McKinsey&Company

Tech-enabled transformation

The trillion-dollar opportunity for industrials

Contents

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Foreword

Applying digital, analytics, and IoT technologies is worth over a trillion dollars of value for industrial companies. To capture that value, however, industrial companies need to approach their transformations holistically, not in the piecemeal manner that we often see.

That complete value chain can be boiled down to five key business elements: innovating and developing products, making and delivering them, selling them, servicing them and running the business. Amidst the noise and overwhelming choices in the marketplace, we have distilled what works into a set of value drivers and use cases as well as developing a systematic way to capture and scale this value across the business. Our insights into how to use these technologies to create value in each of these—and altogether—is derived from a range of client engagements across industries as well as from proprietary research we've developed.

We pulled together this collection to provide an overview of this approach as well as a deep dive exploring each of these five elements. We hope this will be a practical guide for how industrial companies can embark on and accelerate their transformation to capture their fair share of the value at stake.

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The trillion-dollar opportunity for the industrial sector: How to extract full value from technology

Venkat Atluri, Satya Rao, and Saloni Sahni

The digital revolution is just beginning. As data, connectivity, and processing power expand, so do opportunities for industrial companies to extract value through innovative products, services, operational efficiencies, and business models.

With profitable growth in the industrial sector flatlining in recent years,[1] companies have been striving to innovate faster, get much closer to customers, and achieve a step change in operational efficiency. Having exhausted the potential of traditional levers—capital-productivity programs, operational-cost reduction, footprint optimization, and the like—they urgently need to find new ways to grow their margins and their business. But how?

In our view, the explosion in data, connectivity, and cheap processing power and storage means that industrial companies should be looking to technology-enabled transformations for their next horizon of performance improvement and growth. To take just one trend, connected devices in use are expected to more than double between 2017 and 2020. As new data sources multiply and enable companies to generate and act on insights in real time, a whole range of innovative products, services, and business models is opening up.

A handful of leaders are already turning these trends to advantage and reaping early rewards. Yet across the sector as a whole, success stories are few and far between. After seeing promising results from early

initiatives, many companies struggle to scale up and unlock value on a broader front. Indeed, when McKinsey surveyed executives developing IoT solutions in 2017, more than half had been running pilots for one to two years, and more than a quarter for even longer. So what's going wrong?

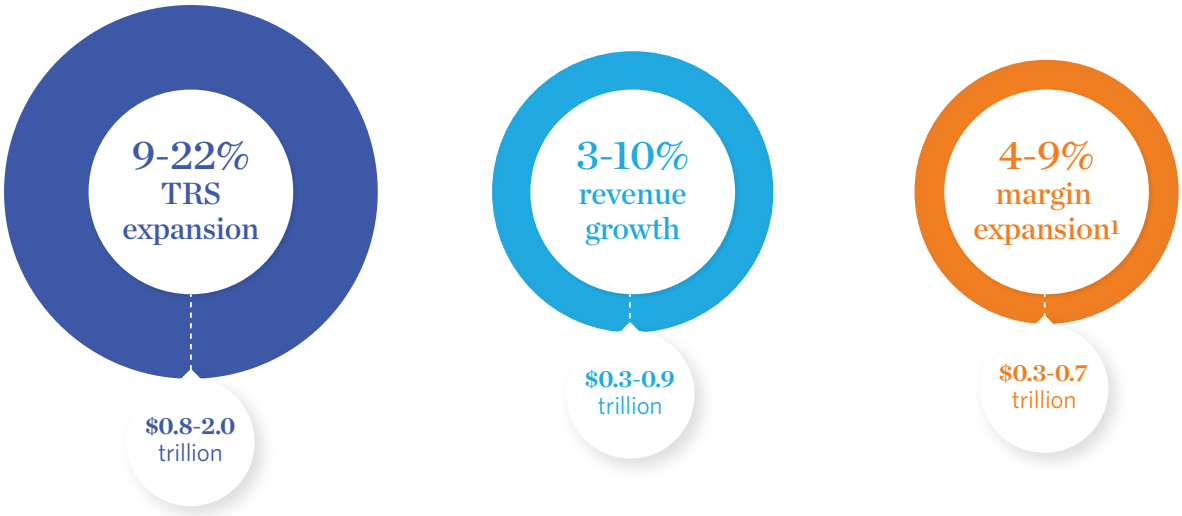
In our view, a piecemeal approach to tech enablement lies at the root of the problem. Many companies are adopting artificial intelligence, machine learning, cloud services, and a host of other technologies on a case-by-case basis, instead of selecting technologies to serve their strategy or meet specific business goals. We believe success depends on a holistic approach to transformation. That means defining your aspirations, linking them to sources of business value, working out which technologies will help achieve them, and then doubling down to achieve impact across the enterprise.

Below, we analyze the value that could be unlocked across the industrial sector through successful tech enablement, look at where this value can be created in the business, identify the enablers needed to capture it, and consider the steps smart leaders take to make their transformation a success.

Sizing the prize

Our analysis shows that successful transformation across the whole industrial sector would be worth $0.8 trillion to $2 trillion in total return to shareholders, an increase of 9 to 22 percent. This value comes from two sources: an estimated $0.3 trillion to $0.9 trillion in revenue growth (an improvement of 3 to 10 percent), and $0.3 trillion to $0.7 trillion in margin expansion from efficiency gains (an improvement of 4 to 9 percent).

In turn, revenue growth is generated by a range of factors: new business models with services and features that unlock value for end users; better knowledge of customers that helps companies tailor products, develop new services, and increase customer loyalty; the broadening of channels and access to new customers via e-commerce; and the optimization of pricing across products and services. Meanwhile, the cost savings that drive margin expansion come from the use of automation, analytics, and digital tools to enhance workforce productivity across the business, coupled with the application of advanced analytics and product-customization techniques to optimize nonlabor costs.



1 Cost reduction through productivity improvements and efficiency gains.

We analyzed these sources of growth and savings both within the enterprise and at industry-segment level to determine where the value lies.

Where value can be captured

The value that could be captured from tech enablement across the industrial sector is divided among five areas of value creation within the enterprise: innovating and developing products and services; making and delivering; selling; servicing; and running the corporation (Exhibit 1).

