 percent). The study found a direct correlation between impact through technology (as defined by the percentage of the target aspiration achieved in 24 months) and the effectiveness of the transformation process (Exhibit 5).

Bringing it all together

The playbook for a tech-enabled transformation is composed of multiple initiatives that touch every part of the enterprise—a daunting proposition. Our experience with successful transformations identified some common themes:

— A tech-enabled transformation starts with a thorough assessment and involves setting aspirational goals linked to revenue growth and margins. These clear targets promote transparency and accountability across the organization.

— Executive sponsorship and scrutiny are critical to successful transformations. The top team and management are the most effective evangelists for new attitudes and ways of working and should seek to lead by example. In companies where a transformation has taken root, role modeling was a vital contributor.

Exhibit 5

A comprehensive transformation approach enables companies to capture a greater share of the potential value.

Realized impact (% of full potential)

Transformation-process effectiveness (on a scale of 1 to 5)
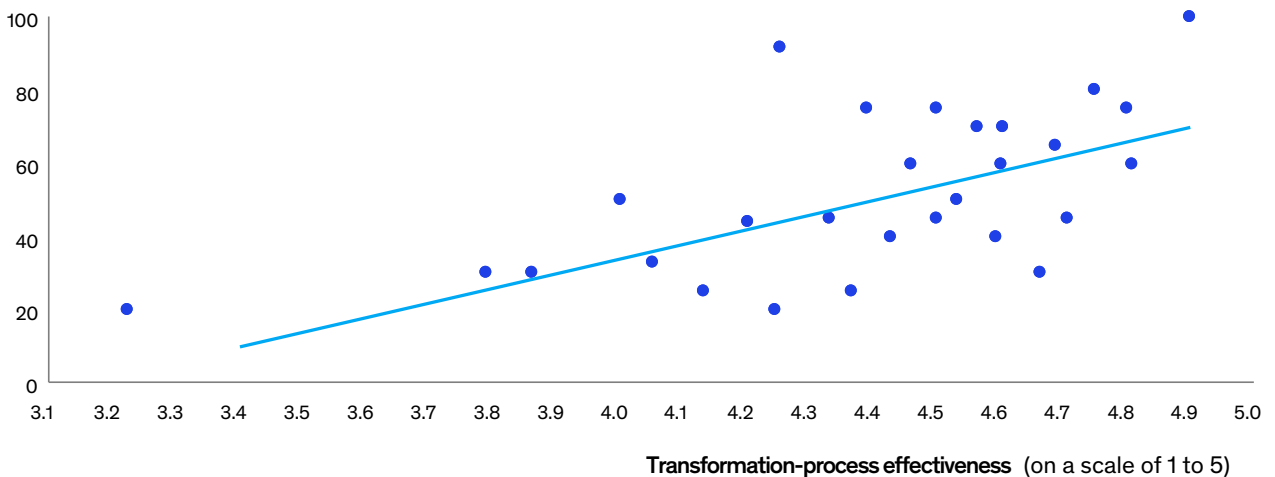
— As the whole notion of a transformation suggests, the degree of organizational change is significant. Companies must take a comprehensive, rather than piecemeal, approach to identify and pursue opportunities to harness technology.

— The initiative works only if technology solutions are woven into the fabric of the organization and processes, integrating with the way the company functions. Technology can't be the domain of a parallel organization. Instead, it must be a foundational element of strategy and decision making.

— To change the operating model, companies must change the way the business is managed.

Many companies have monthly operational or business reviews, conversations between the CEO or CFO and business leaders. Identifying new metrics and using the transformation office's digital tools and dashboards to support these reviews on an ongoing basis will sustain performance improvements.

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Experience shows that companies that approach tech-enabled transformations through a technology-focused lens can only capture about 50 percent of the potential business value. However, industrial companies that follow this comprehensive playbook can secure substantially more value.
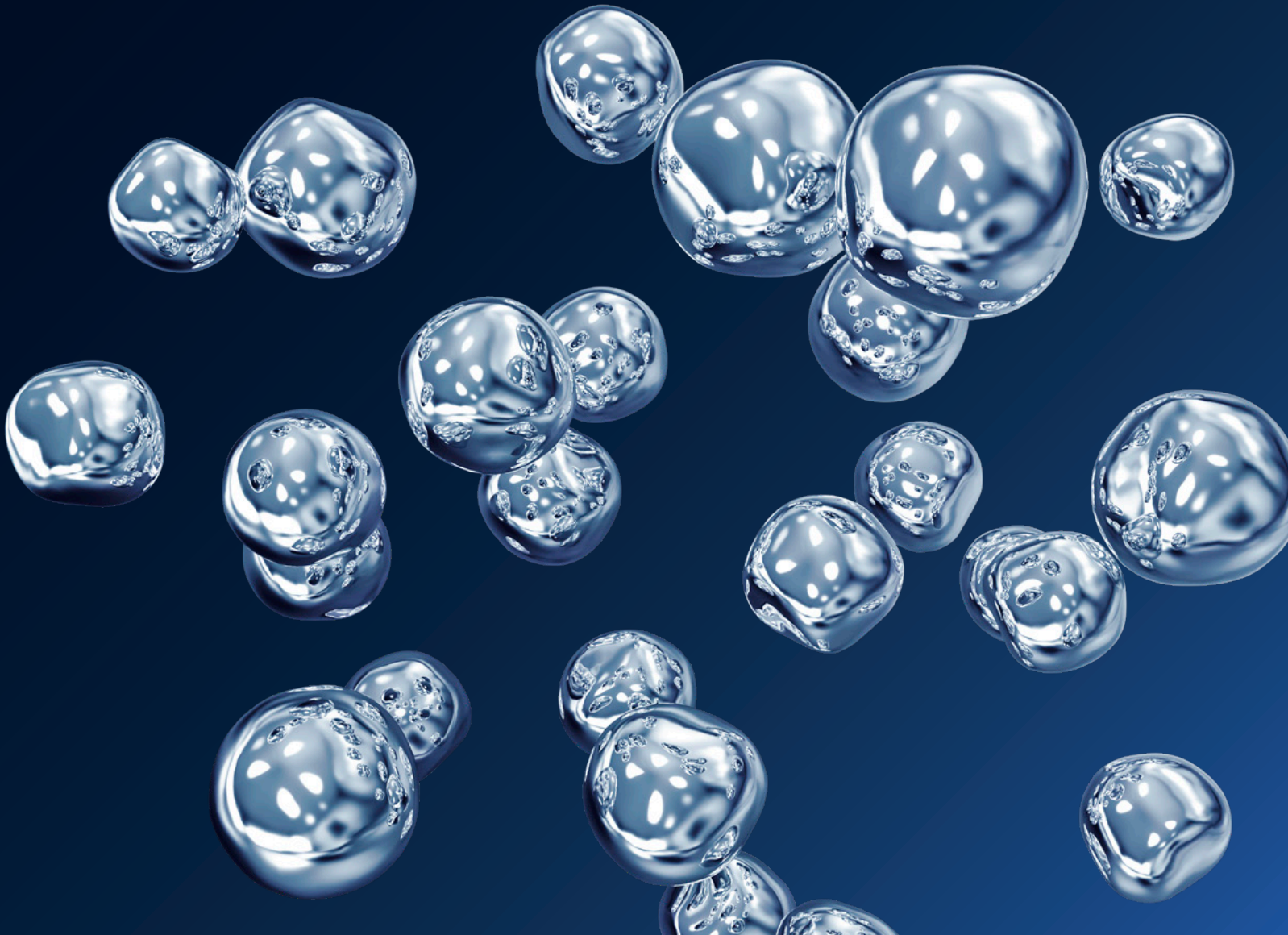
Part 2:

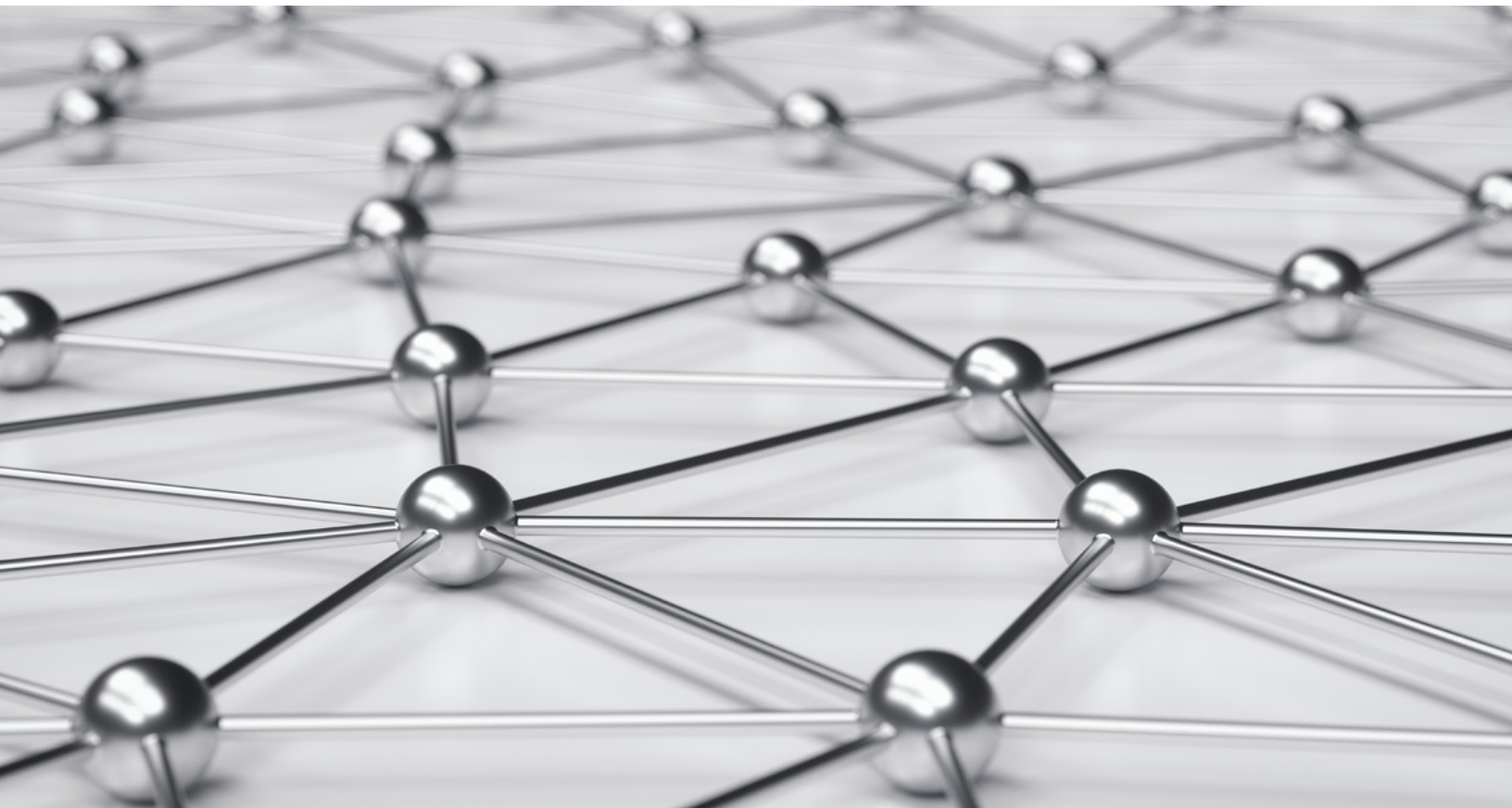# Using tech-enabled transformations to reshape business domains

How industrial incumbents can create new businesses

In the face of what can feel like nonstop threats from new entrants, incumbent industrial companies can create new businesses of their own that can mitigate the risk.

by Matt Banholzer, Markus Berger-de León, Subu Narayanan, and Mark Patel

Successful tech-enabled transformations can help generate cash to outcompete new competitors, but don't fundamentally help incumbents solve the strategic challenge of nimble attackers, which often combine data and software to quickly gain a foothold in their industries. IT, retail, and logistics are just a few sectors that have been reshaped by technology-first innovators such as Amazon Web Services (IT), Warby Parker (retail), and Uber Freight (logistics). In the industrial sector, especially advanced industries, a swarm of IoT start-ups have begun to chip away at incumbents' positions. For instance, Brazilian start-up Solinftec, which was founded in 2007 with a focus on helping the sugarcane industry increase its production efficiency, has already won 60 percent of the Brazilian sugarcane market and will launch in the United States in time for the 2020 crop cycle of corn and soybeans.

To defend themselves from tech-enabled start-ups, incumbent industrials should complement their tech-enabled transformations' existing corporate venture capital (VC) activities by creating new tech-enabled businesses of their own. With their cash reserves, existing customer base, established brands, and in-house expertise, incumbents should in theory create entirely new businesses with higher odds of success. But as with all strategic moves, creating and nurturing a new business as an incumbent is often aspirational yet difficult to implement. Among other obstacles, established companies must overcome operating models and cultures that emphasize iterative operational improvements to the core business over untested strategic choices that can result in immense upside.[1]

To create organic growth in a new business area, incumbents should put aside the assumptions and mind-sets that help them run an established entity. For instance, incumbents will need to accept the near certainty of unprofitable periods for their new ventures and that new businesses may cannibalize parts of the existing business as

they grow and even overtake the parent company. Above all, incumbents nurturing new ventures must be comfortable enough with ambiguity to enable the strategic pivots new ventures can require. This mind-set will help incumbents create new-business ideas, devise a business plan, then launch, scale, and extract value from a new business. Incumbents that are able to think like innovative attackers and cultivate new ventures can look forward to ongoing value creation while those that stand still, are less nimble, or proceed timidly for fear of failure are (by definition) at risk of being disrupted into irrelevance.

The value and pain of cultivating new ventures

The frequency and effects of disruption create an urgent need to cultivate new businesses. Because of the rise of innovative tech-enabled companies and the retreat of old-guard businesses that have failed to react to threats or self-disrupt, the average age of companies on the S&P 500 has fallen to an all-time low of 22 years, down from 61 years in 1958.[2] Technology will continue to be a major source of disruption: while the internet and mobile and cloud computing have already evolved from disruptive to foundational, quantum computing, virtual and augmented reality, and the IoT will likely propel the next wave of disruption. And with customers shifting their purchasing and information-gathering channels, competitors that are eager to expand across sectors, and ample VC funding for a nonstop stream of new entrants, incumbents' best hope might be to create attackers themselves.

In theory, incumbents are better equipped than solo entrepreneurs to take the leap into new-business creation. Industrial Goliaths can give their new businesses the funding, distribution, and customer base that typical new businesses have to fight for. For example, one large machinery manufacturer used its large customer base, brand equity,[3] expertise, and cash flow to grow its IoT products business, which reached $20 million in new sales in its first year after launch.

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[1] Philipp Hillenbrand, Dieter Kiewell, Rory Miller-Cheevers, Ivan Ostojic, and Gisa Springer, "Traditional company, new businesses: The pairing that can ensure an incumbent's survival," June 2019, McKinsey.com.
[2] Michael Sheetz, "Technology killing off corporate America: Average life span of companies under 20 years," *CNBC*, August 24, 2017, cnbc.com; Driek Desmet, Ewan Duncan, Jay Scanlan, and Marc Singer, "Six building blocks for creating a high-performing digital enterprise," September 2015, McKinsey.com.
[3] Brand equity is the value of consumer perceptions of a brand.

Above all, incumbents nurturing new ventures must be comfortable enough with ambiguity to enable the strategic pivots new ventures can require.

In reality, McKinsey analysis found that only 16 percent of new ventures from the Fortune 100 have succeeded since 2000. It's difficult for incumbents to assemble the right resources to establish and grow an internal attacker, especially if the new business's offerings interfere with elements of the core business.[4] In the early stages, a new venture might be seen as a distraction and a drain on the parent company's resources. What's more, significant differences between incumbents and new entities on key elements—such as governance practices, funding models (approaches to make sure a business's core activities are funded), and organizational structures—can result in the parent company being a drag on new ventures.

For example, new businesses often make decisions quickly, with little (if any) institutional distance between the CEO and the rest of the company. The parent company, however, will almost certainly have more management layers and more processes to follow when making decisions. A new business that is required to follow its parent company's processes would almost certainly be unable to make and implement strategic and tactical decisions at the frequency and cadence necessary to quickly find its footing in the market. If the parent company is also prone to loss aversion, it is even more likely to inadvertently smother the new business.

Setting up a disruptive business that can flourish

To establish and grow a new business within an established parent company, the parent company must combine the advantages of an incumbent with those of a new company. In addition to the aforementioned advantages of incumbents, internally cultivated attackers can retain their agile ways of working, push for innovation, and cultures and products that attract talent—as long as they can sidestep the common problems that afflict corporate ventures (see sidebar, "Common problems of corporate ventures").

Create concepts

An incumbent's access to capital helps it cultivate a pipeline of new-business ideas as strategic opportunities arise. Its in-house experts and access to significant markets can also help new businesses' teams investigate and develop concepts. Idea generation will require industrial companies to give up product-centric mind-sets and use their customers' experiences as the impetus for new product and solution ideas.

To identify ideas that have the potential for breakout businesses, teams should adopt the perspectives of customers to identify specific, compelling, and valuable problems a new venture could feasibly address.[5] Teams could then devise solutions to the problem using lenses that focus on customers,

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[4] Hillenbrand, Kiewell, Miller-Cheevers, Ostojic, and Springer, "Traditional company, new businesses."
[5] For more on new-business factories, see Hillenbrand, Kiewell, Miller-Cheevers, Ostojic, and Springer, "Traditional company, new businesses."

Common problems of corporate-led new businesses

Corporate ventures often fall short of their potential because the habits, expectations, and even the resources from their parent companies can hold back their development. Below are some common pitfalls of corporate ventures.

1. Corporate-led new businesses may scale too slowly and be overtaken by external start-ups—often driven by friction between the new business and the legacy company.

2. They may fail to find a product-market fit or find their products stuck in the minimum viable product (MVP) phase because their product was not developed and refined based on customer feedback.

3. The new business may lack critical capabilities, such as talent with the specific mind-sets and skills that make it more likely to succeed. New businesses need teams that are comfortable making quick decisions with incomplete and ambiguous information and are willing to be wrong and correct earlier mistakes based on new information. These teams should also possess technical skills, such as data science, that may not be abundant in the parent company.

4. Corporate-led new businesses may fail to take advantage of their parents' built-in advantages. The obstacles may be structural as well as cultural. For instance, if executives at the parent company are not fully invested in new ventures, they may neglect to provide ad hoc help when the new venture needs it.

5. If parent companies don't provide enough resources, new ventures may slowly starve from a lack of capital.

6. Above all, misplaced expectations can set a dangerous tone for corporate ventures. Specifically, parent companies that focus on near-term profitability or frame the new venture as a source from which to extract earnings instead of a business can easily mismanage it and decrease the new business's long-term value.

competitors, and technology, then periodically solicit strategic direction from leaders. The best ideas should contain a hook around which teams can build an attention-grabbing value proposition. For instance, one advanced-industrials conglomerate took note of the fragmented security market and increasing demand for security software and decided to create an app store and operating system focused on IoT security software and devices.

Finally, teams should test the elements of a promising idea's business model. For instance, teams could articulate how they would launch the new business and confirm that the business would be (at least theoretically) profitable and scalable. One manufacturer assembled technology

partners who could help promote a new solution to prospective manufacturing customers before directing a team to confirm market demand for the offering. The team discovered that the solution was only applicable to a unique set of manufacturing plants and was not scalable in a time frame that would justify an investment. Up-front due diligence—performed in part by using the parent company's advantages—can help ensure that there is a product-market fit before parent companies invest in new businesses.