As part of our analysis, we identified how much additional value each of these five areas could

EXHIBIT 1 Our value capture framework for tech-enabled transformations

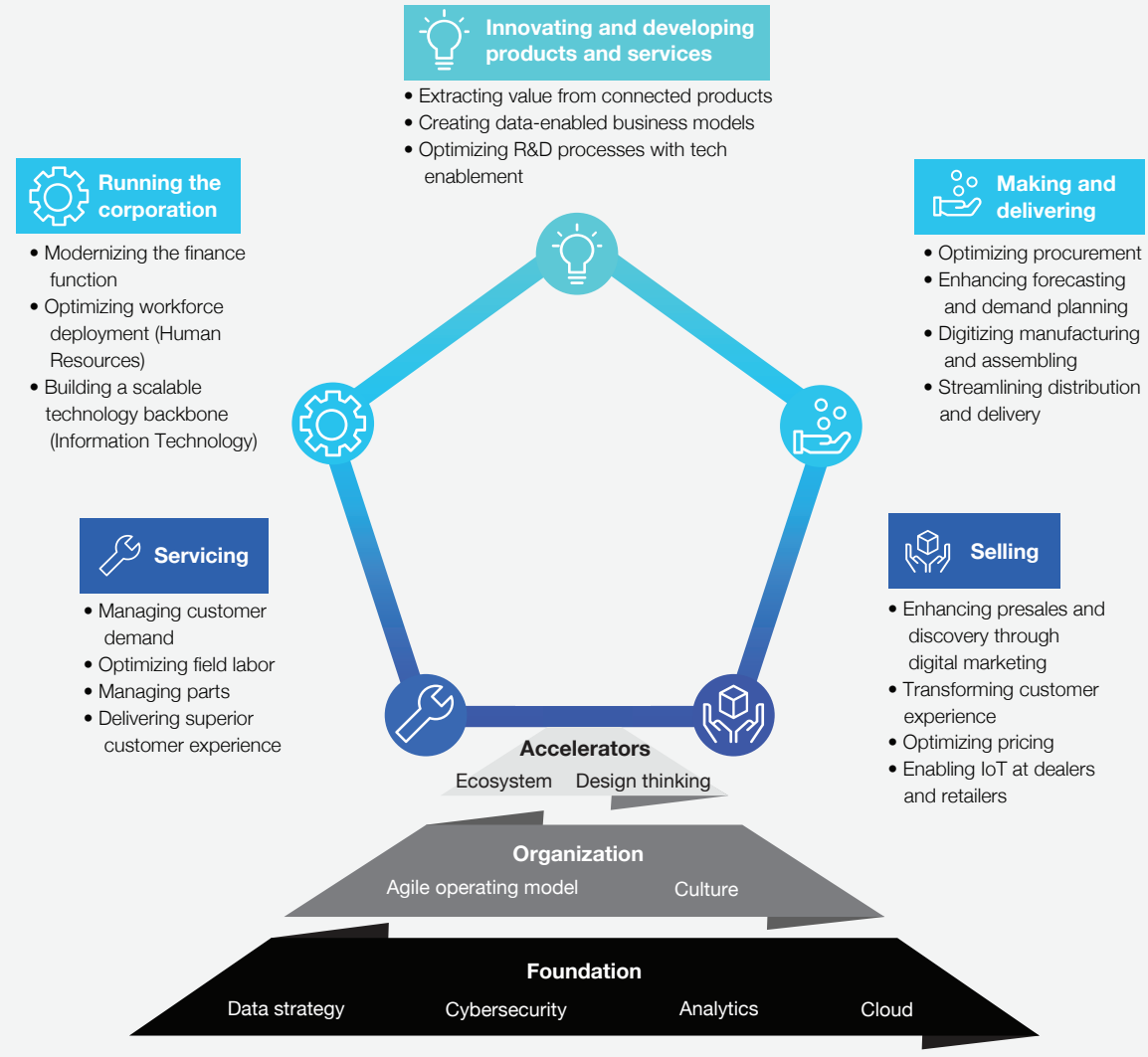
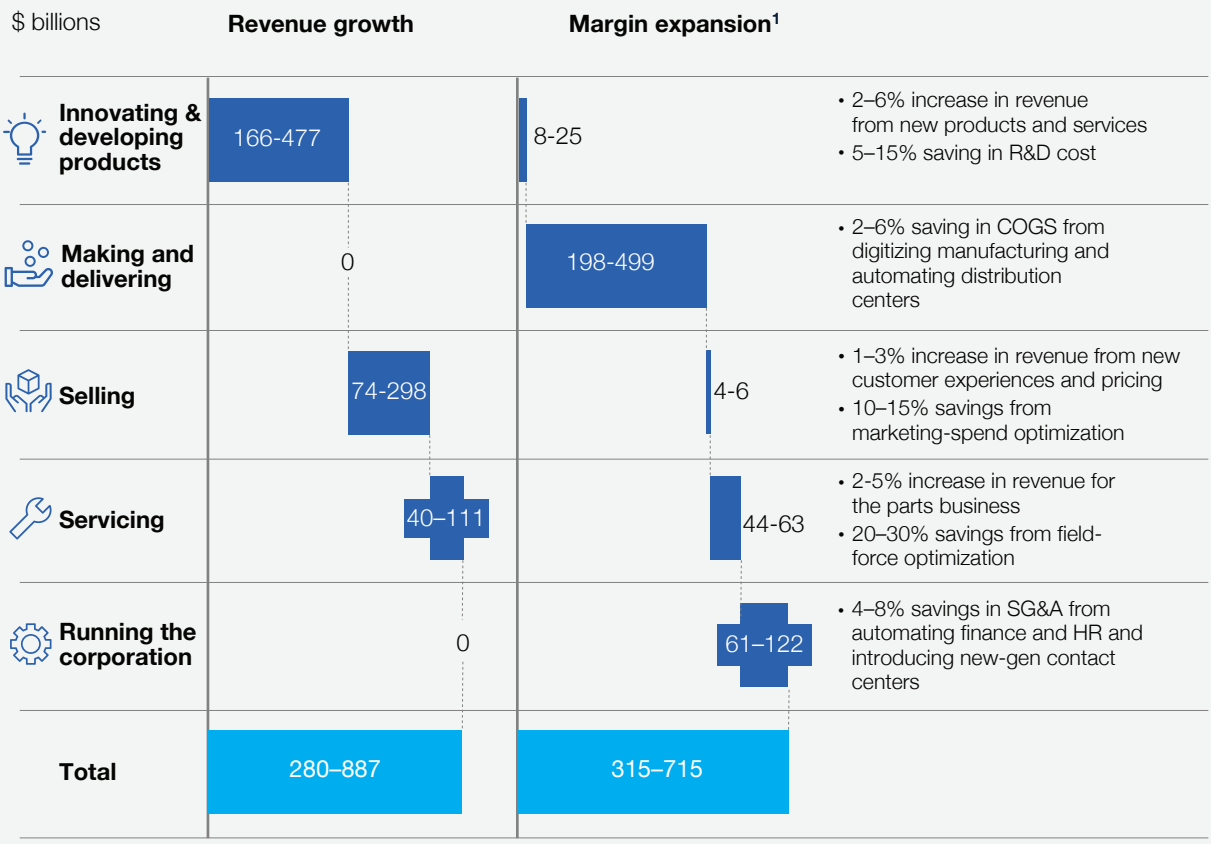