Make a blueprint
Once a concept has been validated, incumbents' new-business arms should assemble a team around a promising concept to build a business plan. The team should define the new company's operating

model, including technology, governance, and the go-to-market approach, and use this knowledge and the insights from the previous stage to build a blueprint for the business launch (see case study "Launching an IoT security business").

At this stage of development, a nascent business should already be a hybrid that has features of both new ventures and incumbents. The ideal team would include members from the parent organization and the strongest candidates it could recruit from the market. The parent company should commit to allocating resources to the new venture, including moving dedicated, entrepreneurial employees there. Ideally, the parent company would ensure that employees are fully committed to the success of the new business by tying their compensation to its success and making it clear they won't have the option to return to the parent company.

Similarly, the new venture's operating model should combine a flat organizational structure, agile work cadences, and an emphasis on key results. This way of operating can be grafted to the parent's assets—funding, relationships (with customers, suppliers, and partners), and brand equity.

Build and launch

A new business can use its parent company's customer base, brand equity, and expertise to smooth the way to building an MVP, then launching, testing, and learning from customers' responses (see case study "Creating a revenue-boosting product with customer input"). Although it's the parent company's responsibility to financially and logistically support the new business, the emphasis at this stage should be on removing risk for both the new venture and the parent company. Teams that focus on building and perfecting products at the expense of testing assumptions and gathering customer insights tend to produce suboptimal product-market fit, waste resources, and miss opportunities to build customer relationships that can make their launch a success. For example, Segway is an almost cliché example of a company that failed to test its assumptions about its product before launching. Although Segway scooters are technologically effective, their weight (up to 100 pounds), uncertain legal status (should users ride them in the street or on the sidewalk?), and high cost ($5,000) limited their adoption.

Although the parent company can be helpful in this step, new ventures and parents must both set

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Case study

Launching an IoT security business

A company that decided to launch an app store for IoT security devised and launched its go-to-market strategy to focus on attracting partners and developers who could help the business grow.

First, the team would build an alliance of industry organizations to establish standards and specifications for common security elements, such as operating systems, IoT infrastructure, data security, and privacy. This alliance would help the business attract developers to a series of activity-focused events, such as hackathons and industry-specific meetups, where the team would be able to show its solution to developers who could list their software on the app store. Next, the new-business team would engage technology integrators who would be responsible for melding new operating systems and tools to existing technology structures.

Finally, the new-business team would bring its solutions to the market by showcasing its end-to-end solutions at a security tradeshow, secure pilots, and launch its operating system and app store. The entire go-to-market process would take about 15 months.

Creating a revenue-boosting product with customer input

One transportation company worked closely with fleet operators to design a digital fleet-maintenance solution. Stakeholders from three customers helped create its solution by joining brainstorming sessions and providing detailed input on the product's features, design, and value as measured by customers' willingness to pay for the product.

The customers' feedback led the transportation company to make significant changes to its initial product features and development priorities. Crucially, customer feedback revealed the company could generate more revenue using data from the software to make tailored offers for aftermarket parts to customers instead of relying on software subscriptions. This finding helped clarify the transportation company's business case and monetization approach.

The digital solution is now in use and propels over $100 million in revenue through software subscriptions and aftermarket parts sales.

boundaries that can protect new business ideas. Because stakeholders at incumbents can be reluctant to support concepts that could grow into ventures that disrupt the parent's core businesses, parent companies can minimize internal competition by managing the new business as if the parent were a venture capital firm. Instead of setting up new-business labs or incubators with minimal accountability or demanding financial results from an early-stage business, incumbents should instead test new businesses for progress and learning. One agricultural company held regular reviews to make sure that its new IoT business performed research to confirm that prospective customers wanted to use its products and were willing to pay the proposed prices. Milestones notched to learning and product development can then serve as triggers for additional funding.

Scale
Scaling new businesses can help teams quickly capture returns on their investment—though industrial companies' new businesses might be more likely to involve hardware, whose production is more expensive to scale than software. As with

the launch, the team can access the parent company's customer base, brand equity, and financial resources to help create positive financial outcomes. And because new businesses have their parents' support, they can experiment more quickly and often while remaining safe. For instance, testing new business models based on customer needs and feedback can help teams learn quickly as they scale their businesses (see case study "Scaling a telco attacker"). Amazon Web Services followed almost this exact path when it first expanded from storage services to cloud computing, and then to adjacent cloud services.[6]

Of course, not all attempts to scale a product or solution yield financial results quickly, and teams should work with the parent company to ensure that a false start doesn't doom a venture. Specifically, teams should evaluate whether the factors that led to poor financial results might prove or disprove their original business case. Teams might discover that short-term results give them insights they can adapt to strengthen the business. Assuming that the business case holds, incumbents should fully invest in the new business to maximize its long-term value.

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[6] Alex Hern, "Amazon Web Services: The secret to the online retailer's future success," *Guardian*, February 2, 2017, theguardian.com.

Scaling a telco attacker

The secondary brand of a leading telco company decided to increase the revenues of its digital-attacker brand by more than 80 percent after seeing declining revenues and gross profits over the previous three years. In a market with more than 100 percent mobile phone penetration (meaning that many users had more than one mobile phone), providers tended to compete on price.

The team supporting the digital attacker set up a cross-functional team focused on digital growth and hired three digital experts to help the brand achieve its growth goals. The team became more decisive and agile, shortening the lead time between planning and execution from two to three weeks to one to four days. In addition, the team's weekly strategic meeting became a daily meeting, which allowed the team to adjust its approach nearly in real time.

The team attracted new customers by running one or two promotions a week instead of one per month. This resulted in a fivefold increase in daily orders, far surpassing the company's original objective.

Contribute value

When a new business can sustain itself, it can interact with its parent company on more equal footing. By this stage, the new company should have its own customer base, its own expertise on technologies and customers, and its own brand (which may be associated with the parent's brand). When a company is mature enough to create value of its own, it can operate as a business unit of its parent company, which would allow the parent company to enjoy ongoing revenue streams from its offspring. Alternatively, the new business could become a subsidiary of its parent or even file for its own IPO, giving the parent company a liquidity event (which converts at least part of the parent company's ownership into cash).

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For established industrials, creating their own new businesses can mitigate the existential risk of disruption. Incumbents can accomplish this task by overcoming the pitfalls that can hamper efforts at each stage of new-business building. The ones that succeed will be rare giants that can also create and shape nimble attackers.

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Accelerating revenue growth through tech-enabled commercial excellence

Industrial companies are transforming revenue growth by using digital technologies and analytics to tap into next-generation commercial levers.

by Minti Ray, Stefano Redaelli, Sidney Santos, Jared Sclove, and Andrew Wong

Industrial companies continue to look for the next horizon of growth. In our experience, a surefire way to boost revenues is to undertake a tech-enabled transformation across three areas—commercial excellence, portfolio and markets, and innovation and business building (see sidebar, "A comprehensive approach to revenue growth"). In particular, pursuing commercial excellence, which encompasses activities from e-commerce to on-the-ground sales, holds immense potential for industrials: McKinsey research found that applying technology to the activities of the commercial function could generate up to nearly $300 billion in additional industry-wide revenues.[1] To date, however, the performance of industrials in the area of commercial excellence has lagged behind that of their B2B peers.

One reason is that, while the industrial sector has become a test bed for new technologies in supply chains and manufacturing, companies have been slow to apply digital and analytics within the commercial function. Business leaders recognize the clear benefits of these technologies: 55 percent of high-performing commercial organizations state that the use of analytics is "absolutely critical," and 46 percent of high performers plan to increase spending on analytics by more than one-quarter over the next two years, compared with just 11 percent of low performers.[2]

Industrial companies cannot improve their commercial function with investments in digital technologies and analytics alone. Instead, they must use a comprehensive playbook to execute a tech-enabled growth transformation through commercial excellence. But, because the commercial function encompasses a range of activities, companies must tailor their playbooks accordingly. A number of organizations have already extracted significant value using this approach, which offers a clear path forward.

A comprehensive playbook for the commercial function

Based on our experience working with industrial companies, we have identified four sources of value for a tech-enabled transformation (Exhibit 1). The application of digital and analytics can help organizations achieve commercial excellence and, ultimately, sustainable organic growth.

When investing in analytics, organizations can increase their odds of successfully extracting value from these sources by following these core tenets:

— Analytics alone will not have meaningful impact absent broader change. Capturing value from analytics requires companies to change their approach to execution, decision making, and frontline processes.

— Analytics should be led by business needs rather than by IT, and analytics should be built one use case at a time.

— Companies don't need perfect data sets to get started; in most cases, they have enough data for immediate impact.

— Analytics need not be a major investment and can be built at a fraction of the cost of traditional IT projects.

— To increase the impact of analytics, the best-performing companies build small but highly skilled analytics teams that work closely with commercial leaders.

These tenets are embodied by a tech-enabled transformation playbook, which is a comprehensive approach to building the strategic road map and scaling the change necessary to achieve growth and commercial excellence.

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[1] "Tech-enabled transformation: The trillion-dollar opportunity for industrials," November 2018, McKinsey.com.
[2] *2015 State of Analytics*, Salesforce, October 2015, salesforce.com.

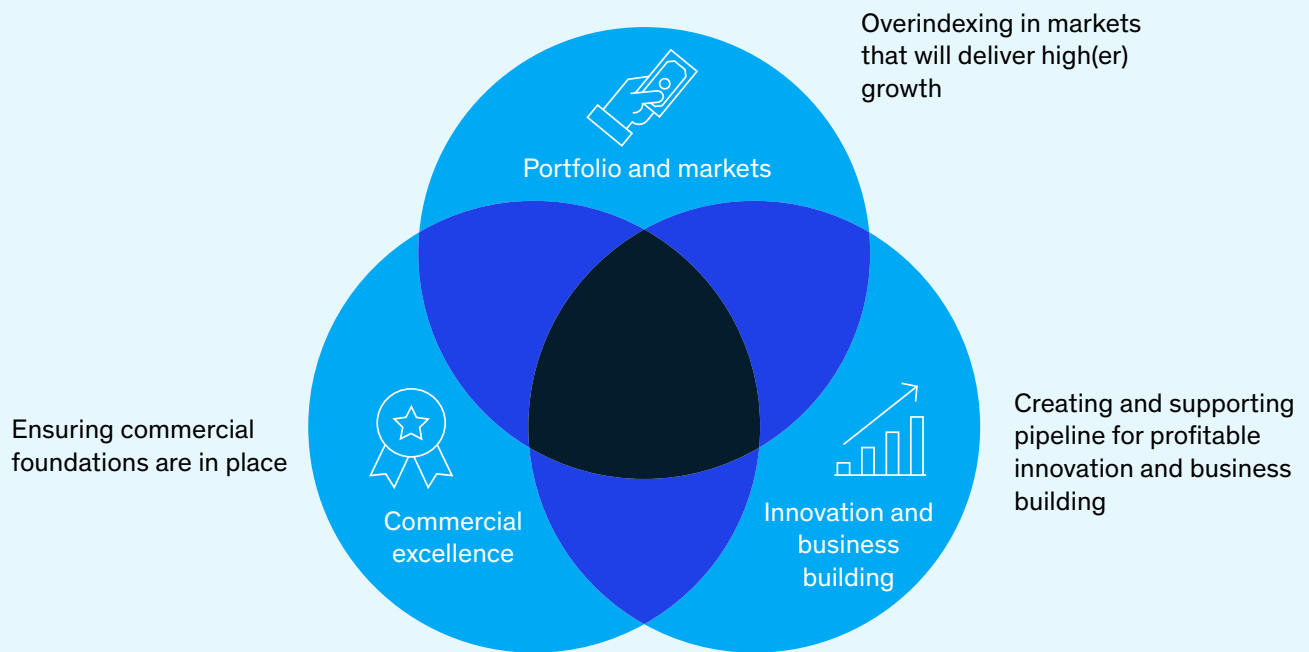## A comprehensive approach to revenue growth

Sustaining growth is difficult for any organization, but the value of doing so is enormous: companies that outperform their peers on both revenue growth and economic profit create more than 6 percent in additional total return to shareholders a year.

Several factors make growth transformations an enduring challenge. Successful growth efforts require collaboration across functions, but organizations often fail to designate an end-to-end owner who is accountable for results. Attractive end markets shift continuously and create new opportunities, but few organizations are able to dynamically reallocate resources. Digital technologies and analytics have the potential to supercharge growth, but many companies lack the necessary talent and capabilities in functions such as analytics and general management to implement these solutions at scale.

In our experience, successful growth transformations require an integrated effort across three areas (exhibit).

Exhibit

Growth transformation requires an integrated, organization-wide effort.

Overindexing in markets that will deliver high(er) growth

Portfolio and markets

Ensuring commercial foundations are in place

Commercial excellence

Innovation and business building

Creating and supporting pipeline for profitable innovation and business building

Taking a comprehensive approach to improving performance in these three areas can compound the topline benefits. In fact, organizations that successfully master one area have achieved annual growth rates one percentage point higher than the average growth rate of their sector. However, mastering two or all three areas can boost annual growth by 3.6 percentage points more than that of their peer companies.[1]

[1] "Mastery" is defined as survey respondents' agreement that their companies are "effective" or "very effective" at 70 percent or more of practices in a given area (there are three areas: commercial excellence, portfolio and markets, and innovation and business building). For commercial excellence, the survey asked about eight practices; for portfolio and markets, seven practices; and for innovation and business building, six practices. For companies that have mastered no lenses, n = 765; for companies that have mastered one, n = 320; and for companies that have mastered two or three, n = 381. See Kabir Ahuja, Abhinav Goel, and Kate Siegel, "Debunking four myths of organic growth," May 2019, McKinsey.com.

Exhibit 1

For a successful tech-enabled transformation, companies extract value from their commercial activities.

Sources of value	Examples of digital levers			
E-commerce and digital marketing	Agile digital marketing	Optimized paid search (SEM[1])	Maximized organic search (SEO[2])	Next product to buy/personalization
Digitized sales and channel	Coverage and channel optimization	Field productivity analytics and talent development	Intelligent lead generation	Analytics for key account management
Advanced pricing	Dynamic (at-scale) price setting	Dynamic deal scoring	Data-driven performance management	Targeted category margin expansion
Analytics-driven marketing	Lead scoring and microsegment targeting	Personalization	Dynamic creative and content	Churn prediction and reduction

[1] Search engine marketing
[2] Search engine optimization

The playbook's two phases and four enablers reflect the best practices of a tech-enabled transformation.[3] However, the way in which the playbook should be applied must evolve based on the particular source of value for commercial excellence. The following sections walk through the playbook and share examples from e-commerce, a digitized sales force, and advanced pricing.

Phase 1: Assess

The first phase of developing the strategic road map involves making quantitative assessments to diagnose issues and evaluate the potential of value-creation opportunities. The assessment approach can vary significantly, depending on the source of commercial value. To calculate the potential of a digitized sales force, for example, companies should evaluate opportunities across a broad

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[3] For more detail on the comprehensive playbook, see Venkat Atluri, Aamer Baig, and Satya Rao, "Accelerating the impact from a tech-enabled transformation," on p. 15 of this collection.

range of levers—from reducing pricing variance to standardizing policies for freight, returns, and rebates to thinking through a holistic book of business with customers. Analytics can help organizations understand the variance, figure out which lever has the most impact, and select the tools and capabilities that the field force needs to address margin leakage.

In addition, companies should assess how long it may take to capture the value. Some levers will need technological fixes. For example, restricting discounts may require updating the back-end sales system through the introduction of an advanced analytics capability. Other changes may lead to additional frontline sales training and education. For example, in the case of freight, salespeople must learn how to have difficult conversations with customers about why their companies will have to pay for a service that previously was free.

For e-commerce, the assessment first focuses on estimating the value of the opportunity and then examines each element that supports e-commerce. The revenue potential can be rendered as this formula:

When assessing device traffic, a company can measure the return on investment (ROI) of each of its digital-marketing programs (such as paid and organic search, email, display, product listing and local inventory ads, and loyalty) and benchmark its performance versus industry peers and cross-industry leaders. For user conversion, a company should conduct a teardown of all digital properties to establish a benchmark for user interface and experience (UI/UX), lead generation and automation, and other advanced levers.

Companies should ensure that the assessments review all relevant digital capabilities and then compare the results with industry benchmarks. The assessments should be complemented by expert-led walk-throughs to test initial results. A US logistics company, for example, failed to keep pace with the industry's adoption of digital-marketing technology as measured by investment, processes, and capability development. To address these weaknesses, the company performed an assessment, conducted a walk-through, and compiled a set of prioritized use cases that had the potential to increase annual revenue by about $150 million. It also identified the required digital-marketing capabilities and technology needed to support this goal.

Revenue =

device traffic X **bounce rate** X
user conversion X **average order value** −
cancellations and returns

To capture opportunities in pricing, companies must first assess practices at all levels, from defining the pricing strategy to getting the desired price (Exhibit 2). This exercise highlights where performance lags behind best practices. For example, one large equipment manufacturer had traditionally priced add-ons to products on a cost-plus basis. However, a comparison between the sales and margins of base products and add-ons revealed that in several categories most customers preferred products with add-ons—which had smaller margins. By moving to value-based pricing, the company was better able to match prices to customer preferences and unlock incremental bottom-line impact.

Once companies have developed a solid understanding of the starting point, leaders can make informed decisions about which capabilities to prioritize and which activities of the sales organization need additional attention to capture more value. For example, one equipment distributor increased margins substantially by empowering the sales force with real-time information about the profitability of different deals. It also made significant investments to train salespeople on pricing concepts. The result was a well-informed sales force that understood the consequences of trade-offs and could make better pricing decisions for every deal.

Phase 2: Build and implement
The second phase of the transformation journey involves executing the strategic road map. Companies must invest in and enhance the playbook's four enablers: capability and talent, technology and data, performance infrastructure, and organization and mind-set. The requirements for each enabler will vary depending on a company's vision, goals, and current baseline—that is, its existing infrastructure and organizational capabilities and skills.

Exhibit 2

Capturing value from pricing requires assessing pricing practices at all levels.

		Base practices	Nascent capabilities	High performer	Next frontier
Assess core pricing practices	**Define pricing strategy**	• Price follower	• Competetive pricing	• Strategic pricing	• Disruptive pricing models
	Set the price	• Cost-plus pricing	• Portfolio pricing • Heuristics pricing	• Value-based pricing • Life cycle pricing	• Dynamic pricing
	Get the price	• Discount guardrails	• Gross margin or discount management • Leakage management	• Dynamic deal scoring • Dynamic pricing grids or dynamic contract management	• Analytics 3.0: dynamic-price sales management

The comprehensive playbook was developed to help companies overcome common obstacles in the course of a transformation. During this phase, one of the main challenges is engaging all stakeholders and breaking down silos between the IT team and the rest of the organization. Collaboration and coordination of efforts across the commercial function are important elements of the playbook. One advanced electronics company, for example, created a multifunctional team that included leaders from learning and development, sales, finance, IT, and change management to build the full-scale implementation plan.

Another challenge is that, after initial gains, the impact of the transformation tends to plateau. This pattern can be traced to multiple causes, including a return to traditional ways of working, limited adoption of changes across the organization, and reduced focus on sustaining progress by management. To be successful in the long term, leaders must champion change and have a relentless drive to achieve initiatives and capture the value at stake.

The following sections examine the four enablers in detail and provide examples of how their emphasis changes by commercial activity.

Capability and talent

To build the necessary workforce and leadership capabilities to support a tech-enabled transition, many companies must upskill their entire sales organization—from the frontline sales team to managers to the executive office. Another key element of building capability and talent involves upskilling the members of the transformation office. These positions, which implement and scale changes, require unique skills and knowledge. Designating formal and informal leadership coaches for transformation-office leaders can enable the leaders to be more effective.

Building capability and talent must remain a continuous process for a company to meet its transformation goals, because the instillation of new skills and knowledge in employees can be challenging to maintain. Companies tend to lose focus after an initial push, erroneously assuming that an updated onboarding process for new hires will be sufficient.

A digitized sales force

Incorporating technology into every facet of the sales force must be accompanied by a coordinated training effort. Sales leadership and a multifunctional team should work together closely to develop programs that cover the new sales processes and policies, sales vocabulary, negotiation strategies, and upgraded tools and dashboards used to monitor and improve performance. An advanced electronics company seeking to digitize its sales force, for example, created content and learning modules that were continuously refreshed, based on aggregated observations of sales-force performance in the field. The organization also invested in personalized coaching for selected leaders.

E-commerce

In e-commerce, it is often possible to accelerate development life cycles by applying an agile methodology. This approach requires organizations to shift from functions coordinated by project managers to truly agile teams that lead sprints toward improvements (Exhibit 3).

Technology and data

Data-driven decision making is a key ingredient of commercial excellence. To accelerate growth, the entire organization must have access to the latest information and analyses. Many companies will have to build an integrated data lake and dashboard. The dashboard's functionality need not be comprehensive at launch, because when it's developed in an agile fashion, an organization can add features every few weeks, based on the road map as well as feedback from the field.

After the initial launch of technology upgrades and changes, infrastructure must be continuously modified to match the transformation's evolving requirements. Testing and feedback should be collected to improve the tools, data, and enabling technology. As the transformation scales across the organization, adoption of the technology infrastructure will increase.

Exhibit 3

Accelerating capability and talent building requires an organizational to shift from functional teams to agile, cross-functional teams.

From siloed, project-management-driven teams…

	E-commerce	Fulfillment	Catalog
Vice presidents			
Directors			
Project managers			
Single-function teams			

Project managers interface across silos and translate to VPs.

… to agile, cross-functional, independent teams

1 Search algorithm

Agile team leader

2 Omni-mobile platform

18 2-day ship to home

Cross-function team members can include front-end software developers, back-end software engineers, data/infrastructure engineers, UI/UX designers, customer-facing experts.
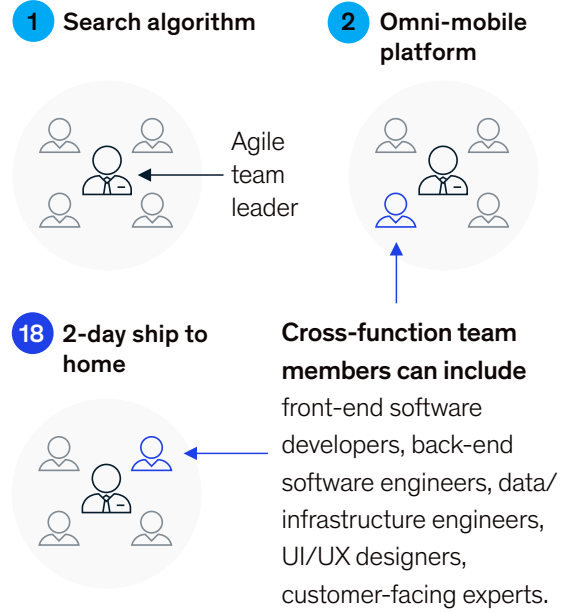
Teams operate the business.
Each team has individual goals to achieve, metrics to track success, and profits and losses—all working toward overall digital goals.

A digitized sales force
The dashboard is a critical element for the sales force, because it functions as the single source of truth. Individual sales agents can use the dashboard as a baseline to improve their performance by reviewing their own past transactions and identifying missed opportunities. At the previously mentioned advanced electronics company, incremental upgrades to improve order-entry systems (for example, employees who repeatedly don't comply with business principles are locked out of the system), the data lake, and the performance-management dashboard (such as increasing the frequency of data updates, from weekly to daily to live) continued through the transformation journey.

System and technology changes were prioritized based on their expected impact and signed off by the full transformation office and C-suite.

The company also designed and launched multiple system enhancements to nudge the sales force to comply with the sales processes and policies and to increase the margins from every transaction—for example, by suggesting price floors to reduce discount variability and prompting agents to pass through freight costs. There was a targeted effort to identify high-value system enhancements based on the value that was at stake. These changes were launched in sync with a change-management and

communication plan, to ensure that the effort's goals were visible and clear to the organization.

In addition, analytics tools can be used to optimize the structure of the sales force by the type and frequency of commercial activity, territory and account loads, or the go-to-market model—which might be direct sales (key-account manager, field sales, inside sales, e-commerce) or indirect sales (partners and resellers, distributors). For example, the combination of attitudinal customer segmentation, total account potential, and historical response curves from outbound-sales activity can lead to an optimal sales-deployment model that aligns all activity against the highest-potential accounts to maximize returns. Using this approach, one B2B distributor was able to identify more than $100 million in additional revenues while reducing sales-management head count by about 15 percent. A chemicals company deploying the same analytical approach was able to develop a commercial strategy that enabled it to grow at above-market rates.

Advanced pricing
Having a centralized data lake is critical to maximizing value from pricing actions. For one global manufacturer, changes in tax structures in Europe significantly affected the market. The sales teams responded by increasing discounts on certain products, which led to negative margins. Since information was scattered across several systems, it took months for management to identify and reprice those items. By establishing and accessing a single source of truth, made possible by the data lake, managers can now more quickly respond to changes in market and customer trends that might open up pricing opportunities.

However, many executives believe that they must have a comprehensive technology solution in place to start capturing value. We disagree. An automotive parts manufacturer, for example, developed standardized analyses and reports using data available in separate systems. While the comprehensive solution was being built, these data sources were sufficient to provide valuable insights to the pricing group, allowing

them to make more targeted pricing adjustments and, as a result, unlock significant value.

Performance infrastructure
A high-powered transformation office is critical to steering efforts and monitoring progress. Senior management should designate employees for the transformation office and then define individual roles and responsibilities. Establishing frequent meetings ensures that the transformation proceeds on an accelerated timeline.

The transformation office plays a pivotal role in achieving impact by moving beyond early-adopting employees to focus on promoting change among the organization's rank and file. The office's members should adopt a strong execution mind-set, with clearly defined metrics for tracking. The design of the office should be fluid enough to allow members to be swapped in and out based on the requirements of specific initiatives.

Across all commercial activities, a digital war room can serve as a powerful way to track in real time the actions and results of those at all levels of the organization, including sales managers and frontline salespeople (Exhibit 4). Such visibility promotes a focus on execution.

These elements are integral to an agile approach, which has demonstrated its effectiveness in achieving sustained improvements. Overall, agile organizations have a 70 percent chance of achieving top-quartile organizational health. With agile capabilities, companies can simultaneously increase customer centricity, accelerate time to market, generate higher revenue growth, and reduce costs.

A digitized sales force
At one company, the transformation office tracked four key performance indicators (KPIs) that had the most impact on margin expansion and identified low and high performers (by business segment, location, and individuals). This information enabled the company to recognize leaders and prescribe remedial action for some. The metrics and performance outliers were also incorporated into the company's regular internal reviews.

Exhibit 4

A war room installed at company headquarters is the central nerve center of a transformation.

| Weekly execution cadence | Real-time tracking against targets | 100,000 actions individually tracked |
| Full frontline deployment and training | | Full data and CRM[1] integration |
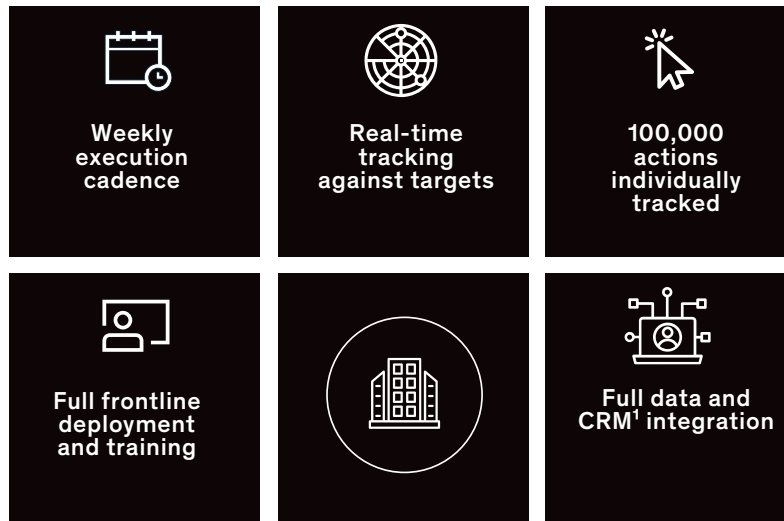
[1] Customer relationship management.

Companies should also reevaluate incentives to ensure their alignment with the transformation goals. At an advanced electronics distributor, for example, the compensation and bonus structure were linked to the overall profit a sales agent generated for the company rather than to increased margins, which were the focus of the transformation. Once the company recognized this misalignment, it undertook a complete restructuring of the compensation and bonus plan, with a focus on rewarding increased margins.

E-commerce
In e-commerce, performance can be measured daily, because of the almost instantaneous nature of feedback from online transactions. For example, one aftermarket retail company established a digital-marketing war room to encourage performance-management discipline in all its campaigns. Owners of each campaign shared progress daily on performance as measured by return on advertising spending, aspects needing improvement, and additional investment required. Once a week, all initiatives were combined into KPIs to be tracked and managed by the chief marketing

officer. Vice presidents and initiative owners were assigned targets for each KPI, and the owners presented weekly progress reports against the targets. The CMO then helped uncover roadblocks and secure additional investment for campaigns that produced a positive ROI.

Advanced pricing
In pricing, the transformation office's function and cadence can provide a forum to resolve conflicts that arise from pricing decisions. These conflicts often involve trade-offs between margins and volume and might require quick action. At one large distributor, the sales force was compensated based on net sales. Salespeople were afraid to follow recommendations from the pricing team, which had used a new methodology to identify ongoing customer sales negotiations that might warrant higher prices. By creating a special initiative under the transformation office, the company was able to ensure that sales reps would not be penalized if some of the negotiations failed. This move freed the sales force to adopt the new approach and improve the bottom line without a complete overhaul of the sales-compensation structure.

Organization and mind-set

Sustaining organizational health and employee morale while carrying out transformation initiatives is a major challenge. Most organizations have a mix of adoption levels. Some employees become early adopters, while others are more resistant to change. The introduction of the data lake and dashboard requires substantial quality testing from designated "super users" as well as extensive training and communication to enable the organization to use the features effectively.

To keep the transformation from stalling, communication about the case for change, sufficient resources to support individuals, and proper incentives become even more important. Often, companies also form a dedicated change-management team as part of the transformation office. In addition, recognition beyond financial incentives plays an important part in promoting the desired mind-sets and behaviors throughout the organization.

A digitized sales force

At an advanced electronics company, senior management implemented financial incentives for improving margins (the overall goal of the company's transformation). In addition, it held short-term competitions among different locations to improve specific metrics on the margin levers (such as how frequently freight costs were passed on to customers). The winners received nonfinancial rewards, such as recognition in CEO town halls. The company also provided employees with a "bonus calculator" that allowed them to quickly see the incremental bonuses they could earn by following the new business principles.

E-commerce

At the previously discussed aftermarket retail company, managers sought outside inspiration to help shift the mind-sets of their highly capable team of data scientists and analysts. The team members had focused on 15 descriptive analytics cases whose impact was unclear. The company brought the team to an external AI experience center that worked with the team members to migrate their efforts from descriptive to predictive use cases. This mind-set shift allowed the company to identify and size predictive use cases, define an advanced AI data stack, and enable use-case development through improved data governance.

Advanced pricing

The transformation team at a large equipment manufacturer appointed initiative owners from sales to test and promote the adoption of new pricing tools. Because the owners were high-profile sales reps, collecting feedback and improving the tools was relatively easy, given the high levels of trust between the company and the sales reps. By constantly celebrating successes and using language that resonated with the sales reps to communicate the benefits of the tools, the initiative owners were able to quickly embed the new tools into sales processes and ensure that new pricing insights were applied broadly.

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Using tech-enabled commercial excellence to accelerate revenue growth requires industrial companies to continuously adapt and respond to the changing digital, technological, and analytics landscape. Building the strategic road map and scaling the necessary changes according to the playbook help to lay a solid foundation for a tech-enabled transformation while providing the flexibility industrial companies need to excel across all the value-creation levers of the commercial function. The result will be an organization with the necessary capabilities and tools to make better decisions, pursue new opportunities more readily, serve customers more effectively—and accelerate growth.

Industrial 'lighthouses' for tech-enabled transformations

For industrial companies, so-called lighthouse sites that incorporate all applicable tech solutions can help organizations transition from trials to sustainable change.

by Kevin Goering, Yogesh Malik, Victoria Potter, and Kevin Sachs

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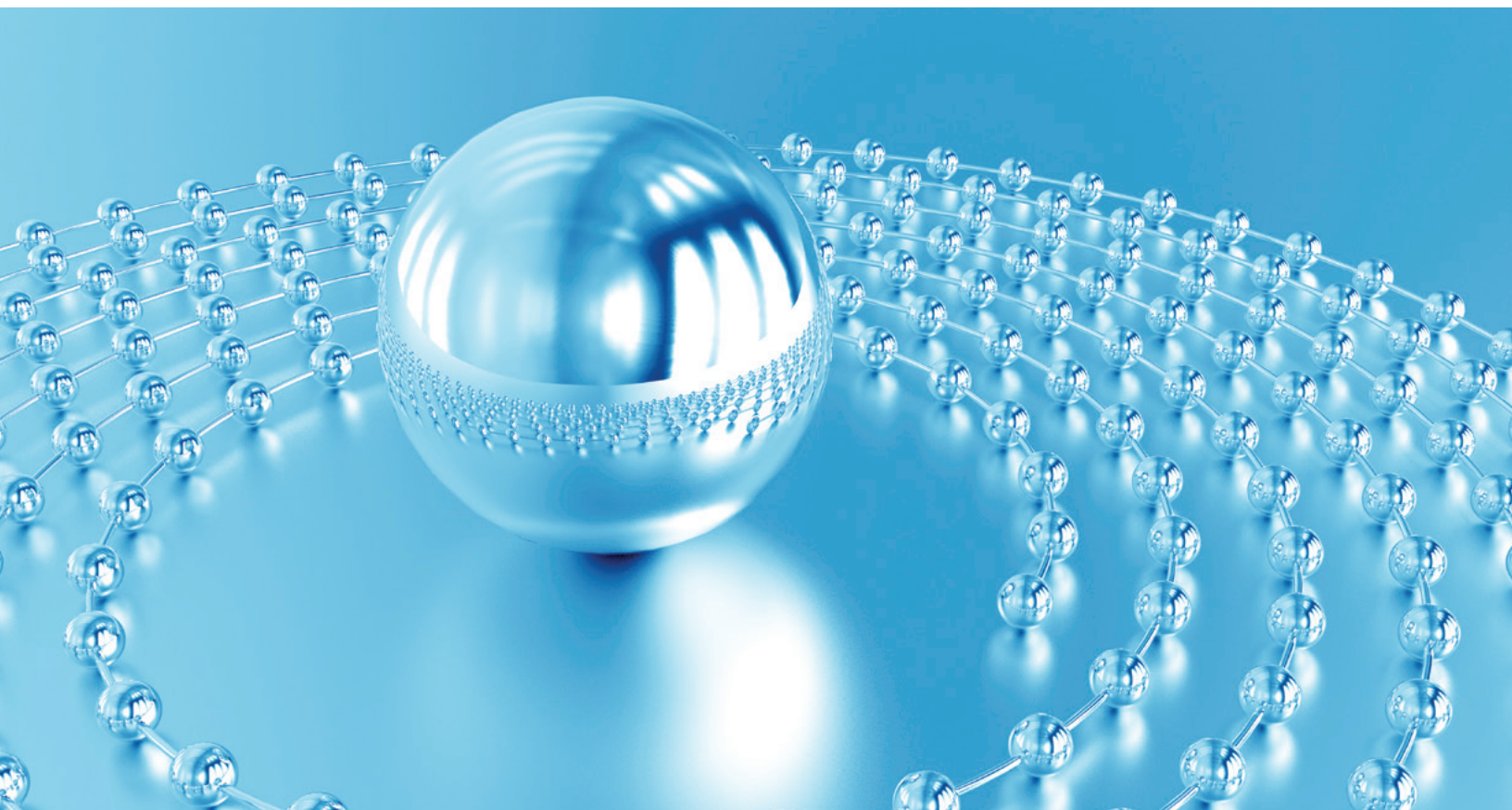
Knowing the potential of tech-enabled transformations to meaningfully improve business performance, executives in the industrial sector have been pondering how to use new tech for maximum effect. The efficiency that tech-enabled transformations can create can also be a major force behind margin growth. While there are many possible areas of focus—such as revenue generation, cost optimization, and operational improvements—our analysis found that the manufacturing and supply chain (making and delivering) area of focus often provides the largest opportunities (Exhibit 1).

However, many industrials fail to capture value from their tech solutions, in part because solutions tend to be spread among too many pilots for their impact to be optimized. While testing might seem to be a low-risk approach to new tech tools, the proliferation of decentralized use cases can lead to lack of focus, organizational fatigue, little enterprise-level understanding of the impact of promising tools, and complications from integration between IT and operations systems.

A few industrial companies have managed to use new tools and tech and have seen bottom-line benefits from greater margins. These companies succeeded not by utilizing one-off use cases, but by implementing an integrated set of solutions across a single manufacturing facility that served as a "lighthouse."

Exhibit 1

Tech-enabled transformations can help industrials improve their performance.

% improvement

Domains	Auto OEM	Aero OEM or supplier	Industrial distributor	Broader industrial components
Revenue				
• Innovating and product development	0–0	0–0	0–2	1–5
• Selling	0–0	0–0.1	2–5	2–5
• Servicing new	0.3–1.4	0.3–1.4	0–0	0.5–1.2
COGS Making and delivering	5–7	5–10	2–5	3–9
SG&A (incl R&D)				
• Selling	0–0	0–0.1	2–5	2–5
• Servicing new	0.3–1.4	0.3–1.4	0–0	0.5–1.2
• Running a corporation	4–6	4–6	0–0	4–8
• Innovating and product development	0–0	0–0	0–2	1–5

Experience with successful transformations confirms that instead of testing different initiatives and tools across a large number of sites and business units, companies should companies should choose a single lighthouse site to serve as a model for how to implement their tech initiatives. Doing so will push companies to develop tech-enabled end-to-end transformations within these lighthouses and maximize margin growth through complementary initiatives. In fact, recent McKinsey research with the World Economic Forum identified 26 lighthouse facilities that used this methodical comprehensive approach to boost their overall productivity by 20 to 30 percent—results that allowed their transformations to break even in less than two years.[1]

The evidence suggests that industrial companies should set up lighthouses of their own. This will help them redesign processes throughout their organizations and focus on increasing margins by combining the most effective solutions. Conversely, companies that are slow to transform using tech risk falling behind.

Pilots and function-specific focus limit tech's impact

Companies themselves realize that one-off use cases are preventing them from tapping into the full potential of tech-enabled transformations. In a recent McKinsey survey of manufacturing companies around the world, 52 percent of respondents reported that their companies' tech-enabled solutions were characterized by use cases and ad hoc implementation, not redesigned end-to-end processes that integrated tech. As a result, only 29 percent of organizations believe they will receive value from implementing new tools. The unfocused application of tech means that these companies rich in use cases are paradoxically poor in results.