EXHIBIT 2 Tech enablement could create enormous value across the industrial sector



[1] Cost reduction through productivity improvements and efficiency gains

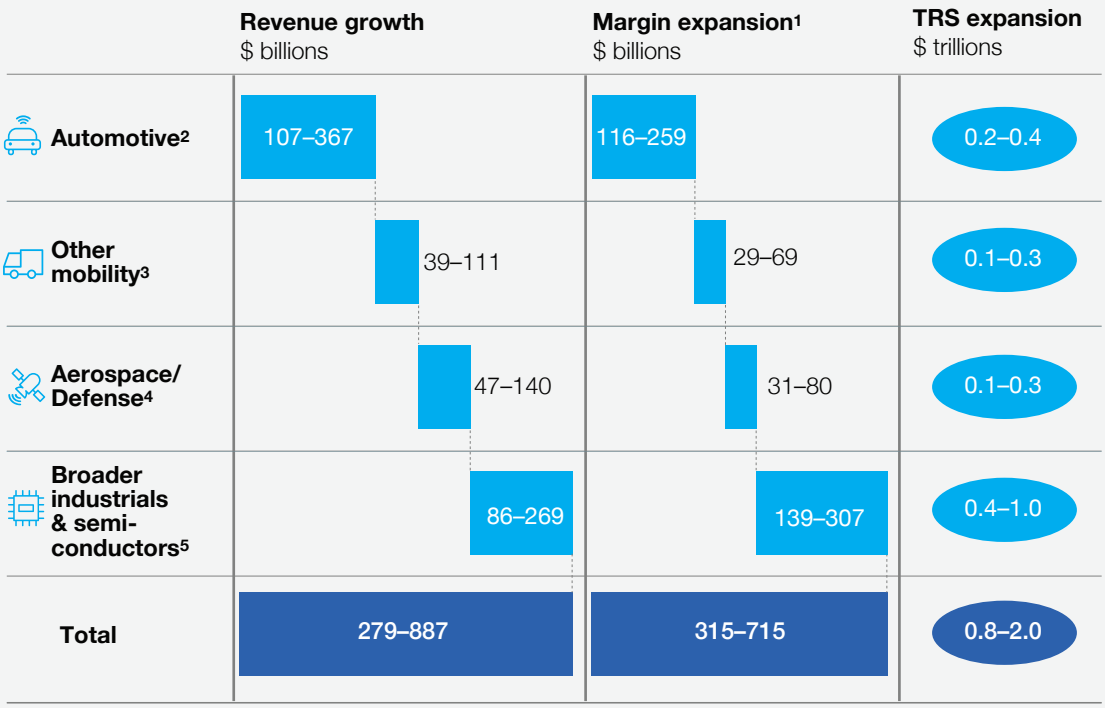
contribute at an industry level. The results are illustrated in Exhibit 2.

Finally, we examined how value is distributed across the four core segments in the industrial sector: automotive; commercial and other vehicles; aerospace and defense; and semiconductors and other industrial products, as shown in Exhibit 3.

Innovating and developing products and services

As connectivity spreads, data sources proliferate, and valuable insights can be generated in real time, companies have unprecedented opportunities to innovate across the board in products, services, and business models. Successful innovation relies not only on sound data and technology but on a deep understanding of how to use them to tap into new sources of value. For industrial companies, this begins with an intimate knowledge of end users' needs and pain points. Depending on where you sit in the value chain, this could well mean getting to know not just your customer but your customer's customer. It's also likely to mean expanding into unfamiliar areas outside the boundaries of your traditional business.

EXHIBIT 3 The value at stake varies by industry segment



[1] Cost reduction through productivity improvements and efficiency gains
[2] Whole value chain including tier-one suppliers, automotive OEMs, and dealers
[3] Commercial vehicles and off-highway equipment (e.g., for construction and agricultural use) including tier-one suppliers, equipment manufacturers, and dealers and distributors
[4] Includes tier-one suppliers and equipment manufacturers
[5] Includes industrials, food processing and handling, motion and controls, industrial automation, and electrical, power, and test equipment across the value chain: component suppliers, equipment manufacturers, distributors, VARs, engineering and services providers, and product companies

Manufacturers of heating, ventilation, and air conditioning (HVAC) systems, for example, are venturing beyond their core of equipment sales. By using technology to analyze data from motion, temperature, and energy-use sensors, they can take over temperature monitoring and control in the office or factory from corporations, and help them manage their energy costs. In much the same way, original-equipment manufacturers (OEMs) and suppliers selling agricultural equipment have devised sophisticated controls that automatically adjust operating parameters and settings in real time to suit external conditions. The speed and direction of, say, a harvester can be fine-tuned to crop density, enhancing productivity and reducing equipment wear and tear. Manufacturers can deliver and charge for these and many other features on demand.

Making and delivering

Businesses can capitalize on advances in automation, machine learning, and robotics to make themselves

more cost-efficient, flexible, and responsive to customer needs. The new era of automated production and data exchange opens up a broad range of use cases that can cut cost, increase yield, and support new manufacturing methods. Take the autonomous guided vehicles that move materials in plants and distribution centers, like the Kiva robots (renamed to Amazon Robotics) that Amazon uses to pick and pack goods in its fulfillment hubs. Automation can cut storage, picking, and sorting costs by 10 to 30 percent—a hefty savings given that these activities typically account for up to 40 percent of costs in a distribution center.