Framing tech-operations implementation as a function-specific initiative can also curtail initiatives' impact. Sixty percent of organizations

we surveyed reported that implementation is the responsibility of a single function, usually IT or operations. It's therefore unsurprising that 87 percent of organizations also reported minimal cross-cutting digital operations solutions at their organizations when they haven't involved practitioners from all the relevant functions. One company was able to make its lighthouse successful by assembling a team with expertise in quality, manufacturing, engineering, and IT and having this cross-functional team create an integration plan. This comprehensive approach meant that every function was able to help design the relevant solutions and infrastructure for maximum usability and impact. As a result, the lighthouse saw 33 percent lower rates of equipment breakdowns and required 90 percent less time to resolve quality deviations (Exhibit 2).

Even though the benefits of comprehensive, cross-functional, tech-enabled transformations far outweigh the benefits of less extensive transformations, functional leaders can be hesitant to commit resources to such an effort. In these situations, passionate sponsorship from C-suite executives will be crucial to power the leap of faith needed to launch a collaborative transformation that changes the way multiple functions work.

A new approach to end-to-end tech-enabled transformations

Organizations must shift their approach to address more than just use cases and individual solutions. While organizations should identify solutions as part of their self-assessments, a more useful implementation model is one that pulls together a set of interlocking solutions that maximize margins, define the required infrastructure, and help the organization build capabilities.
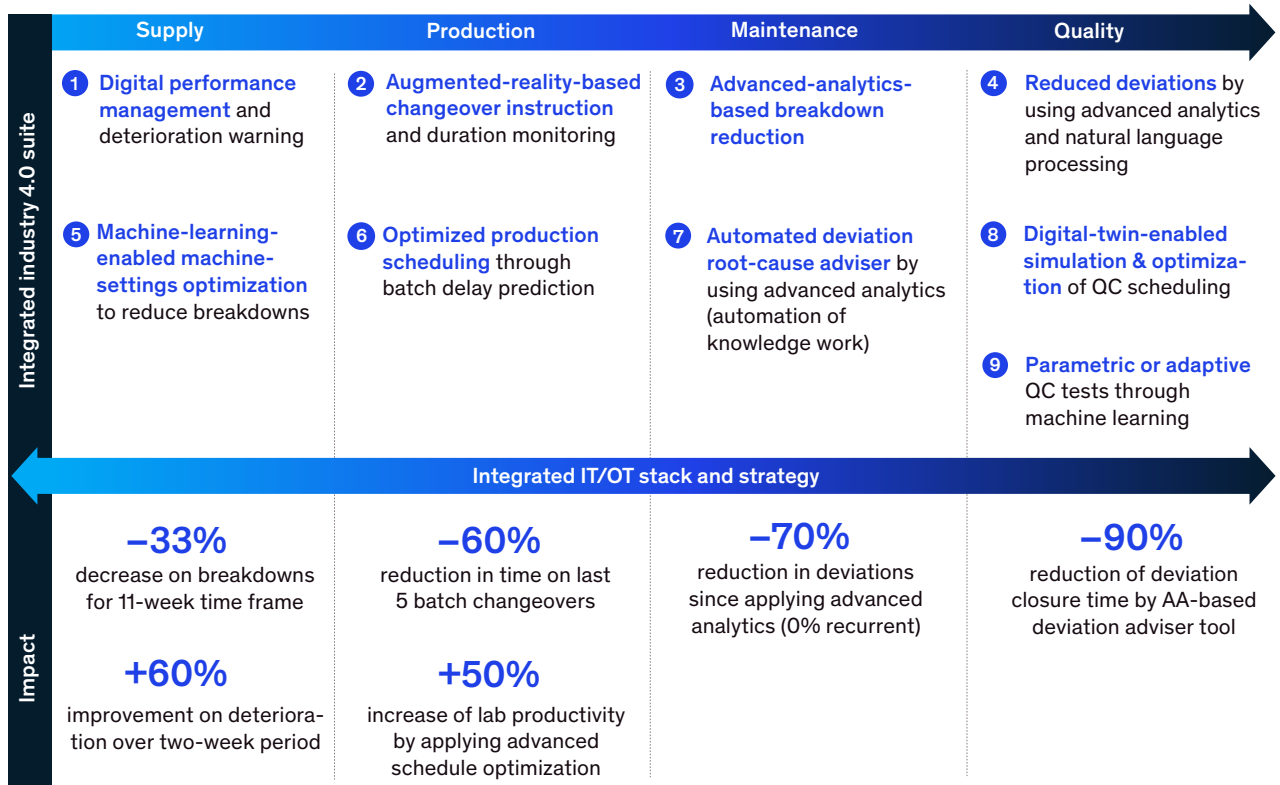
Assess
Before selecting a lighthouse, leaders must set a clear vision for the transformation that includes direct performance targets. Because the lighthouse will serve as an exemplar of digital technologies,

Exhibit 2

Implementing a cross-functional approach to tech-operations implementation can prove beneficial to organizations.

	Supply	Production	Maintenance	Quality
Integrated industry 4.0 suite	**1** **Digital performance management** and deterioration warning	**2** **Augmented-reality-based changeover instruction** and duration monitoring	**3** **Advanced-analytics-based breakdown reduction**	**4** **Reduced deviations** by using advanced analytics and natural language processing
	5 **Machine-learning-enabled machine-settings optimization** to reduce breakdowns	**6** **Optimized production scheduling** through batch delay prediction	**7** **Automated deviation root-cause adviser** by using advanced analytics (automation of knowledge work)	**8** **Digital-twin-enabled simulation & optimization** of QC scheduling
				9 **Parametric or adaptive** QC tests through machine learning

Integrated IT/OT stack and strategy

	Supply	Production	Maintenance	Quality
Impact	**−33%** decrease on breakdowns for 11-week time frame	**−60%** reduction in time on last 5 batch changeovers	**−70%** reduction in deviations since applying advanced analytics (0% recurrent)	**−90%** reduction of deviation closure time by AA-based deviation adviser tool
	+60% improvement on deterioration over two-week period	**+50%** increase of lab productivity by applying advanced schedule optimization		

leaders must work with both internal and external thought leaders and innovators to set an ambitious but achievable goal based on business needs. Leaders and practitioners who are used to working in lean methodologies should resist the habit of looking for 5 to 10 percent improvements through small process changes and instead set bigger margin-enhancement goals. Visits to existing lighthouses or industry-leading thinkers and organizations (also known as go-and-sees) can be powerful sources of inspiration for executives to develop bold visions.

Once ready to select a lighthouse site, leaders should carefully choose a location that has meaningful business impact, is somewhat

representative of other sites (especially when it comes to the existing IT/OT stack), and has leaders who are enthusiastic champions of the transformation. From there, the focus should be on decisive execution.

Build and implement

To devise solutions that match the organization's needs, the transformation team must understand underlying business needs as well as the company's operations. In fact, anchoring the design of new solutions in their intended impact is more important than understanding the potential technologies. While this idea may seem self-evident, many companies approach their tech-enabled transformations by leading with tech instead of

business improvements. One aerospace company invested tens of millions of dollars in supply-chain visibility tools with little understanding of how they could benefit the company. As a result, the tools produced rich visuals from the data they collected, but the company had no idea how to meaningfully improve the relevant business outcomes.

An impact-oriented approach also means that each transformation will be distinct in its scale and use of solutions. For instance, while some companies might need to integrate 20 important solutions, others might benefit from just a handful of key technologies. Indeed, the focus of implementations should be on quality solutions that create efficiency gains rather than just the quantity of solutions.

And while it can be tempting to enter the implementation process with an eye on minimizing initial costs, lighthouse teams should approach the build-and-implement phase with enterprise scalability as the goal. While the majority of time and effort should be focused on lighthouse design and deployment, decision makers should consider requirements of diverse sites and account for current levels of enterprise-level IT. Additionally, transformation teams should use lighthouse experiences to build strong change-management teams, codify processes, and record lessons learned. This medium- to long-term perspective will increase the returns of the eventual tech-enabled transformation.

Enabling digital lighthouse transformations

Many standard transformational tenets hold true for tech-enabled lighthouse transformations: organizations must build capabilities, shift team members' mind-sets and behaviors, and establish systems to monitor performance and accountability for the transformation's progress.

However, tech-enabled transformations require a few modifications to the best practices associated with traditional transformations.

Building capabilities

Companies likely have some conventional transformation skills in-house, including change-management and continuous-improvement capabilities. But many lack the technical skills required for successful tech-enabled transformations. At a minimum, companies need translators to help business and tech teams communicate effectively, data engineers and architects to prepare data for analytics, data scientists to derive insights from the data, and user-interface experts to prepare digital tools for users. Because organizations rarely possess the complete set of necessary skills, they should hire or contract professionals with the requisite skill sets as needed. However, all skills must ultimately reside with the company's employees. In addition, lighthouse change agents will need to operate in a new way.[2] Because agile delivery requires teams to develop, test, and iteratively improve solutions in close collaboration with key business functions, teams should ideally be co-located, cross-functional, and supported by agile working cadences (usually two-week sprints in which teams design, test, and refine solutions).

Finally, companies should train frontline workers and managers to participate in the development of new capabilities. This approach is twofold: to have employees co-develop solutions to ensure that final products are usable, helpful, and intuitive, and to have change agents train the permanent workforce. Managers and leaders should participate in administering this training so they can help reinforce the organization's understanding of this work once change agents have transitioned to other sites.

Cultivating mind-sets and behaviors
A less siloed mind-set is important if operations

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[2] The concept of change agents was first popularized with the advent of lean transformations. Now, change agents are individuals who help organizations transform. For more on change agents, see "The change agent challenge," March 2017, McKinsey.com.

and IT teams are to participate as full partners in developing tech and solutions. Operations teams will be the solutions' end users, so technical teams must collaborate with them to make sure tools are easy for them to use and tailored to their needs.

For their part, operations teams should remain open-minded and cognizant of potential technical constraints. This delicate balance means that a cohesive partnership between the two groups is often hard to create but imperative to success.

Once the transformation is underway, lighthouse change agents must work with a mind-set oriented around decisive action. Approaching lighthouse initiatives as a series of agile sprints instead of projects with hard deadlines that can succeed or fail will be a departure from most organizations' established mind-sets, so leaders must consistently communicate and demonstrate that the emphasis is on decisive action and learning.

Setting up performance infrastructure
Given the fast pace of tech development, all lighthouse initiatives deserve thoughtful ongoing scrutiny. Therefore, the organization should begin by establishing a transformation office and name a single transformation leader. The transformation office should also establish key performance indicators that address operational, financial, and time-based metrics. These KPIs can help the transformation office keep teams accountable for their—and the organization's—progress. In recurring reviews, progress (or lack thereof) can be measured and will define potential decisions on continuing or stopping agile sprints. The key measures of progress should be based on their impact to core

business KPIs instead of merely the progress of technical execution. To that end, the transformation office should allocate resources and provide help to teams and individuals as needed.

Building a tech backbone
One feature that will be new to experienced practitioners of conventional lean implementation is the development of a tech stack. Lighthouse teams should build an integrated IT/OT stack with a "minimum viable design" for their tech-enabled solutions. A common pitfall is to develop an elaborate tech stack without consideration for the solutions, on the assumption that teams can simply "layer on" use cases. This approach often leads to overspending and overly complex systems that are difficult to maintain and time-consuming to scale.

While specific stack designs may vary, organizations must focus on a few crucial components. The stack must be usable for both customers and in-house operators, which helps it deliver insights. Software must be interwoven with the stack to manage large volumes of data from diverse sources and make it easily accessible across the organization. Cloud or on-premise storage and hardware must be used to store and process large amounts of data, and a database can help obtain, import, and process it. The stack also requires facilities that allow data to be transmitted to a central platform for processing, and connected devices and sensors that can continuously gather information about their environment.

When it comes to investments in the lighthouse's IT/OT stack, an approach that emphasizes integrated solutions will help companies reap higher margin

A less siloed mind-set is important if operations and IT teams are to participate as full partners in developing tech and solutions.

improvements from their investments. Indeed, the highest returns on digital investments will come not from implementing a single solution, but from implementing a combination of complementary ones. In one case, a direct supplier for automotive companies combined four solutions that were tied to a single data repository and analytics platform for a key asset. The combined solutions created a 20 percent productivity gain, far greater than the impact that a single solution could make, especially if the company had implemented those solutions in disconnected ad hoc pilots. While organizations can develop portions of the stack in-house, two or three core tech partners can be invaluable in developing the lighthouse's tech and stack. This practice is important because outside tech partners can bring needed skills

and perspectives in a time of rapid technological evolution and help create solutions that are highly specific to the lighthouse.

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A system of complementary tech solutions can help organizations avert the struggles of singular use cases and get much greater margin returns, but building this system requires decisiveness, planning, and a mind-set that's suited to a tech-enabled transformation. Following a comprehensive playbook in a lighthouse is the best way to bring promising solutions together. This approach will help organizations maximize the value of the latest tools while gaining insights into how an implementation will translate from the lighthouse to the enterprise.

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The services solution for unlocking industry's next growth opportunity

At high-growth industrial companies, services aren't just an optional add-on, but an essential revenue driver deserving thoughtful investment.

by Guy Benjamin, Hugues Lavandier, and Senthil Muthiah
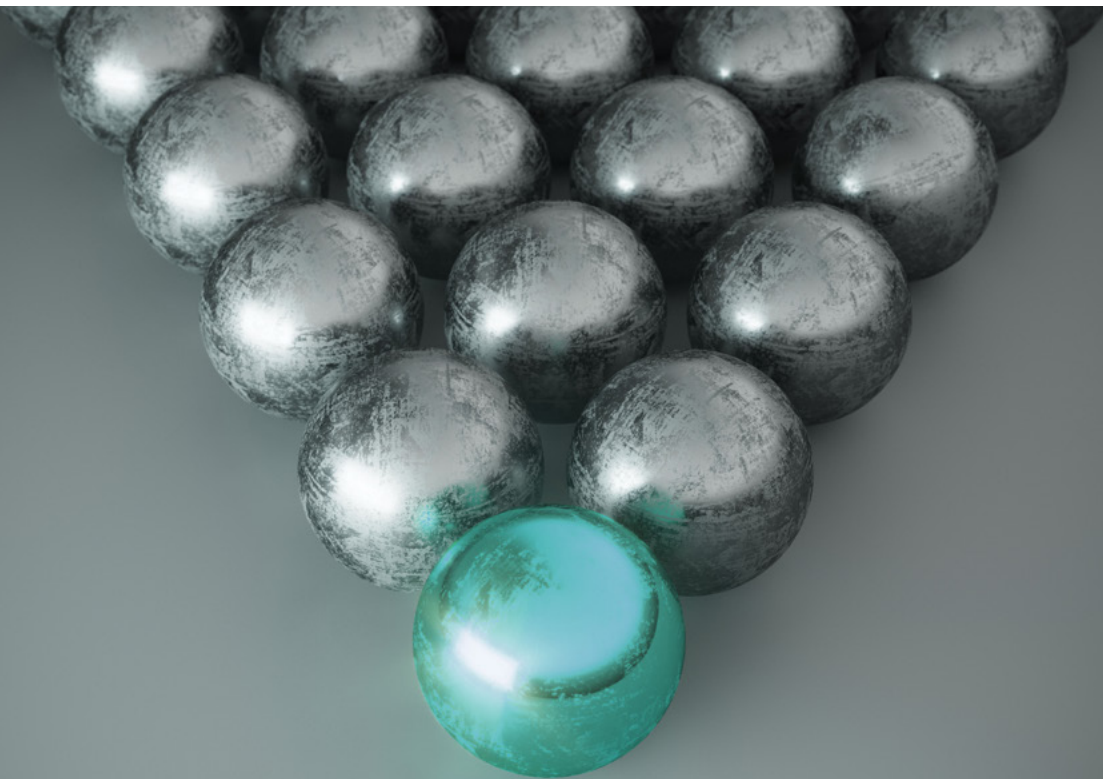
A set of paradigm shifts is forcing companies to rethink their approach to services businesses to promote both growth and operational efficiency. The increasing complexity of products and rapid evolution of technology have made it imperative for organizations to develop new service products tailored to customer needs. For most industries—including auto supplies, aerospace, oil and gas equipment, power and renewable energy, telecom, and medical products—the headroom for growth and efficiency gains is significant.

A services business generates value in numerous ways:

— *Growth acceleration.* OEMs can double their services revenue within three to five years without requiring large investments in capital expenditures, new product development, or extensive cost-reduction programs.

— *Margin improvement.* EBIT margins for services can be up to four times higher than those for original equipment, with a doubling of margins possible in three to five years.

— *Income stream predictability.* Life cycle benefits are also much greater, as the services business spans the entire product life cycle and provides a cash source that is more sustainable and predictable and less cyclical.

— *Customer intimacy.* Service provision allows a company to build a life cycle view of the customer with respect to needs and usage, among other attributes. Whereas touchpoints for product sales end when a sale is completed, touchpoints for services occur on a regular basis and in multiple locations. Companies can take advantage of the more frequent contact to expand their knowledge of customers' personnel and locations. They can apply this knowledge to improve service levels and tailor targeted offerings of products and services.

— *Product intimacy.* Services allow a company to gain better visibility into how customers use its products and how the products are performing.

These insights provide the basis for refined product designs and for the next generation of products.

Because these value drivers for services providers also enhance the technical and customer experience, services are a win-win for both parties. Customers benefit from increased equipment uptime and simpler and less frequent touchpoints with field technicians. Well-executed services businesses can increase customer satisfaction by 10 to 20 percentage points and reduce costs by 15 to 25 percent.

It should come as no surprise, then, that companies that invest wisely in their services businesses have been rewarded with higher revenue growth (Exhibit 1). However, many engineering-centric product organizations still regard selling the platform as the core business, while viewing services as a freebie to close the deal. As a result, they overlook how services can drive margin improvement and contribute to enterprise value.

"How disruptive technologies are opening up innovative opportunities in services," published in 2018, outlined where the value lies in tech-enabled servicing. Here we delve deeper into how companies can capture these opportunities.

Technology opens up new growth opportunities

Five categories of technology-enabled changes are creating new opportunities:

— *Connectivity.* As the Internet of Things (IoT) grows in size and complexity, devices are becoming more connected and generating large volumes of useful data. The additional visibility can often be gained at low cost. For example, some organizations use add-on hardware that costs less than $200 per unit for a connectivity retrofit. The insights can be applied to reduce mean time to repair (MTTR), cutting costs by 5 to 7 percent.

— *Analytics.* The application of advanced analytics allows organizations to generate new revenues through commercial optimization. By using

advanced analytics to predict customers' propensity to buy, organizations can improve the customer attach rate (the percentage of customers who purchase services in addition to equipment) by 5 to 15 percent. Companies can also reduce costs through remote troubleshooting enabled by advanced analytics. Insights generated by smart devices accurately report failure reasons, leading to shorter diagnostic times.

— *Artificial intelligence.* AI allows organizations to predict maintenance needs before problems arise. For example, organizations have started using deep-learning and machine-learning

models to help predict and prevent equipment issues, as well as to conduct root-cause analyses that facilitate faster issue resolution. Costs can be cut by 10 to 20 percent by reducing parts costs, equipment downtime, and labor time.

— *Digitization.* The digitalization of engineering design and knowledge about the installed base is enabling productivity improvements. For example, organizations are using AR and VR technology to help technicians reduce the time spent on complex repairs. MTTR can be reduced by 10 to 25 percent.

Exhibit 1

Companies that invest wisely in services are rewarded with high revenue growth.

Total revenue change, 2013–17
Index, 1=0

Services growth
CAGR services revenues 2013–17
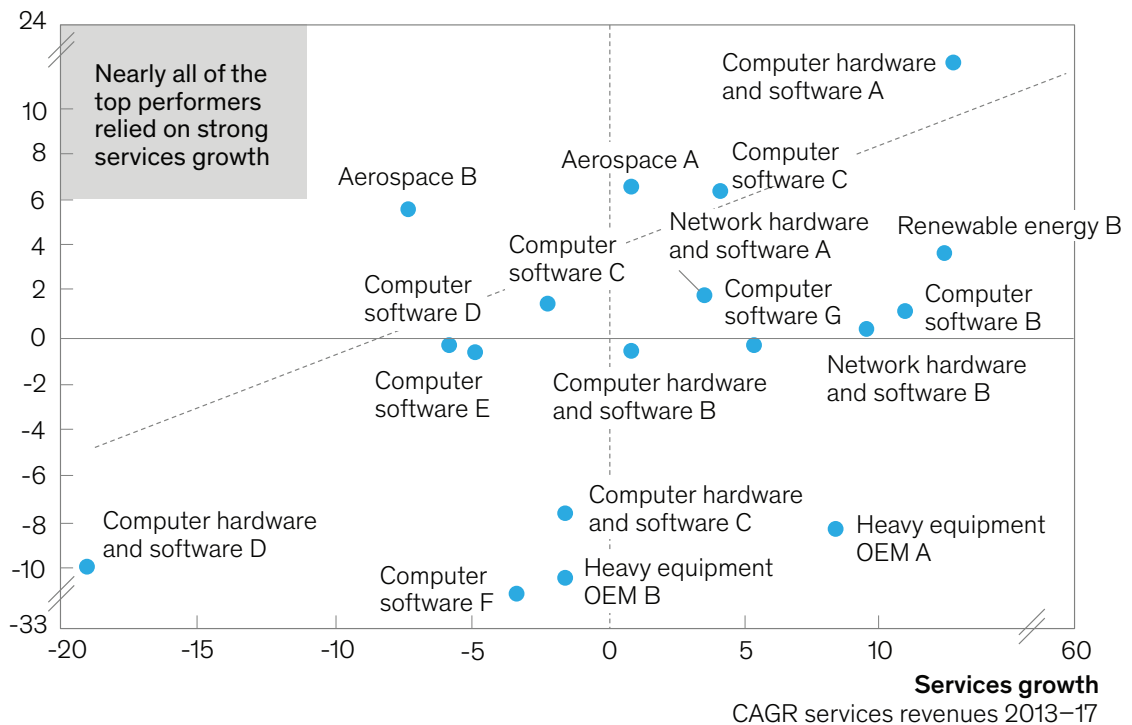
Key distinctive facts about top performers that led to their winning market positions:
- **Longitudinal view of the customer's journey** throughout the product life cycle vs point-in-time view
- **Intimate familiarity with products** that helps create more robust next-generation products
- **Regular inflow of cash** vs large swings in cash-inflow cycles (for products-only companies)

— *Knowledge management.* Knowledge management, powered by machine learning, allows organizations to improve their productivity. For example, organizations can implement a continuous improvement toolkit to make cultural shifts that unleash productivity gains. MTTR reductions in the range of 30 to 40 percent are achievable.

These advances are especially powerful when used in combination. For example, organizations can enhance their ability to resolve service issues remotely by applying AI and advanced digital technologies (Exhibit 2). They can use virtual agents to reduce the call volume reaching customer-care agents. They can also resolve rudimentary tasks at the technical help desk, leading to a reduction in service calls by the field force. Labor cost reductions and an improved customer experience can drive down costs by 10 to 20 percent.
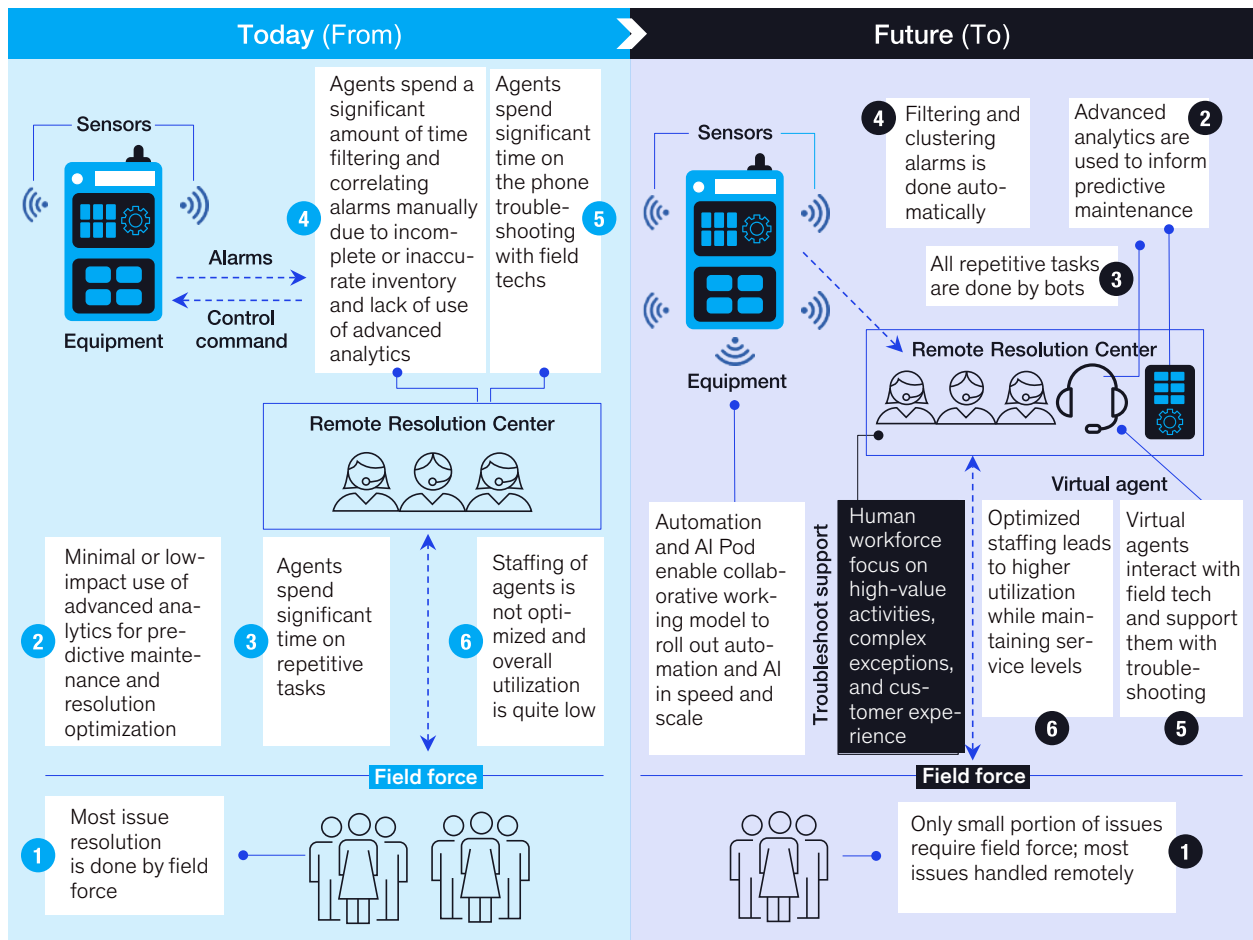
Even as technology opens up new business models, companies should not overlook the opportunities to strengthen their core businesses in parts, repair, and maintenance. To gain clarity into the opportunities, companies must undertake a detailed examination of aftermarket lifetime value— the total revenue they receive from servicing their

Exhibit 2

A cross-functional approach to tech-operations implementation can prove beneficial to organizations.

Today (From)

Sensors

Alarms

Control command

Equipment

4 — Agents spend a significant amount of time filtering and correlating alarms manually due to incomplete or inaccurate inventory and lack of use of advanced analytics

5 — Agents spend significant time on the phone troubleshooting with field techs

Remote Resolution Center

2 — Minimal or low-impact use of advanced analytics for predictive maintenance and resolution optimization

3 — Agents spend significant time on repetitive tasks

6 — Staffing of agents is not optimized and overall utilization is quite low

Field force

1 — Most issue resolution is done by field force

Future (To)

Sensors

Equipment

4 — Filtering and clustering alarms is done automatically

2 — Advanced analytics are used to inform predictive maintenance

3 — All repetitive tasks are done by bots

Remote Resolution Center

Virtual agent

Automation and AI Pod enable collaborative working model to roll out automation and AI in speed and scale

Troubleshoot support

Human workforce focus on high-value activities, complex exceptions, and customer experience

6 — Optimized staffing leads to higher utilization while maintaining service levels

5 — Virtual agents interact with field tech and support them with troubleshooting

Field force

1 — Only small portion of issues require field force; most issues handled remotely

installed base. This measure, which is typically calculated for each product line, provides a more comprehensive view of aftermarket value than commonly used metrics such as service revenue captured per customer. Companies that examine aftermarket lifetime value closely may find that certain services, including core offerings, contribute more to the bottom line than expected.

Creating a new growth platform

To take advantage of the new opportunities in services, a company must both recognize that the traditional table stakes are evolving and take steps to capture the next horizon of technology-enabled opportunities.

Traditional table stakes are evolving
The hallmark of organizations that successfully grow their services businesses is the ability to recognize that designing and selling services differs from their traditional product-focused businesses. Traditionally, companies have had to put in place several table stakes in order to grow a services business. Today, these table stakes are evolving as the new paradigm in services takes hold:

1. *Services-specific execution skills and an execution engine.* To facilitate the transformation to services as a growth platform, not simply an add-on to the product business, leading organizations have created an independent services unit. To be successful today, the unit must leverage tools specifically for a technology-enabled approach to services, be staffed by skilled data scientists, and be supported by the right technology infrastructure. It must also institute a change-management program to motivate experienced workers to adopt a new technology-centered paradigm that emphasizes remote monitoring. To execute against the new capabilities, the organization must establish standard goals and metrics across the entire organization, including services, manufacturing, procurement, sales, and supply-chain functions.

2. *Deep understanding of customers.* To target the right customers, the services unit must have in-depth knowledge of customer segments and economics, specifically as they relate to services. The services journey must also be distinguished from the traditional product-focused customer journey.

3. *Clear services offering.* The services unit must support the broader organization in selecting which services offerings to pursue, as well as in aligning technical, marketing, and sales capabilities with the selected offerings. The value proposition of the offerings must be clearly communicated to customers.

The experiences of two organizations illustrate the importance of defining a clear services offering and ensuring that the right supporting capabilities are in place. Each organization identified a $10 billion opportunity in services in its industry and drew up plans to grow in the market. One succeeded in achieving annual growth of 26 percent in its services business, while the other saw its annual growth in services decline by 2.5 percent. The successful organization selected a relatively small number of service offerings to focus on, based on a thorough analysis of its capabilities and the opportunities and limitations of going to market. Recognizing the need for specialized expertise, it acquired core service providers and leveraged its existing sales specialists. In contrast, the organization that saw its growth rate shrink offered a wide variety of services and committed to building the supporting capabilities in-house.

Capturing the next horizon
Beyond these evolving table stakes, a company should take several actions to capture the next horizon of opportunities enabled by the technology-driven paradigm shift.

1. *Use insights from analytics to increase profits from your installed base.* To succeed with services, companies need insights into how likely their customers are to buy something other than the product (such as parts or a maintenance

Organizations that successfully grow their services businesses recognize that designing and selling services differs from their traditional product-focused businesses.

plan, logistics support, or parts management services). They can use advanced analytics to quantify their customers' propensity to buy services, and thus segment these customers accordingly. By aggregating internal data and supplementing it with external public information on customers and markets, companies can run analytics to group customers into three categories: those with a high propensity to buy services; those with a low propensity to buy; and those in the middle, or on the fence.

2. *Use digital to improve technical and customer experience.* Organizations can resolve simpler service issues remotely by using automation, thereby reducing the volume of rudimentary tasks flowing to the field force. For more complex jobs, field technicians can apply detailed instructions from advanced-troubleshooting technologies—such as digital tools, augmented reality, or virtual reality—to complete maintenance or repairs faster and with greater accuracy.

3. *Apply advanced analytics to understand root causes of equipment failures in real time.* Companies can use analytics to assess and prioritize repair issues in real time, conduct advanced troubleshooting, and even predict issues before they occur. Machine-learning models can be used to recommend the "next best action" to handle the identified issues. The output of the model can be sent to either a human agent or an automation engine. Companies can apply such innovations to reduce costs related to service personnel—including the field force and staff in remote resolution

centers and call centers. Repair analytics also allow companies to generate additional revenues in a variety of ways, including creating new offerings and improving the service levels of existing offerings.

4. *Adopt connectivity-driven commercial models.* Companies have traditionally used a "cost-plus" commercial model for services, based on a formula that considered the frequency and severity of service calls and added margin. This model is rendered obsolete by the new paradigm for services. Tech-enabled remote repairs mean that uptime increases while the visibility of the field force decreases—for example, an elevator can be repaired remotely before a breakdown occurs. To capture revenues in this new environment, companies need connectivity-driven commercial models based on equipment performance or condition. Companies must also find innovative ways to monetize the trove of data they are collecting about customers and products.

Laying the groundwork

To lay the groundwork for capturing the next horizon of opportunities, companies should take several steps:

— Start the process by setting an aspirational strategy and identifying the areas that will create the most value. Align on the levers (operational, commercial, and digital) that will produce the greatest improvement in revenues and margins. Set bold "moon shot" targets for the strategic vision and performance metrics.

— Ensure that senior leaders sponsor the transformation and clearly communicate the goals of the effort and the achievability of the targets to the organization. Reiterate the top-down communication throughout the process to remind people of the objective. Ask members of the field force to generate ideas for achieving the targets and to take ownership of the corresponding initiatives.

— Establish a rigorous process to track every project milestone, clear up bottlenecks and roadblocks, and ensure that each initiative is executed on time and with the right impact. The effort should be supported by rigorous performance management.

— Identify the most supportive personnel as well as those who are not on board. Enlist the help of the supportive personnel to persuade the skeptics to get on board. In some cases, those who are unsupportive should be excluded from participation in the effort.

— Establish clear connections among all the initiatives and financials and maintain a clear line of sight on how the transformation will influence profits and losses.

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The growth of services is a key driver of both the top line and the bottom line for any product-based organization. Advancements in digital technology and analytics are providing organizations with ample opportunities to grow and optimize their services businesses. Successful organizations have already started thinking about services as an independent growth unit. They are also investing resources to build the required capabilities (in terms of both people and technology) while shifting some of their focus from products to services.

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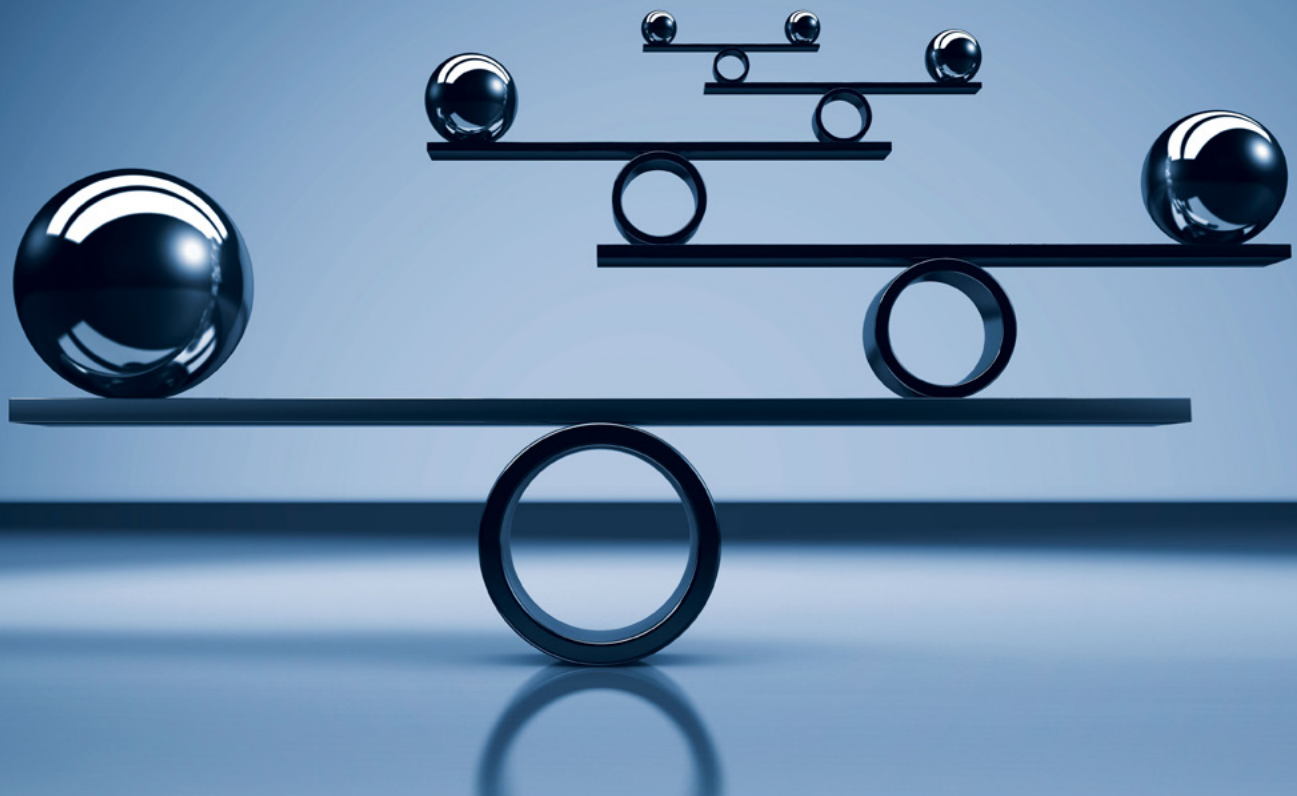
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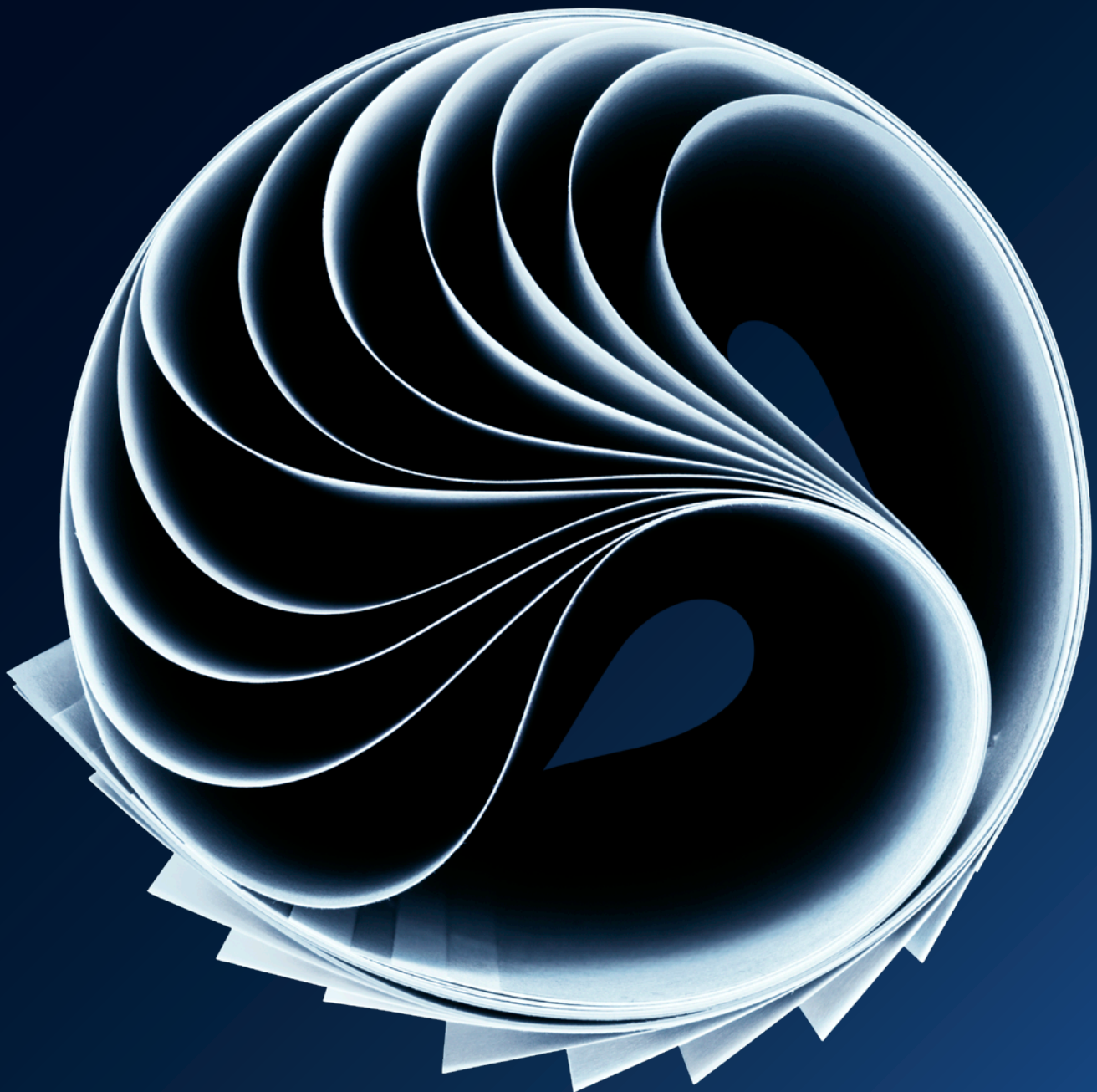
Building the right capabilities to support a tech-enabled transformation

Industrial companies that balance investments in technology with a focus on the human side of the equation increase the odds of a transformation's success.

by Venkat Atluri, Aamer Baig, Darshit Gandhi, Christopher Paquette, and Satya Rao

In industrial companies, the clarion call to harness digital technologies and analytics has been heard. Executives clearly recognize the value these solutions can generate, and many have already spent millions setting up technology infrastructure—such as data collection platforms and data lakes—and hiring data scientists and engineers. But in many cases, these investments haven't produced the expected results. Just 20 percent of transformations focused on digital and analytics have succeeded in their efforts.[1] Why do these attempts consistently fall short?