In manufacturing, one of the many activities that lend themselves to automation is welding, a highly manual and error-prone process at most plants. Welding can account for 20 to 30 percent of the cost of manufacturing automotive equipment and large energy pipelines, for instance, and bad welds can be responsible for up to 5 percent of welding costs. Using robotic welding with intelligent controls, and monitoring quality during the process rather than afterward, can reduce bad welds by up to 80 percent, adding up to 0.5 percent to manufacturers' margins.

Selling

Today's industrial companies sell their equipment through a complex set of channels that have evolved over decades. However, as industrial buyers and end users become more digitally savvy, they are increasingly doing their product research and order tracking online, often via tablets or smartphones. Meanwhile, traditional channels and sales models are being disrupted by innovators using technology to carve out new roles in the value chain.

To catch up, industrial companies should first gain a clear understanding of how their customers are buying and then work back along each customer decision journey to assess which digital tools and channels will add most value to the sales process and how to reinvent their selling platform. The options to consider range from e-commerce through an analytics engine that informs pricing and proposes the next product to buy, and from microsegmentation to digital customer-experience tools. When applied throughout the business, tools like these can improve productivity, margins, and customer stickiness, boosting profitability for first movers in a given sector.

Servicing

In aerospace, automotive, commercial vehicles, and other advanced sectors, aftermarket sales have grown more quickly than other areas of the business as capital investment in new equipment has slowed. Accordingly, aftermarket services—the provision of parts, repairs, maintenance, and digital services for the equipment a manufacturer sells—are the new focus of attention for leading industrial companies. These services provide more stable revenues than sales of new equipment and, often, higher margins as well. One McKinsey analysis across 30 industries showed that the average EBIT (earnings before interest and taxes) margin was 25 percent for aftermarket services, compared with 10 percent for new equipment.[2]

The aftermarket service process is ripe for disruption. As innovative solutions such as predictive maintenance mature, manufacturers can use them to create stronger links with end customers, form a clearer view of how these customers use their products (and how the products perform), and capture increasing revenues from services. At the same time, tech enablement can be applied to field-force management, scheduling, and parts management to reduce costs and improve productivity.

Running the corporation

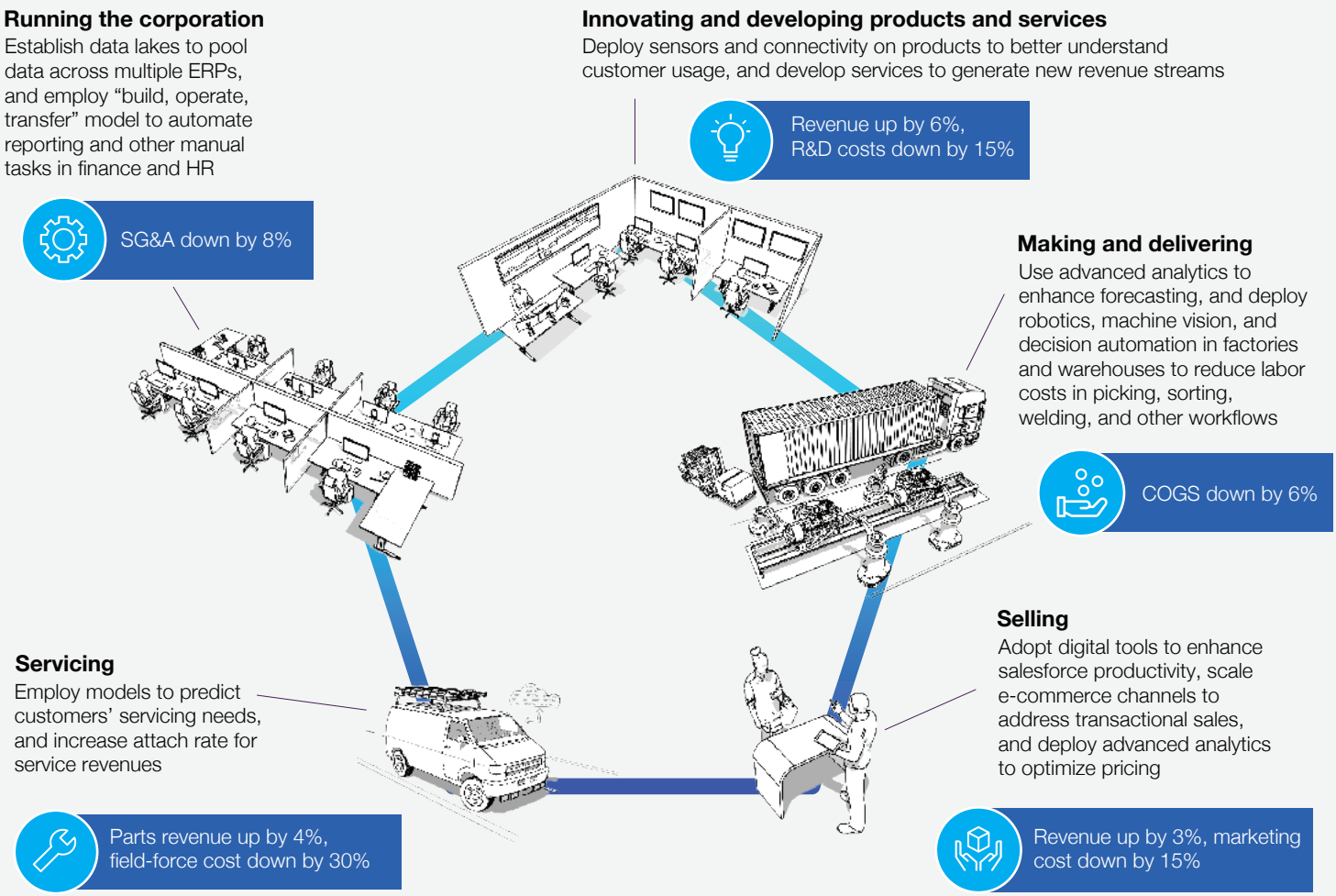
The many industrial companies that have pursued growth via acquisition end up running their business on multiple enterprise resource-planning (ERP) and legacy systems. Not surprisingly, across the advanced industrial sector, the median spend on general and administrative expenses accounts

for 4 to 8 percent of revenue. Automating manual processes via robotic process automation (RPA) can significantly reduce these costs. Other measures to cut costs and improve cash flow include building data lakes to centralize data sets across ERPs, automating financial reporting and invoice generation, and using advanced analytics to improve cash management.