In the comprehensive playbook for a tech-enabled transformation at industrial companies, the infrastructure to support and scale change has two components: a technology and data backbone as well as capabilities and talent.[2] These components are most effective when organizations can keep them balanced; if technology outstrips capabilities, or vice versa, it can impede the transformation's progress. Too often, industrial companies have focused on the technology while not investing adequate time or resources into building the capabilities required to scale projects across the enterprise.

To capture the full potential of a tech-enabled industrial transformation, organizations must equip the business, especially the senior leaders, with the knowledge required to adopt a data-driven mind-set. Organizations must also build the right capabilities in tech teams (alongside the business) to support execution, from upskilling soft and hard skills to attracting and retaining world-class tech talent to supplement existing workforce. Finally, organizations must ensure that end users embrace the digital and tech-driven solutions to capture bottom-line value.

Industrial companies that build the right capabilities will not only be positioned to succeed at a tech-enabled transformation but also be better equipped to pursue new business opportunities.

Equipping the business to engage a tech-enabled transformation

In many industrial companies, digital and analytics projects are led and deployed by a few tech or data specialists but with limited involvement of actual business teams—the eventual users of the solutions. Often, the business teams are left out because they lack the capabilities to contribute. The impact is low adoption levels of data-driven insights as well as a lack of ideas and sponsorship on how these new technology platforms and tools could support better performance. Lack of capabilities can mean that digital and analytics efforts fall short.

One advanced industries company dealt with this during a large sales transformation. Data analysts had developed and deployed several analytics tools in the sales organization, but the insights they produced fell on deaf ears for a couple of reasons. First, frontline salespeople weren't involved in the development process, so they had little understanding of how to embrace these tools. In addition, sales managers and regional vice presidents lacked the capabilities to digest and act on the results in a systematic way, leading to lower usage levels. As a result, the company had to pause the integration of these tools and invest in outreach and training programs to boost adoption.

Given the dearth of digital and analytics experts and the competition for this talent pool, organizations can't hope to hire their way out of the problem. Instead, companies must undertake a combination of upskilling and strategic hiring to bridge the divide. The changing demands of technology roles and the need to promote collaboration across the enterprise mean that a wide range of employees must understand both technology and the business.

Efforts in these areas can help companies assemble high-functioning teams able to scale promising technology projects. However, capability building is not a one-size-fits-all endeavor; companies must understand the needs of their tech

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[1] Emily Lawson and Colin Price, "The psychology of change management," June 2003, McKinsey.com.
[2] Please see Venkat Atluri, Aamer Baig, and Satya Rao, "Accelerating the impact from a tech-enabled transformation," on p. 32 of this collection.

teams and the organization as a whole and develop curriculums accordingly. The goal is to ensure that all employees involved in these projects have a baseline knowledge of technology and business so that they can partner effectively. When successful, such programs can also help promote broader culture change throughout the enterprise.

Building capabilities in tech teams to drive execution

As organizations focus on assembling cross-functional teams to take on technology projects, the operating mode and required skills for technical teams need to fundamentally change. In many industrial companies, the default mode of engagement is purely transactional and best defined as "analytics as a service." For example, if data analysts are assigned to a marketing-related project, they might have little direct contact with the marketing team. Instead, marketing submits requests to the analytics team, which builds models and provides analysis. The marketers then draw conclusions from the data without further input from the analytics function. This scenario plays out all too often and is a huge

missed opportunity, all because of a lack of the right capabilities deployed in the right way.

Technical teams and experts should seek to transition from being a transactional resource to being business colleagues. Over time, tech specialists could become strategic advisers, with the ability to counsel functional teams on how to use digital and analytics to address key business issues. Making this leap requires much deeper capabilities in business strategy and value creation as well as key soft skills—such as effective communication, problem solving, teamwork, and the ability to influence and counsel others.

Upskilling

Before tech teams can adopt a new, more collaborative approach, they will have to learn more about the business and its overall strategy. Tech talent should seek to experience the issues that users are facing at every level. This approach could require spending a day on the plant floor to understand the usage of the tools and their impact in an actual setting. Once tools are deployed, tech teams should closely monitor usage metrics to understand adoption levels, be open to feedback,

Just

20%

of transformations focused on digital and analytics have succeeded in their efforts

and address any obstacles by making the necessary modifications to the tools.

The teams must also become more familiar with the agile methodology—a core part of a tech-enabled transformation's performance infrastructure and mind-sets and behaviors.[3] Data scientists who acquire this knowledge will be better equipped to engage with nontechnical colleagues, meet shorter deadlines for model building, and incorporate feedback from frequent reviews of tools and models in development.

The rapid pace of innovation in technology fields means it is essential for specialists to adopt a continuous learning mind-set regarding technical methods and best practices—for example, the deployment of latest algorithms such as convolutional neural networks (CNN), recurrent neural networks (RNN), and natural language processing. Companies can ensure tech teams are exposed to the latest developments in their fields through professional development programs that include attendance at seminars, workshops, and professional interactions, among other activities.

Building the necessary skills and adopting a new mind-set don't happen overnight. Industrial companies should be prepared to launch and sustain a focused capability-building effort over an extended period. A field and forum approach has helped companies upskill their workforce and can be particularly effective for tech teams. It consists of the following elements:

— Tailored role-based learning journeys for each cohort (for example, data scientists, product owners, and data engineers)

— A mix of training sessions (both traditional classroom and online learning), in-the-field apprenticeships, and coaching with experts on live projects

— A focused internal program to spur adoption and reward and recognition (including certifications and communication campaigns)

When carefully curated and deployed, such an approach can cover a lot of ground while also reinforcing key concepts in traditional and immersive formats. A Europe-based steel manufacturer that was pursuing a tech-enabled transformation established a dedicated academy to train its existing plant employees. Topics included data science, engineering, and advanced analytics. Roles directly related to digital and analytics, such as data scientists, data engineers, and visualization analysts, were also included in the training. So far, hundreds of employees have graduated from the academy. Their shared understanding of analytics and the agile methodology have begun to infuse the organization with a culture of digital and analytics, fundamentally transforming the operating model of the plant to become more data driven.

Talent attraction and retention
Industrial companies can augment their existing tech teams by hiring promising candidates. However, the best analytics talent is at a premium: companies across sectors are all competing for experienced workers who can jump-start or scale analytics efforts. Companies can demonstrate their commitment to prospects by creating a culture that values digital and analytics and sets up new hires to succeed. One important consideration: companies must strike the right balance between integrating technical talent into their broader organization and keeping them separate. We have seen the center-of-excellence model work well in some companies, while others have embedded dedicated analytics teams in different functions. The degree of centralization of the analytics capability depends on an organization's structure and culture.

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[3] Wouter Aghina, Karin Ahlback, Aaron De Smet, Gerald Lackey, Michael Lurie, Monica Murarka, and Christopher Handscomb, "The five trademarks of agile organizations," January 2018, McKinsey.com.

Companies must strike the right balance between integrating technical talent into their broader organization and keeping them separate.

Managing this specialist talent requires a different approach than the traditional systems that most organizations follow. Qualified candidates are experts in their field and have different needs and aspirations than the typical employee. Analytics specialists expect constant learning opportunities so that they can apply their skills to new problems and initiatives. They also want the freedom to keep up with the latest developments in the field. Analytics specialists, who are usually millennials, may be looking for meaning beyond compensation—for example, the chance to make a lasting impact on the company, the industry, or the world at large.

Companies that are aware of the unique needs of tech teams can devise training programs and career paths to get the most from these employees.

Ensuring end users adopt tech-driven solutions

All levels of the organization need to develop capabilities to promote an analytics-driven culture and engage productively with the tech team. Top executives and leaders must become educated (and even excited) about digital and analytics and how they can be used to create a competitive advantage. They also need to

view these tools as necessary value creators and potential differentiators rather than optional capabilities.

By the same token, knowledge workers and frontline staff must become active proponents. This mind-set is critical because the full benefits of these solutions can be captured only by incorporating them into daily workflows. Employees also need to look for new and innovative ways to harness these tools to support business strategy.

Industrial companies must dedicate a significant amount of organizational resources to build capabilities and change behaviors and mind-sets at an enterprise level. In our experience, the most successful companies view capability building as a spearhead of change-management initiatives.[4] When companies focus on these several elements in tandem, they can greatly increase the likelihood of a transformation's success:

Capability building. Employees must have a basic level of digital and analytics literacy—an appreciation of the value of data and the potential impact of using analytics tools as well as an understanding of common misconceptions. In addition, leaders should understand the potential of analytics and their roles in championing initiatives across the organization.

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[4] These elements are part of McKinsey's "influence model," first introduced more than 15 years ago. For more information on the model and its supporting research, see Lawson and Price, "The psychology of change management."

Role modeling. All senior executives and business leaders should be role models for data-driven decision making in their organizations.

Belief. Companies must create a strategic vision around digital and analytics supported by a "risk-free" environment that fosters experimentation and supports a test-and-learn approach.

Formal systems. Data-driven key performance indicators (KPIs) should be integrated into performance management and incentive systems to ensure they become part of the way business is done.

One large industrial company embarked on a tech-enabled transformation of its more than 1,000-member sales force. To embed digital and analytics into the function, the company had to invest in upskilling its leadership and employees. The team first deployed a large-scale "train the trainer" formal learning program during the early part of the initiative's deployment. The purpose of this program was to promote buy-in among sales reps, train users in analytics-driven pricing and customer management, and familiarize the staff with new tools such as dashboards.

Once this program was deployed, management had to be role models for the change. For example, senior managers integrated the same dashboards into their monthly meetings with the sales force. By using a common set of tools and metrics, management reinforced the importance of adopting digital and analytics to achieve impact. In addition, the company closely monitored adoption of the tools by using indicators such as dashboard logins and exceptions for pricing recommendations.

Only when all these efforts were rolled out in a comprehensive, coordinated manner did the company see end-to-end adoption of the data-driven management approach, achieving a true transformation across the sales force.

Getting started
Integrating digital and analytics at scale into an organization is a formidable challenge, but the benefits can be substantial. Companies can begin by focusing on the following critical steps:

— Develop an aspiration for the strategy and scope of digital and analytics in the organization and determine the capabilities—for both technical talent and nontechnical employees—that will be required to support them.

— Conduct a thorough and honest assessment of talent sources and determine the optimal mix between hiring external candidates and upskilling internal talent.

— Identify discrete areas within the organization (such as a manufacturing plant, function, or business unit) to act as test cases for analytics integration.[5]

Integrating digital and analytics at scale into an organization is a formidable challenge, but the benefits can be substantial.

[5] Kevin Goering, Yogesh Malik, Victoria Potter, and Kevin Sachs, "Industrial 'lighthouses' for tech-enabled transformations," on p. 43 of this collection.

— Start formalizing a capability-building program for both technical and nontechnical talent to ensure the company has the required workforce to scale initiatives across the organization.

By taking these steps, companies can lay the necessary foundations to enhance their capabilities. A well-coordinated effort can not only embed digital and analytics throughout the organization but also foster and sustain a data-driven culture.

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Enhancing the tech backbone

By making the right investments in this foundational asset, industrial companies will be better positioned to take advantage of next-generation, data-driven tech solutions.

by Mark Huntington and Christoph Schrey

Most industrial companies struggle to quickly and effectively deploy technology solutions for their customers and internal business functions. All too often, new technology-enabled initiatives—such as aftermarket solutions to create new revenue streams, Internet of Things (IoT) platforms to improve the efficiency of manufacturing processes, or analytics use cases that could transform core operations—fall short of expectations. One key reason is that a company's tech backbone is outdated, inflexible, or insufficiently resilient to support the requirements of next-generation technologies.

Why is a tech backbone so critical to operations—to say nothing of a tech-enabled transformation? In short, the tech backbone manages the storage, aggregation, analysis, and provision of data across the organization. Companies with obsolete legacy systems face significant challenges in consolidating data from different sources, maintaining consistency and quality, and making the necessary updates within the required timelines. And because solutions based on analytics, AI, and the industrial IoT all rely on unfettered access to comprehensive, high-quality data to generate business insights, an inadequate tech backbone will severely limit the impact of these technologies.

Well-considered investments in upgrading the tech backbone can generate real value. Industrial companies that successfully modernize their tech backbones can improve efficiency of their end-to-end tech solutions by more than 20 percent. Further, optimized systems can be more than 20 percent cheaper to operate and maintain in addition to being more resilient and secure.

So how should industrial companies move forward? The path will be shaped by a company's strategy and its starting point—each organization has its own advantages and obstacles to overcome. We have identified three archetypes for enhancing the tech backbone, from a complete overhaul of foundational systems to a more surgical approach. By explicitly connecting tech-backbone upgrades to specific use cases and priority domains,

industrial companies can ensure these efforts translate into business value.

The elements of the tech backbone

As a first step, industrial companies must assess the current state of their tech backbones. Understanding what its elements are and how they work together to power technology solutions can help business leaders gain clarity on where they are falling short.

Core systems and integration architecture. To design, manufacture, and service a new product, multiple systems must work together effectively. With the right integration layers, critical data elements (for example, engineering data, manufacturing data, and bill of materials) can seamlessly move between the core systems of record—which include enterprise resource planning, product life-cycle management, and manufacturing execution systems—to create a "digital thread" from engineering to servicing. Furthermore, the divide between information technology and operational technology can be bridged to enable data exchanges across both areas. An effective integration architecture prevents manual rework, allows products to be brought to market faster, and supports data-driven decision making.

Data management and storage. To support operations and make better decisions, the way companies manage and store data must be improved. This effort applies to master both customer and product master data as well as transactional data that is often stored across many different systems. An effective tech backbone successfully manages data across the full ecosystem to provide relevant, quality data in an efficient way. Companies should define the "golden sources" of record for master data and set up a data warehouse, data lake, or other fit-for-purpose data-storage solution. Managing data correctly in the tech backbone significantly improves reporting quality, the performance of analytics, and overall business operations.

An API ecosystem. Application programmable interfaces (APIs) enable the IT function to conveniently build and implement new applications in the ecosystem. Having the right integration

The tech backbone manages the storage, aggregation, analysis, and provision of data across the organization.

architecture and data-management capabilities is critical to effectively connecting the existing software solutions in the backbone. With the right API ecosystem, applications can be built and refined in days rather than months. APIs can seamlessly build on the data foundation and existing system functionality, which allows customer-facing domains (for example, aftermarket services) to respond flexibly to customer requests and new business needs.

Next-generation approach to hosting and infrastructure delivery. The software solutions and data need to be stored on the right infrastructure (such as servers and networks). In the past, many companies avoided their own data centers and hosting solutions. With next-generation cloud solutions, companies can design and implement infrastructure that features unprecedented cost efficiency and security. In the past, companies would sometimes need weeks to execute new servers. Now, however, the latest infrastructure offerings reduce provisioning time to mere minutes.

Agile execution model. The tech backbone is one critical building block for faster and more effective solution delivery. However, new hard- and software solutions alone are not enough; IT and business employees will need to work together using agile delivery methodologies to unlock their full improvement potential. If the infrastructure allows for multiple releases a day, for example, the joint business and IT teams must be able to coordinate their activities to capture the business improvements that come with this ability.

Secure environments. Organizations must ensure that the faster and more efficient delivery of software and analytics solutions doesn't result in higher security and safety risks. The tech backbone needs to be designed and built to better protect intellectual property, sensitive data, and the overall stability of the systems. Companies that integrate information security effectively into the design and maintenance of the backbone can strengthen infrastructure security while retaining the necessary flexibility to support their operations. Furthermore, this can be done without increasing the cost of deployment and maintenance.

Challenges to improvement efforts

Once industrial companies have identified the gaps in their current tech backbone, as well as the necessary improvements to support business strategy, they must take on a more difficult task: overcoming the entrenched obstacles standing in the way of a renewed tech backbone. Several challenges can obscure a clear path forward.

First, changes in the backbone should always directly support business value. However, companies often struggle to determine which elements in the tech backbone are critical to support specific use cases or priority domains. The seemingly continuous procession of new solutions can also overwhelm organizations. Companies can get too fixated on technologies and software rather than asking how specific capabilities and features can help make a broader impact on the business.

In addition, companies can be discouraged by the scope of and commitment to renewing the tech backbone. It is usually a multiyear journey that requires significant investment, and a multitude of dependencies make it difficult to decide where to start. Specifically, if a company has limited funds, the key question is which changes should be made now rather than later. The complexity of

a backbone transformation is characterized by a multitude of interdependencies and tight timelines. As a result, companies often fail to develop an integrated architecture plan and comprehensive road map. Overly long cycles (such as a yearly cycle rather than quarterly or monthly) and weak program management further hinder progress and execution.

Last, companies frequently overlook the work required to gain consensus with stakeholders. Backbone transformations are costly and require support across the organization. If stakeholders don't understand the need and impact of the work, funding and support for these initiatives can falter when priorities change.

As a result of these challenges, we usually see two types of failures:

1. Companies make investments in technology without demonstrating value in digital or analytics use cases or clearly articulating a long-term vision. This approach usually means that an organization's large investments have little or no impact.

2. Organizations create digital or analytics solutions without investing in the backbone, meaning that promising solutions cannot be scaled across the enterprise. As a result, many companies have found themselves in "pilot purgatory," where multiple pilots run in parallel without enhancing each other and with no clear path to enterprise-wide application.

To avoid these types of failures, companies should ensure their backbone renewal efforts embody the following principles:

Link any improvements to business value.
Replacing any part of the tech backbone without understanding how upgrades will help generate value for the business (in the form of increased revenues, reduced costs, or better performance) will risk the success of the overall transformation.

Companies must recognize the importance of foundational elements. These elements may not appear to be directly linked to a business initiative, but they ultimately help accelerate the delivery of business solutions or otherwise improve a business- or customer-facing project. Understanding these motivators is important for the success of a backbone transformation.

Define the road map and vision for the backbone.
Without a compelling vision for why the tech backbone must evolve and the path to improvement, every transformation will fail. Companies must articulate the vision and road map and then use these pieces to gain buy-in from stakeholders. To focus these efforts, business leaders should identify the capabilities or solutions they want to support during the next two to five years. For example, if a company is interested in developing a digital experience for customers that is tied to its products, then the transformation should concentrate on enabling connected products.

*Establish a transformation office.*
A backbone transformation is a significant undertaking that touches many different IT and business functions and requires assistance from external parties: vendors that can help build and refine the backbone as well as the potential suppliers and partners that will connect to it. Therefore, a dedicated and well-resourced transformation office is critical to guide the transformation. This office should deploy an agile development approach to ensure that the road map is executed correctly and achieves the expected business value.[1]

Use a layered architecture. The tech backbone needs to remain flexible so that it can accommodate changing business needs and support growth (exhibit). The layers of successful architecture include core systems of record (data management), integration, and APIs. When assembled appropriately, these elements will enable greater flexibility.

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[1] For more about the transformation office, see Matt Banholzer, Etienne Billette, Laurent Kinet, and David Pralong, "How transformation offices help tech-enabled transformations succeed," on p. 77 of this collection.

A reference architecture supporting industry 4.0 is data-centric and separates data from applications.
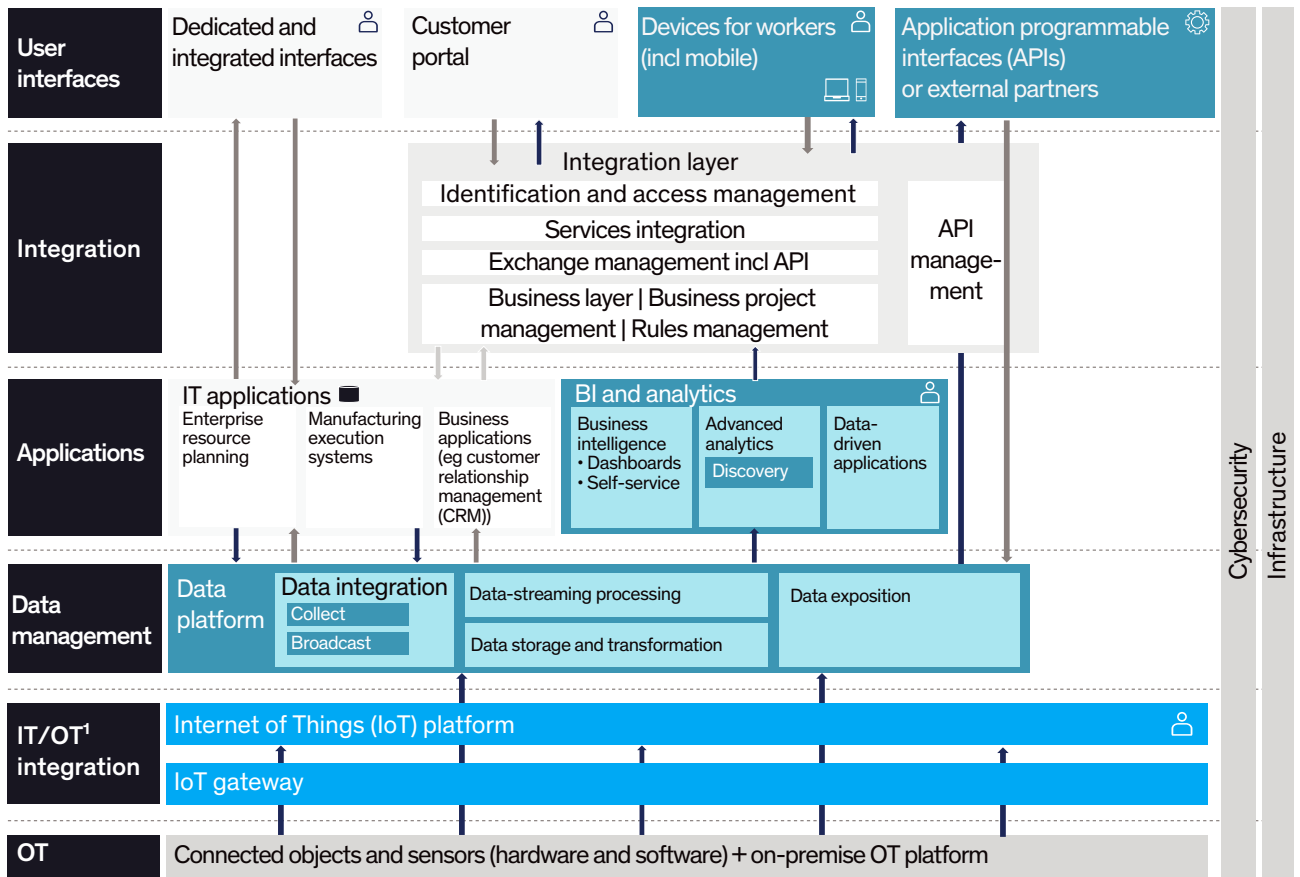
¹ Information technology and operational technology integrations.

Renewing the tech backbone: Three strategies

There is no single recipe for success in transforming the tech backbone. Indeed, the starting point depends on several factors: the current state of an organization's backbone, the prioritized list of use cases, and internal capabilities (including talent). The trick is to balance immediate needs with long-term plans—all while ensuring the organization continues to operate with minimal disruption. Companies, both within industrials and across other industries, have followed three strategies successfully: the first

involves a more ambitious overhaul of foundational elements of the tech backbone, while the other two are ways to improve the performance of the existing backbone in the short term.

1. Replace core systems of record
Some companies start to transform the tech backbone by strategically replacing core systems of record first and planning their new backbone around the enhanced capabilities. These systems are costly and difficult to replace, so this strategy requires a significant and sustained commitment of resources to be successful.

One large OEM, for example, recognized its outdated core systems of record were an obstacle to improved productivity. Rather than building work-arounds, executives decided to systematically replace its legacy systems to achieve company-wide data consistency. It also did a greenfield build of an integration layer around those new applications. This road map sought to transition the company to the target state over a five-year period and included milestones. Done right, we have seen that these transformations can generate a return on investment (ROI) of more than 20 percent.

2. Abstract data and APIs

In the event that replacing the core systems of record is not feasible, companies can start by transforming the data and API ecosystem. This approach involves creating a new data and API layer on top of legacy systems. Companies can thus gain greater access to data and quickly develop and deploy new solutions. By investing in this work-around, industrial companies can make immediate progress.

One large pharma company with dozens of fragmented legacy systems decided to build a highly structured data lake that could collect critical data and make it available for digital applications through advanced APIs. With this strategy, the highly fragmented legacy system was effectively "shielded" from the new digital landscape. In addition, the company was able to achieve performance improvements without immediately replacing core systems of record (a step that would still need to happen at some point).

3. Adopt an agile delivery methodology

Some companies decide to first address the delivery methodology. These companies can include organizations with poor delivery processes as well as those that lack the funding to make larger technology changes. Once they have built the processes and capabilities to accelerate development cycles, organizations can start to address the underlying tech backbone to remove the respective bottlenecks.

A bank decided to implement an agile delivery methodology before replacing any of its systems. The plan was to ensure development teams were trained to be customer focused and build software solutions faster and more effectively. DevOps (development and operations) and other technology methodologies were introduced to further shorten delivery cycles. Through this approach alone, the bank achieved cost savings of more than 10 percent in software delivery as well as much shorter deployment cycles. This effort laid the methodological foundation to ensure the organization had the capabilities in place to start addressing its system challenges.

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Done right, these transformations can generate an ROI of more than

20%

In any transformation, choosing the right path is critical. Given the complexity of the tech backbone, a company can start by conducting an assessment of the status of its current backbone as well as the most critical business initiatives and corresponding tech requirements. This assessment can help the company develop a portfolio of initiatives, which can be used to build a business case for investments in backbone upgrades—an important element to gain stakeholder support. Companies should then move as quickly as possible on initial use cases by drawing on existing data (rather than waiting until the data is ready). This test-and-learn approach enables companies to make smarter investments, move faster, and develop better solutions.

Industrial companies that can successfully transform their tech backbones will have a crucial asset to not only power emerging solutions but also respond more rapidly to new opportunities.

Mark Huntington is an associate partner and **Christoph Schrey** is a partner in McKinsey's Chicago office.

How transformation offices help tech-enabled transformations succeed

Effective transformation offices can help organizations combine technical know-how with "soft" capabilities.

by Matt Banholzer, Etienne Billette, Laurent Kinet, and David Pralong
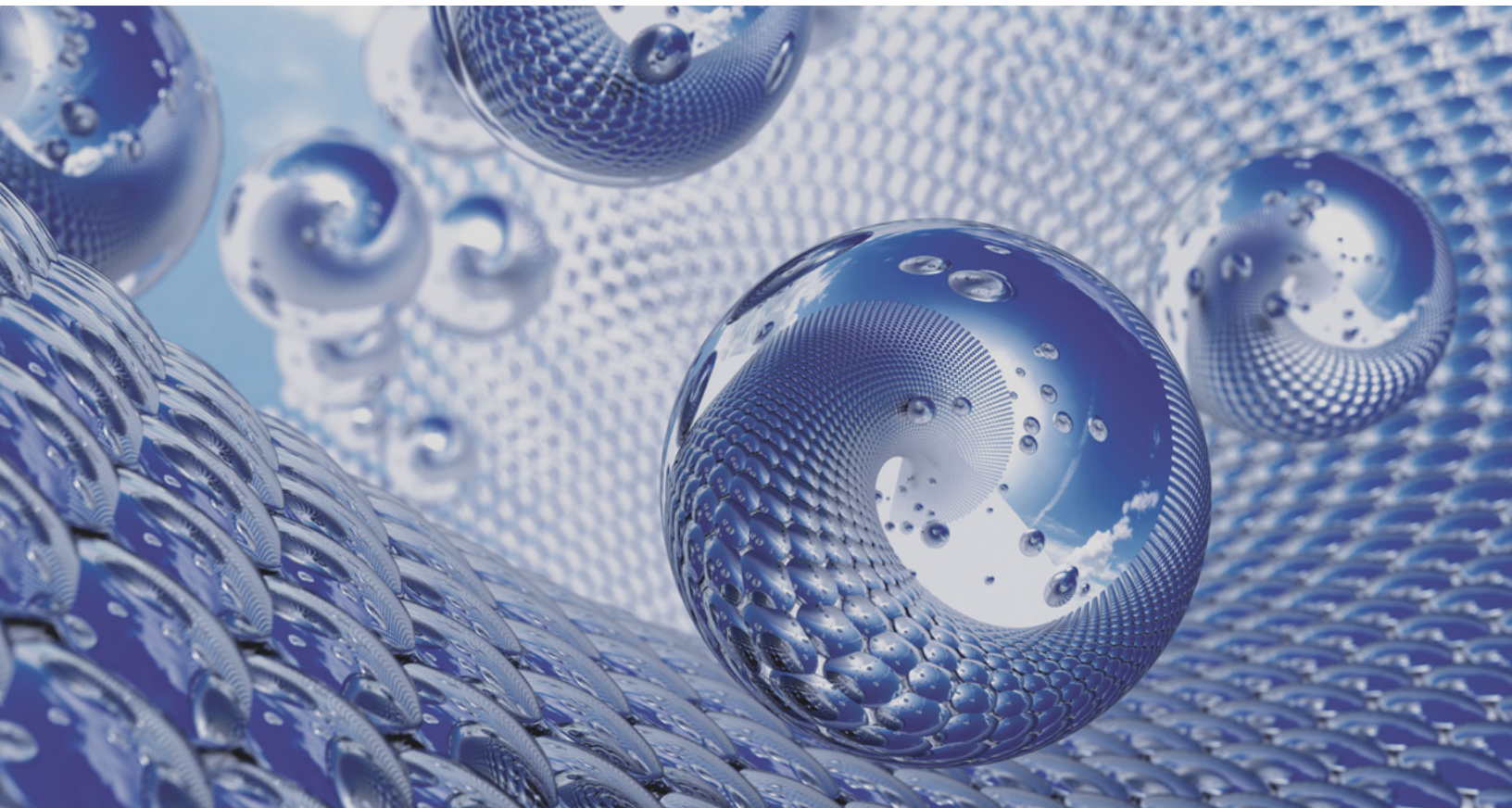
The failure rate of corporate transformation efforts is startlingly high: 70 percent of transformations (both tech-enabled and conventional) fall short of their goals.[1] If conventional transformations are difficult, the tech-enabled kind—which use technology in innovative, comprehensive ways to improve business results—are even more complex. Tech-enabled transformations often bring unfamiliar technologies and processes into the working lives of almost everyone at a company. Leaders must manage this upheaval while maintaining focus on shared goals.

But the typical workforce lacks the critical mass of technology skills that can help smooth and sustain a tech-enabled transformation. Even when technologies are in place, too many of companies' processes remain stuck in the pre-transformation world, to say nothing of the disconnect that remains between IT and systems groups and the rest of the business. It turns out that a tech-enabled transformation also requires a shift in workforce capabilities and ways of working.

Most successful tech-enabled transformations benefit from the supervision of an effective transformation office. Its function as air traffic control monitors and prioritizes the many various workstreams, processes, and initiatives that make up a comprehensive transformation. The office can also arbitrate attainable technology goals and actively shape solutions. Combined with a focus on measurable progress, an effective transformation office can ensure that a tech-enabled transformation progresses at a pace that allows the organization to adapt to new tools and processes while reaching ambitious performance goals.

Taking advantage of a transformation office's resources should be natural for organizations, given that its potential contributions are significant, although its mandate may vary widely (see sidebar, "Four archetypal roles of the transformation office"). Companies that take the time to develop the office, ensure it works closely with IT and technology groups, and empower it to iterate solutions with end-user feedback are more likely to reap financial and operational benefits. Conversely, companies that fail to take full advantage of transformation offices risk falling behind.

Why tech-enabled transformations flounder

The challenges that hold back tech-enabled transformations are distinct from those of conventional transformations. A lack of technical expertise and so-called soft organizational capabilities can exacerbate inadequate coordination with IT and make tech-enabled transformations even more fraught.

It's not surprising that most companies lack in-house expertise before the start of a tech-enabled transformation. Companies need both technical and soft skills that allow them to work in new, more flexible ways. But embarking on a tech-enabled transformation without enough technical experts—developers, data scientists, and user-experience designers, among others—puts the entire undertaking at risk.

With ample technological expertise, it is easier to coordinate and manage the performance of cross-functional efforts between the business and IT. Without such fluency, the transformation office may be unable to keep underperforming teams accountable, but a technically proficient transformation office can help teams find creative work-arounds.

A lack of technological fluency also isolates IT efforts to connect systems and solutions, depriving both business and technology teams of meaningful feedback. For instance, one company embarked on a robotic process automation (RPA) effort to reduce operating expenses but neglected to involve the established IT team in the ad hoc RPA team's plans. The disconnect resulted in friction when it came time to internally launch the new system: because the IT team had been excluded from the development process, it perceived that the RPA team's design had failed to account for the complexities of the existing IT system. The ensuing rework and

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[1] Brent Gleeson, "1 reason why most change management efforts fail," *Forbes*, July 25, 2017, forbes.com; Boris Ewenstein, Wesley Smith, and Ashvin Sologar, "Changing change management," July 2015, McKinsey.com.

Four archetypal roles of the transformation office

Every transformation office aims to help an organization navigate its tech-enabled transformation. Not only must the transformation office collaborate closely with IT, it must also serve as a translator between business and technology organizations. And to ensure that organizations' tech-enabled transformations bear fruit, offices must act as both coach and taskmaster to enforce discipline and accountability on key performance indicators. In light of these demands, transformation offices might approach their (multiple) roles differently, depending on the organization's needs and capabilities. Below are four distinct roles the transformation office could play.

— An organization needing to change its operating model can benefit from a persistent **advocate for agile ways of working**. This kind of transformation office will likely spend time and energy building its organization's agile capabilities to support the transition to a different operating model. Such transformation offices usually adopt an agile approach themselves to help manage progress on initiatives whose intermediate outcomes are less certain.

— A **use-case and portfolio coordinator** is usually in close communication with the leaders in charge of each use case as well as company leadership. This level of interaction is especially important as tech-enabled transformations often need more thoughtful involvement from management to adjust the pace and approach of projects throughout their life cycles.

— Under an **incubator** model, the transformation office would help teams build proofs of concept and business cases to advance risky use cases. The business case would then be submitted to an internal investment board for approval for further funding.

— Because maintaining the progress made during a tech-enabled transformation requires new kinds of roles and new kinds of talent, a **technical-talent coordinator** would help set talent strategy: how to recruit, retain, and develop tech talent such as developers and data scientists. A separate team can then implement this strategy at the transformation office's direction. Besides defining and filling new roles, this approach to technology talent can also help companies develop and retain relevant intellectual property.

redundant time and effort were ultimately avoidable. Likewise, technology organizations might inadvertently create products that don't fit operations groups' needs.

Some of the difficulties stemming from the aforementioned problems might be mitigated via processes built for tech-enabled ways of working. But without a coordinating body, process redesign can be scattershot and lead to many missed opportunities. Worse, a lack of prioritization and coordination makes companies more likely to wander into "pilot purgatory," in which numerous pilots run in parallel without enhancing each other and with no clear path to enterprise-wide application. What's more, traditional enterprise project-management practices make ongoing monitoring, feedback, and responsiveness—parts of the much-lauded agile methodology—more difficult.

How transformation offices can contribute

With support from passionately committed executive leaders, the transformation office functions as a steward of the technology vision and road map. The office should advise on assembling and allocating resources—including talent—to

realize that vision. To that end, the transformation office should excel at translating data and technical information into actions for functional teams. The transformation office should also provide objective assessments of the transformation's progress. As the only unit devoted to advocating for the transformation, the transformation office's focus allows it to identify and remove obstacles for teams as needed.

Creating a successful and efficient transformation office means setting it up with the right people and then letting it coordinate with IT and operate in a way that best supports the transformation.

Setting up the transformation office
A transformation office can be effective only if it's staffed with the right people. Besides being respected and credible, the leader of the transformation office should be technically proficient, understand the affected business domains, and have a strong relationship with technical teams. Plus, these traits can help the transformation office leader earn and keep the respect of both business and technology teams throughout the organization. Otherwise skilled leaders who do not have the ideal depth of technical expertise could be supported by technically proficient team members. Not only does this expertise help the transformation office team measure progress with the right analytics, it lets team members meaningfully discuss technology implementation with IT.

Indeed, without a transformation office in place to advocate for the optimal approaches to technical problems, organizations might find themselves in need of rework. One aerospace company created what it thought would be a data lake (a centralized depository of both structured and unstructured data) only to discover that it was in fact a collection of databases. A transformation office was hastily put together with the requisite technical expertise, and it guided the design of a bespoke data lake with databases optimized for their intended uses instead of pursuing the company's original plan of transferring all of the company's data to the data lake. In the end, this intervention minimized the effort and resources required to make the data lake quickly usable.

If a company does not have the right subject-matter experts on staff, bringing outside technology experts into the team, at least in the early days, may be beneficial. Technology experts often bring experiences with diverse solutions, other tech-enabled transformations, and a detachment from internal politics. This detachment allows outside technology experts to challenge the thinking of internal stakeholders for the benefit of the transformation and the company.