Pulling it all together

To maximize value creation in a tech-enabled transformation, smart companies start by establishing a sound set of use cases across all five of these business elements. That's a critical step in setting aspirations, capturing value, and tracking value capture over time. Whether a company focuses on two or three of the business elements or looks to create value from all five through tech enablement, like the example in Exhibit 4, will depend on the nature of its business and its position in the value

EXHIBIT 4 What successful tech enablement could look like for an OEM



chain. But to avoid leaving value on the table, leaders would be well-advised to examine all the elements in detail before deciding on the best approach.

The other imperative in starting out on a transformation journey is to check that your organization has all the supporting elements it needs, as described below.

Ensuring the right enablers are in place

In considering the capabilities, structures, and practices that industrial companies need for a successful transformation, we find it helpful to define three sets of prerequisites that executives can use as a checklist in prioritizing initiatives and allocating resources.

Foundation: Data strategy, cybersecurity, cloud infrastructure, and analytics

A comprehensive **data strategy** involves identifying the data sets you need to drive insights across your priority use cases, understanding the sources of those data sets, and forming partnerships to access those that you need but don't own. For instance, a manufacturer seeking to reduce downtime for its mining equipment will need to combine its own data with a host of maintenance and usage data from the mining operators that use the equipment. Establishing which data sets you need and then building productive partnerships with OEMs and component manufacturers to access them will be critical in maximizing value capture.

As companies connect enormous numbers of devices and develop ever-more-complex data structures, **cybersecurity** becomes increasingly important. Once, cyberrisk was mainly confined to IT functions, but as businesses hook up their production systems to the Internet, operating technology comes under threat as well.[3] Seventy-five percent of the experts who took part in a recent McKinsey survey said that IoT security was important or very important, yet only 16 percent felt their organization was well-prepared. Building resilience will involve prioritizing assets and risks, improving controls and processes, and establishing effective governance.

Establishing the right **cloud infrastructure** involves creating flexible environments and sound application programming interfaces. Companies also need to think through which data should be in the cloud and which on the "edge"—on the devices themselves. Such decisions will largely depend on how much real-time processing is required. For instance, autonomous driving lends itself to an edge architecture, whereas analyzing consumption trends by aggregating data from connected appliances can be handled in the cloud.

Equipping your organization with **data analytics** capabilities to drive insights will be critical in capturing value. Whether you build the capabilities in house or outsource them will depend on your circumstances and needs. Often it makes sense to do both in the early stages, building capabilities over the long term while using outsourcing to accelerate short-term impact. Regardless of which route you take, data analytics and insight generation must be linked to actions that you can take to generate impact. For instance, if you are introducing analytics-driven dynamic deal scoring to improve margins, your reps will need a quoting tool that shows them the recommended prices, and leaders will need a performance-management system that tracks improvements across the whole sales team over time.

Organization: Agile operating model and culture

The ability to respond quickly to changes in the business environment relies on an **agile operating model** with small, flexible teams and clear processes that allow timely decision making on issues relating to governance, funding mechanisms, resource allocation, and so on. Old-style yearlong development cycles must give way to rapid iterations

in which teams repeatedly test and refine concepts and products with customers.

Such an approach requires corresponding changes in an organization's **culture**. Successful companies take great care to foster a mind-set that embraces change, is comfortable taking risks, and views failure as a springboard for learning.

Accelerators: Design thinking and ecosystem

Using customer insights to rapidly innovate on products, services, and offers calls for new capabilities and tight linkages between a company's sales channel and its product organization. **Design thinking** uses closed-loop processes to generate customer insights, translate them into product features and services, rapidly deploy these elements with the customer, test the impact, and repeat as necessary until the desired impact is achieved.

Building an **ecosystem** is the final enabler and involves establishing a set of technology and go-to-market partnerships. The complexity of a tech-enabled transformation requires partners to share data, insights, and the value created in a mutually satisfactory and sustainable manner.

Getting started

- Though tech-enabled transformations in the industrial sector are still in the early stages, companies have no time to lose. An early mover with the right strategy could not only grow profitably across the board, but also leapfrog over competitors and capture disproportionate value by gaining market share from peers or being the first to respond to radical shifts in customer behavior.

- Every company's approach to transformation will reflect its individual starting point and business priorities, but any leader would do well to follow a few basic steps:

— *Analyze every aspect of the business.* When embarking on a tech-enabled transformation, the best way to start is by taking a step back and considering exactly what you want to achieve. Obvious though that might sound, it's not so easy to act on. Some companies are so overwhelmed by, say, the promise of the Internet of Things that they jump straight into working out how to introduce IoT applications into their products and operations. Instead, evaluate your whole business to see where technology could unlock the greatest value. If you are an industrial distributor, for instance, you may be able to improve your margins much faster by adopting analytics-based pricing or digitizing your selling process than by creating IoT-enabled services. Implementing and scaling basic technologies is a quick way to learn and capture value before venturing into more sophisticated territory such as remote diagnostics and maintenance.

— *Reimagine your business model and aspirations.* Don't use technology to make your current model marginally more efficient. Set a bold aspiration to ensure the changes you make don't just reinforce the status quo. Define metrics and operational performance indicators to track improvement, and ensure you have leadership support. Treat your program as a transformation, not an incremental initiative.

— *Understand how new technologies affect working processes.* To succeed, new technologies need to operate in conjunction with legacy systems and existing workflows. Consider an OEM adopting IoT-enabled solutions to offer predictive maintenance. When a client's system detects an equipment problem, it automatically notifies the OEM to

send a service rep to carry out unscheduled repairs. But for this to work, the OEM has to integrate these notifications into its service-dispatch processes so that reps are sent out promptly. Closing the loop on workflows in this way is a critical step in capturing value.

— *Understand where you are and build your transformation roadmap.* Too often, companies deploy solutions without first taking care to understand their current situation. Set a baseline and be realistic about your starting point and digital maturity—which will partly determine how much value you can expect to capture. Then, work out where the value lies, assess your capabilities, and build a roadmap that prioritizes and sequences the key elements in your transformation. Develop a clear view of the value-chain elements your business touches, your competitive environment, and the ways technology could disrupt it: for instance, through customer-service apps. Think in terms of three-to-five-year horizons to ensure you keep pace with the evolving technology and business landscapes.