Collaborating with IT
That the transformation office must collaborate with the IT function in a tech-enabled transformation seems obvious, but many companies fails to bridge the two units. Company leaders can encourage a close working relationship between the transformation office and IT—obvious areas of partnership include data and cloud infrastructure. Transformation offices and IT organizations should jointly evaluate and prioritize their initiatives so the most important and valuable projects can receive support, regardless of which office ultimately oversees those initiatives.

Working with business functions
As the unit leading the central effort, the transformation office can make sure that the overall organization enacts the necessary changes by using regular business reviews to present data on progress to company leadership. For example, the metrics and scorecards used in such reviews can also help demonstrate the benefits of easy-to-access and clearly displayed data as benefits of technology solutions. Where agile methods are relevant, the transformation office can also model its practices.

The transformation office must also consider the highest priorities for the different business functions. Depending on its function-specific goals, the office may diagnose a need to increase technology adoption; alternatively, it may encourage role-model behavior from functional leaders and partner with them to make sure any insights and solutions are practical and usable.

For example, another aerospace company's transformation office had a mandate to educate stakeholders about the company's tech-enabled

With support from passionately committed executive leaders, the transformation office functions as a steward of the technology vision and road map.

transformation and help cultivate new ways of working. The transformation office team began by conducting tailored workshops and training sessions for working teams and C-level executives over the course of several weeks. This upfront investment of time helped both groups better understand the mechanics of resource allocation, solution releases, agile methodology, and development timelines during the transformation.

Running the transformation office
The rhythms of a classic transformation office lend themselves to tech-enabled transformations too. Deliverables are defined and tracked in detail, and actionable—rather than isolated—information is emphasized. For instance, the meetings of a transformation office designed to move an initiative forward or to remove roadblocks can focus on the needs of technology initiative teams and proceed briskly.

In addition, agile methodology is a natural fit for technology transformations because brisk agile cadences help teams achieve results quickly and adjust priorities as needs arise. For example, one effective transformation office incorporated sprint reviews into their frequent meetings. This approach gave the transformation office a full picture of the technology components and helped it adjust its direction to working teams while minimizing lost time and effort. The reviews help transformation offices plan subsequent sprints based on business priorities. At the same time, teams that work on developing day-to-day solutions can gain insight into higher-level goals and participate in discussions that center on end users' needs. An agile approach can even be expanded to encompass the entire enterprise.

In the short term, the transformation office may model how the entire company could eventually approach its work. As redesigned processes— shepherded by the transformation team—cascade throughout the company, external experts on the team might transition out of the office. Finally, when the team has determined that the tech-enabled transformation is fully reflected in the company's solutions, processes, and mindset, the office might be absorbed into existing performance-management groups.

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A dedicated team fluent in technology, analytics, and agile ways of working can be an invaluable source of support. The unit best equipped to provide this support, a transformation office can bridge the gap between business and technology functions, improve the performance of an entire organization, and help a tech-enabled transformation achieve its goals.

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The importance of talent and culture in tech-enabled transformations

The right combination of talent and culture can help industrial companies set up effective technology functions.

by Reed Doucette and John Parsons

The professionals with the jobs of carrying out, adopting, and sustaining tech-enabled transformations deserve as much attention as the technological solutions they create and oversee. When an organization manages both its talent and culture effectively, the interplay between them can create a virtuous cycle: attracting talent, sparking innovation, and creating impact. However, transforming organizations' culture and talent in a tech-enabled transformation is often more challenging than tackling the technical elements.
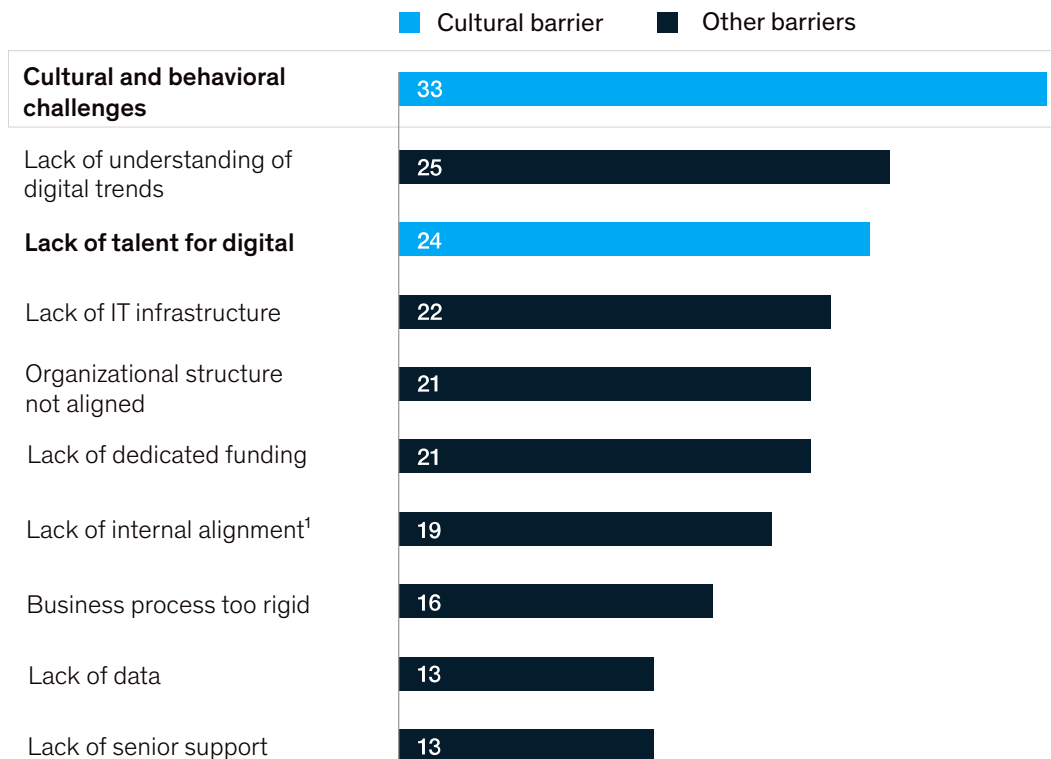
Creating the right talent and culture for a tech-enabled transformation is not easy. Respondents to a McKinsey survey of global executives said that culture and talent occupy two of the top three slots for the most significant challenges to tech-enabled transformations (Exhibit 1).[1]

Although leaders may already know that culture and talent are significant challenges to tech-enabled transformations, they are often unsure what to do about them. To overcome common hurdles and pitfalls

Exhibit 1

Executives said culture and lack of talent are among the most significant challenges to unlocking the power of digital.

Which are the most significant challenges to meeting digital priorities?
n = 2,135; % of respondents

■ Cultural barrier   ■ Other barriers

Cultural and behavioral challenges	33
Lack of understanding of digital trends	25
Lack of talent for digital	24
Lack of IT infrastructure	22
Organizational structure not aligned	21
Lack of dedicated funding	21
Lack of internal alignment[1]	19
Business process too rigid	16
Lack of data	13
Lack of senior support	13

[1] Of digital and traditional business.

[1] Julie Goran, Laura LaBerge, and Ramesh Srinivasan, "Culture for a digital age," *McKinsey Quarterly*, July 2017, McKinsey.com.

such as defaulting to creating parallel technology-focused organizations, industrial companies need to take a different approach to digital talent. This will affect where and how they recruit, the career paths and development opportunities they offer, and the workplace experiences they create. While these changes will not be easy, companies that tailor their talent strategies and cultures to what it takes to succeed with digital are up to three times more likely to succeed than those who don't.[2]

The challenges of changing digital talent and culture

Industrial companies often approach recruiting in-demand technology talent the same way they have approached nontechnology hiring. Furthermore, they often do not identify the kinds and number of new technology hires they will need in the short and long term (see also sidebar, "Critical technology roles in industrial companies"). Once they have filled their technical roles, companies

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[2] "How to beat the transformation odds," McKinsey Global Survey, April 2015, McKinsey.com. There were 1,946 executive respondents to the November 2014 online survey.

Critical technology roles in industrial companies

A tech-enabled transformation requires industrial companies to build digital organizations, staffed with people with new skills and in new roles. A detailed talent plan can help new digital organizations target and fill the right roles. Following are some of the most common digital roles for which industrial companies need to recruit.

Experience designers understand and advocate for the customers and users of technology. Their tools include ethnographic research, human-centered design (putting the user's perspective at the center of products and experiences), and rapid testing cycles with customers.

Experience engineers translate designs into software that can be rapidly tested and refined.

Scrum masters and agility coaches facilitate agile development, in which software is developed in quick iterations. Scrum masters manage development teams while also understanding the relevant technology. Agility coaches, meanwhile, focus on coaching stakeholders in the organization in developing agile ways of working.

Product owners function as the CEOs of their digital products. They steer and track the development of their products and services, making decisions that help the fruits of their work create business value.

Full-stack architects are generally experienced developers knowledgeable about different stacks—or structures—of large software systems. Because of their technical knowledge and skills, full-stack architects can link the technical vision to business goals and build solutions that are technically sound and generate business value.

Machine-learning engineers use machine learning to work closely with diverse types of customer data and create comprehensive models of customer behavior.

DevOps (development and operations) engineers build tools that provide development teams with tools and automated processes to enable self-service, on-demand access to resources in their technology infrastructure.

might struggle to retain the people they hired, who often seek career paths and incentives that are different from their nontechnologist colleagues. For instance, while many nontechnical workers aim to rise through the management ranks, technologists may aspire to spend their entire careers as practitioners advancing their skills.

If industrials' talent strategies weren't built for technologists, neither were their cultures. Technologists work best in an agile environment, with cross-functional teams that rapidly form and re-form to build the best solutions for end users. In fact, technologists expect to work in such an environment and may turn away from a company that cannot (or will not) work that way.
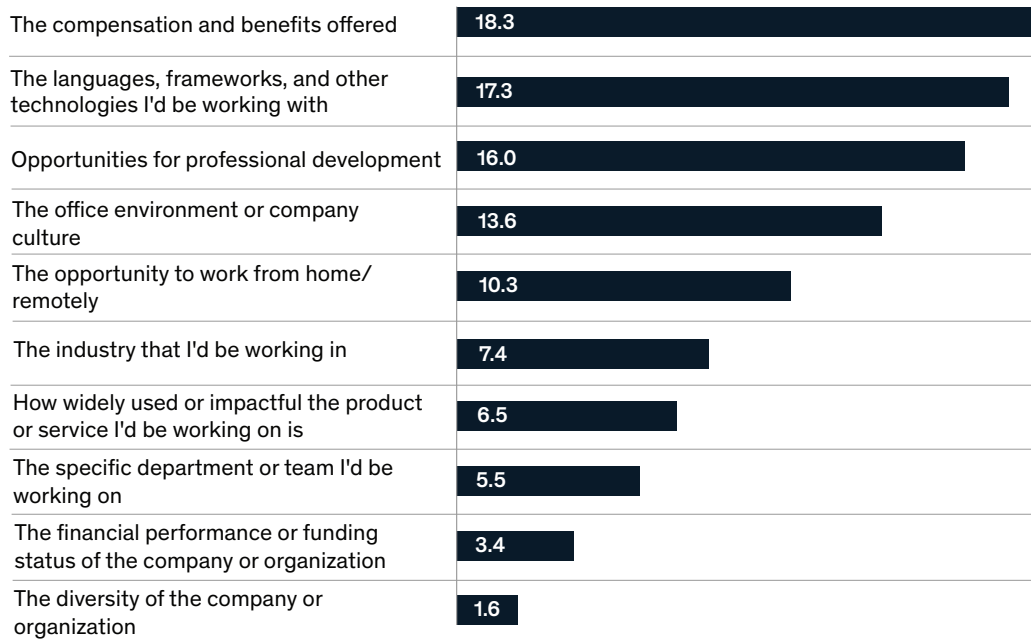
Transforming talent and culture

Many industrial companies may assume that top technology talent is out of reach and that their brand and even location might prevent them from attracting the kind of people they need. But technology professionals are less biased against industrial companies than might be expected. Only 7.4 percent of the respondents to a 2018 survey of technology professionals considered their employer's industry important. Compensation, the work environment, and professional development—all factors within an industrial company's control—were the factors that matter most to technology talent (Exhibit 2).[3]

Exhibit 2

Only 7.4 percent of the developer respondents said their job choices depend on the industry of the employer.

What is your top priority when assessing a potential job?
n = 66,985; % of respondents[1]

The compensation and benefits offered	18.3
The languages, frameworks, and other technologies I'd be working with	17.3
Opportunities for professional development	16.0
The office environment or company culture	13.6
The opportunity to work from home/remotely	10.3
The industry that I'd be working in	7.4
How widely used or impactful the product or service I'd be working on is	6.5
The specific department or team I'd be working on	5.5
The financial performance or funding status of the company or organization	3.4
The diversity of the company or organization	1.6

[1] Figures may not sum to 100%, because of rounding.

Source: Stack Overflow Annual Developer Survey 2018; stackoverflow.com.

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[3] Stack Overflow, Annual Developer Survey 2018, stackoverflow.com. More than 100,000 developers responded to the international survey in January 2018.

In this light, industrial companies' prospects for attracting technology talent look much brighter. But to find, hire, and retain these employees, companies must build their technology organizations around the right leaders, explore new ways of hiring, create career paths that fit technology talent, and transform their cultures to facilitate the work. Following is an exploration of several practices that industrial companies can consider to enhance the way they attract, hire, and retain top technology talent.

Anchor hires

Anchor hires—senior leaders with outsized credibility and the ability to attract technology talent—can use their reputation and networks to help organizations staff technology organizations with exceptional talent. Because these leaders make disproportionately large contributions, companies should invest extra time in evaluating and pursuing them. To attract anchor hires, companies should offer them entrepreneurial and creative freedom to shape the organizations they help to build.

One leading North American industrial company looking to embark on a tech-enabled transformation prioritized bringing in a chief digital officer (CDO) who had credibility among technologists. The company hired a CDO who previously had led businesses at major technology companies and was able to attract three leading product managers and designers from similar organizations. The company used these new hires—who were intimately familiar with rapid, user-centric design—to signal its commitment to world-class digital development. The company then directed its recruitment efforts to people from large technology companies and well-regarded design agencies. Using this approach, the organization built its product and design team from zero to 30 people in less than a year.

Acquiring companies for their talent

Large organizations might decide to acquire a smaller company—usually a start-up—for access to its technology workforce. This approach risks igniting culture clashes between the larger acquiring company and the more nimble start-up. Companies can mitigate this risk by having rotating teams from the acquiring company interact with the start-up team, exposing the new employees to company culture while the acquiring organization learns from the new talent, including absorbing the start-up's more agile approach to work.

Technology-specific recruiting

Hiring technology talent can be challenging for industrial companies because strong candidates may not have conventional résumés, use mainstream career sites, or even be seeking new employment. To overcome these hurdles, companies should seek out technology talent in the in-person and digital communities where technologists spend time. Companies must either retrain or hire recruiters who have the technical fluency required to speak to candidates to promote the opportunities within the companies and evaluate candidate fit. It can be even more effective to enlist top technical talent already in the organization to recruit other technologists.

Organizations can also partner with technology-services vendors, including agencies, to fill short-term gaps in their ranks. Engaging with a diverse array of vendors for short-term technology talent needs can help companies discover technologists they may want to hire as full-time employees.

Reshaping career paths

After technology talent is on board, companies often find that traditional career paths are not relevant to the new hires. For instance, technologists are often more motivated by work on complex problems or prestigious projects than by the rewards of becoming managers.

To effectively manage technologists in accordance with their motivations, companies must develop clearer criteria to identify high performers and low performers, ensure that managers are equipped to give technical feedback, and prioritize individual development. For instance, performance-management criteria may emphasize the principles of successful technology organizations—customer understanding, knowledge sharing, collaboration, and innovation. Incentives should be a balance of compensation and opportunities to work on challenging problems. To facilitate on-the-the-job learning and productivity, feedback should

While many nontechnical workers aim to rise through the management ranks, technologists may aspire to spend their entire careers as practitioners advancing their skills.

be delivered as close to real time as possible. Building the capabilities of both technologist and nontechnologist employees is also a critical part of tech-enabled transformations.[4]

Building a culture that works for technology organizations

To maximize the impact of tech-enabled transformations, an organization's culture also needs to adapt to support it. Our research shows that a healthy culture in any organization starts with several core practices: role and strategic clarity, competitive insights, and personal ownership.[5]

Several additional practices become especially important in tech-enabled transformations.[6] Specifically, entire organizations—not just technologists—must have a clear view of their end users' needs, overcome organizational silos, and embrace risk and experimentation. These may seem like best practices for any organization, but they are crucial to fulfilling the potential of tech-enabled transformations.

To focus on end-user needs, a company must give its entire organization the independence and resources needed to understand and respond to end users' needs and wants. Fulfilling this mission might involve importing ideas and practices from outside the organization. Before developing its own products, for example, one industrial company looks for examples of solutions to similar problems. The product team learned from a leading agriculture company's development of a digital marketplace, which was similar to one the team was considering for its products.

Consistent with the spirit of continuous learning, organizations must also defeat silo mentalities so that knowledge is shared throughout the organization and communication is continuous and candid. One industrial company set up "digital factories" of multiple teams whose members came from design, engineering, finance, risk, legal, and every other function required to rapidly design, build, test, and launch a product.

Executives seeking to lead technologically strong industrial companies effectively also need to embrace risk and experimentation, because their organizations likely have never before completed a tech-enabled transformation. Leaders can support such an environment by fostering team harmony, mutual support, and genuine caring about the each other's welfare. Leaders can also empower employees by communicating that they trust and value their expertise and by consulting with them and delegating projects to employee teams. Finally, leaders and organizations can create a safe place for teams to experiment by identifying and mitigating anticipated risks and responding rapidly—and nonpunitively when possible—to unexpected problems as they arise.

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[4] See Venkat Atluri, Aamer Baig, Darshit Gandhi, Christopher Paquette, and Satya Rao, "Building the right capabilities to support a tech-enabled transformation," on p. 62 of this collection.
[5] Amy Daschle, Nikola Jurisic, John Parsons, and Rahul Varma, "Set your cultural aspiration with these four steps," July 2019, on McKinsey.com.
[6] Michael Bazigos and Jim Harter, "Revisiting the matrix organization," *McKinsey Quarterly*, January 2016, McKinsey.com.

For example, the digital product team at one industrial company was two months into building a new product when it discovered that it lacked a market fit for the product. Instead of pushing the team to proceed along its original path, withdrawing funding, or otherwise acting punitively, leaders promptly began to explore next steps with the team. Team members were assigned to a new solution and were even able to appropriate some of the features they had already developed.

As a partial result of an environment characterized by a focus on problem solving, flexibility, and psychological safety, employees might develop new ideas and business-improvement initiatives of their own. Such intrinsic drive is a boon to organizations, and leaders should recognize and reward employee-led innovation.

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Building the talent and culture required to activate the benefits of tech-enabled transformations requires a fundamental change in whom industrials recruit, how they recruit, and how the recruits do the work. In parallel, companies need to shift their cultures to focus on the end user, collaborate across silos, and foster experimentation. These modifications are critical for attracting and retaining the digital talent it takes for an industrial company to launch and sustain a tech-enabled transformation and to thrive.

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Our capabilities

McKinsey has built a significant track record of promoting impact across industrial companies to transform their business and take advantage of the value that technology offers. Notably, our deep experience of the business models of industrial players (including suppliers, distributors, and OEMs) provides us with a unique understanding of where and how technology can propel business value for our clients. Our growing set of practitioners has expertise in deploying digital and analytical solutions in an agile manner, building the required capabilities, running effective transformation offices, and pushing the necessary cultural changes.

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