Though the industrial sector has been slower to digitize than many other sectors, advanced technologies now allow companies to reshape all their activities from product development to sales and servicing. Our experience indicates that taking a bold, strategy-led approach and identifying opportunities systematically across the entire business is the best route to a successful outcome. ■

[1] Richard Jones, Felix Recht, Nick Santhanam, Xiaoran Tong, and Shekhar Varanasi, "What's ahead for industrials?" McKinsey.com, March 2017.

[2] Aditya Ambadipudi, Alexander Brotschi, Markus Forsgren, Florent Kervazo, Hugues Lavandier, and James Xing, "Industrial aftermarket services: Growing the core," McKinsey.com, July 2017.

[3] Thomas Poppensieker, Wolf Richter, Rolf Riemenschnitter, Gundbert Scherf, "A new posture for cyberrisk in a networked world," McKinsey.com, March 2018.

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Innovating
and developing
products
and services

Photo credit: Getty Images

Tech-enabled disruption of products and services: The new battleground for industrial companies

Venkat Atluri, Jeremy Eaton, Mithun Kamat, Satya Rao, and Saloni Sahni

Industrial companies are finding that technology is an important link in the value chain for innovation and product development. The transformation is challenging, but there are ways to getting it started.

With economic profit flatlining, industrial companies are turning to revenue growth to drive value. Using technology to innovate and develop new products and services is fast becoming the new battleground. Companies are not only enhancing their offerings through software and data but making the transition from selling hardware-based products to creating tech-enabled businesses.

The effect on the industrial sector will be profound. In the auto sector, for example, estimates suggest global revenues will almost double from $3.5 trillion in 2016 to $6.6 trillion by 2030. As much as 84 percent of this growth is expected to derive from disruptive new offerings such as shared mobility, connectivity, and electrification. To get a share of this growth, companies have no option but to pursue tech-enabled innovation for themselves.

What's more, innovation in products will go hand in hand with innovation in business and revenue models, just as aerospace-engine original equipment manufacturers (OEMs) have long since made the transition from selling engines to selling power by the hour. Similarly, agricultural-equipment providers are selling farmers not only tractors and harvesters but productivity solutions enabled by connectivity and remote monitoring.

This article examines how much value could be created by tech-enabled product innovation in the industrial sector, identifies the key digital levers and enablers companies need to have in place, and suggests how they can go about capturing a fair share of the value at stake.

Sources of value

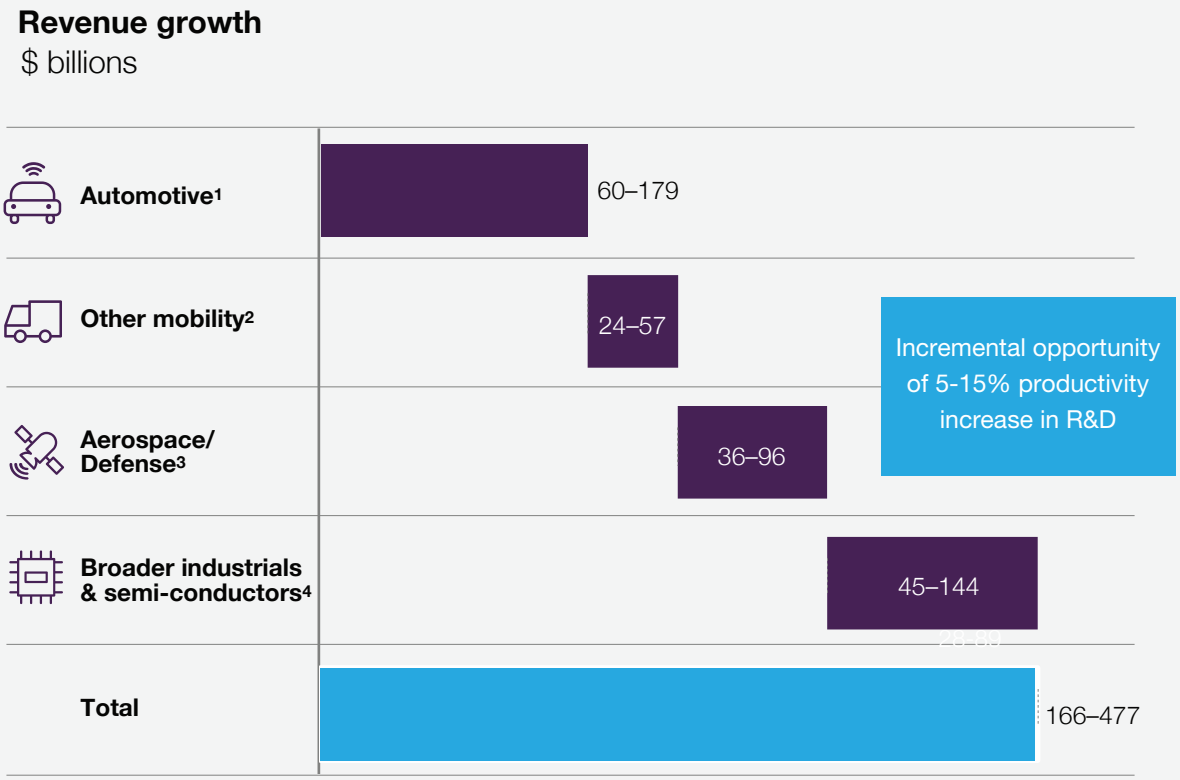
McKinsey's analysis indicates that using technology to improve innovation and product development could deliver $166 billion to $477 billion in new revenue and $8 billion to $25 billion from margin expansion through greater efficiency in R&D. Exhibit 1 illustrates how this opportunity breaks down across the subsectors in the industrial sector.

Exhibit 2 provides an overview of the key levers and enablers needed to capture value from the three main sources we identified, namely:

Extract value from connected products and services

Our analysis indicates that connected products could deliver $34 billion to $95 billion in incremental

EXHIBIT 1 The value from tech enablement in innovating and developing products varies by industry segment



1 Whole value chain including tier 1 suppliers, automotive OEMs, and dealers
2 Commercial vehicles and off-highway equipment (e.g., for construction and agricultural use) including tier 1 suppliers, equipment manufacturers, and dealers and distributors
3 Includes tier 1 suppliers and equipment manufacturers
4 Includes industrials, food processing and handling, motion and controls, industrial automation, and electrical, power, and test equipment across the value chain: component suppliers, equipment manufacturers, distributors, VARs, engineering and services providers, and product companies

EXHIBIT 2 Value drivers and enablers in product development and innovation

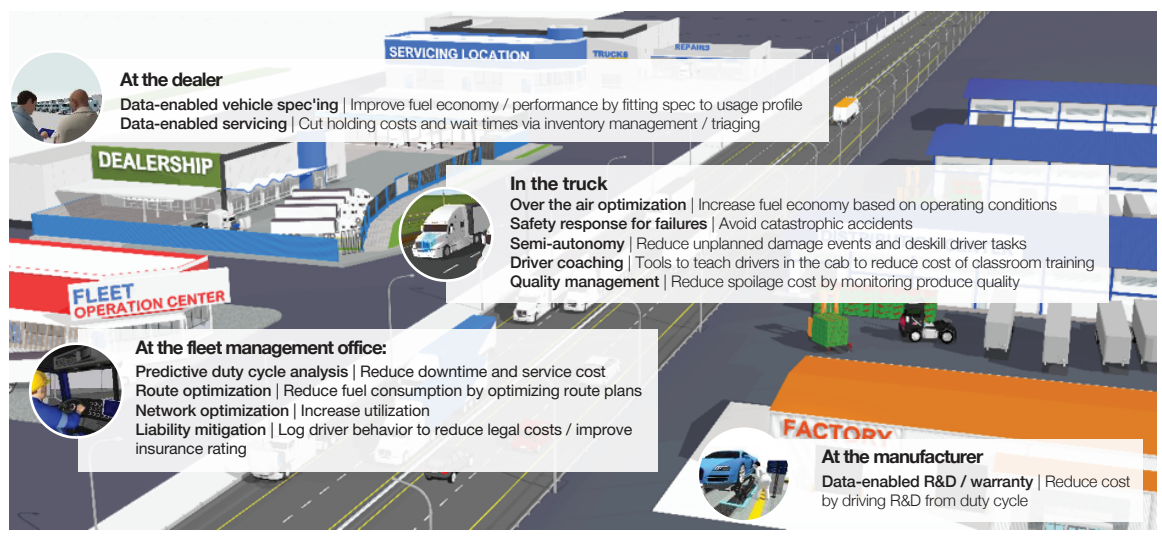
Sources of value	Examples of digital levers and enablers			
Extracting value from connected products and services	Smart sensor enablement (e.g., wearables)	Data-based product configurations (e.g., parameter-based performance optimization)	Smart features (e.g., on-demand performance enhance-ments, predictive maintenance)	Automation (e.g., auto configura-tions, remote control)
Creating data-enabled business models	Analytics and insights-based services (e.g., dealer-enabled solutions, operations and maintenance optimization)	Data monetization (e.g., insurance-rate optimization based on driver behavior)	Developer platform for third-party services	Marketplaces and data exchanges
Optimizing R&D processes with tech enablement	Data-driven R&D process planning	Advanced analytics–driven R&D project efficiency	Rapid experimentation and simulation; MVP-based development process	Closed-loop feedback for ongoing product enhancements

industry revenue growth. As the costs of sensors, connectivity, and computing continue to fall, leading companies are harnessing technology to reinvent their products and services and launch innovative new offerings in a bid to leapfrog competitors and gain market share.

In line-haul trucking, for instance, technology will make it possible to reimagine operations across the entire value chain, as illustrated in Exhibit 3. A commercial fleet could save on fuel costs and improve vehicle performance by calibrating vehicles over the air to match operating conditions. A dealership could spec vehicles more intelligently by using data on individual customers' usage patterns, and cut wait times at service facilities by managing inventory and triaging service jobs in real time. At distribution centers, semi-autonomous tractors could save time spent moving trailers around the yard and reduce the incidence of damage. Finally, manufacturers of line-haul trucks could collect data on duty cycles to inform R&D and cut warranty costs.

Bringing connected products to life in this way requires industrial companies to address a number of practical challenges. Chief among them is building an IoT platform—a complex undertaking, especially for a sector that has traditionally treated engineering and IT as separate disciplines. Another challenge is deciding on the most suitable architecture from a

EXHIBIT 3 Examples of connected products in commercial vehicles



wide array of providers and options, such as building on a generic IoT platform or procuring a turnkey solution from a specialty IoT partner.

Successful companies take two key steps to facilitate product connection:

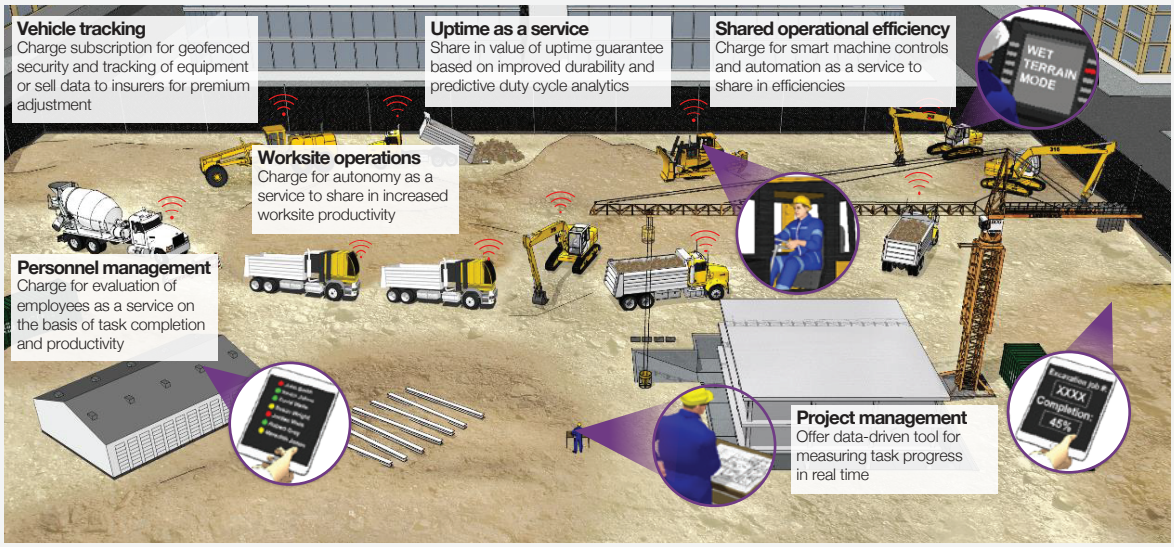
Ensure that use cases drive platform requirements both while developing minimum viable products (MVPs) and over the long term. For example, use cases that require the real-time processing of large data sets, such as autonomous driving, demand significant edge computing capacity in the vehicle as well as in the cloud, while use cases based on aggregating data from a multitude of devices, such as consumption trends from connected appliances, can be handled exclusively in the cloud, at much lower cost.

Take an end-to-end approach to architecture. A siloed approach, in which device, cloud, and app data are all handled independently, is likely to cause duplication, with each layer over-developing its own features rather than delivering functionality across the whole customer experience. By contrast, focusing on adding incremental end-to-end capability forces companies to address dependencies between data models, communication protocols, and so on, at an early stage in development programs, thereby greatly reducing risk.

Creating data-enabled business models

New business models offer the largest opportunity in tech-enabled product development, with an estimated $132 billion to $382 billion in incremental industry revenue growth. Some of these business models are likely to disaggregate value chains in much the same way that Uber is disrupting investment allocations for automotive companies, and increasingly aerospace companies as well. Manufacturers of mining equipment, for example, could explore a range of opportunities to create new revenue streams, such as charging insurers for vehicle usage data that helps them set premiums or offering mining companies uptime as a service (Exhibit 4).

EXHIBIT 4 Examples of data-enabled business models in mining equipment



Unplanned downtime accounts for more than 10 percent of working time and causes considerable operational disruption. Our analysis indicates that a mere 1 percent improvement in the availability of earth-moving equipment could create more than $200 million in value in the US alone. An OEM could reap enormous benefits by offering uptime as a service, issuing a reliability guarantee for its equipment, and claiming a share of the value thus created for its customers.

Launching data-enabled businesses can be even more challenging for an industrial company than creating connected products, especially in two key aspects:

Getting from data to insight to value. Many industrial companies assume that the raw data generated by their IoT offerings is monetizable in its own right, but this is seldom the case. Companies usually need to combine multiple data streams—often including third-party data sets—before they can achieve a level of insight that yields commercial value. Another common misconception is that IoT offerings generate so much data that companies should be able to discover a silver bullet somewhere in it. Misled by this belief, one multinational industrial company tied up dozens of highly qualified data scientists for a decade on data projects that failed to find a viable route to market or indeed demonstrate any real commercial potential. Successful companies make sure that data-enabled offerings are owned by the business from the outset, and they take care to answer the question, "Who values this offering, and can I sell it to them?"

Getting to market. Pushing data-enabled offerings through existing channels and sales teams is likely to produce mixed outcomes at best. Reps may lack the expertise and customer connections to sell the new offerings effectively and may turn to other products to make up their quota, leaving the innovations branded as failures. One building-management company developed a data-driven product to reduce

clients' operational and energy expenses, opting to launch the new offering through its existing branches to get to market quickly. However, one of the product's core benefits lay in reducing the time building owners spent on service issues in the local branches, while the company rewarded its branch managers based on the number of service hours they sold. Given the clear conflict of interest, branch managers mostly ignored the new offering.

Leading industrial companies aren't afraid to cannibalize their core if it brings them greater overall benefits, and they plan their organization, hiring, and incentives to support their new offering and maximize its chances of success.

Optimizing R&D processes with tech enablement

With an estimated $8 billion to $25 billion in incremental industry revenue growth, this is the smallest value-creation opportunity of the three. But it is still important, given that traditional approaches to R&D efficiency—peer benchmarks, lean engineering, trial and error—are producing diminishing returns and ceasing to confer competitive advantage. The fundamentals of tech-enabled R&D efficiency are a shift to agile iterative product-development cycles and the rapid deployment of digital- and analytics-based productivity techniques. Consider a typical company where engineers use ten or more systems in a typical day's work, ranging from timesheets, emails, and project plans to bills of materials and suppliers' systems. By integrating data from all these disparate systems into a common structure, the company can use machine-learning algorithms to track metrics dynamically and extract powerful insights that provide a fact-based, granular guide to sources of value.

One aerospace and defense company applied advanced analytics to identify productivity drivers and metrics in its software engineering. It began by creating a data lake that combined data from a dozen or so sources, including the enterprise value-management system, software code tracking, timesheets, and Microsoft Exchange. Then it ran multivariate algorithms to identify factors that correlated to productivity metrics. It found, for instance, that replacing late-stage software testing with early-stage testing using automated scripting would improve productivity by 5 percent.

Finally, the company created a business case and action plan to address target initiatives. This entire process was completed in just 16 weeks, thanks to a sprint-based approach that combined traditional engineering practices with advanced analytics. The company found opportunities to reduce software defects by 35 to 50 percent and increase engineering capacity by 20 percent.

How to capture the value

For all their promise, few industrial Internet of Things (IoT) products have reached full maturity and scale as yet. In our experience, one of the main barriers to adoption is a lack of understanding of how to capture the value of technology. Developing new offerings is only half the battle; companies must also invest in an effective go-to-market approach. This involves two elements:

Knowing where the value is created.

Those industrial companies that have succeeded in scaling connected products or data-enabled services understand where the value is created (by direct customers, end users, or ecosystem partners, for instance) and how it is created (through lower transaction costs, improved safety, fewer defects, or some other benefit). This knowledge is fundamental to developing appropriate business, pricing, and revenue models, quantifying value creation, and understanding how much value accrues to each party. For many connected products or data-enabled

services, the end user is the primary beneficiary of the value created. Component and subsystem suppliers will need to find a path to monetization that reaches the end user, perhaps via an ecosystem approach or partnership with OEMs.

In upstream oil and gas, for example, the value created by reducing downtime at a fracking site or oil rig is captured by drilling contractors but delivered by a combination of players. Data ownership is fragmented: the drilling contractors control the data from the large equipment they manage; manufacturers of, say, frac blenders own the algorithms and data that generate insights into the equipment and how it works; and component manufacturers, in turn, own performance data on individual products such as pumps. In this environment, creating value will entail forming partnerships with multiple manufacturers and designing a model that enables value to be fairly shared among the partners.

Establishing the right monetization model.

Industrial companies can monetize their products directly or indirectly. Direct options include bundling products, launching add-on services, and delivering an offering as a service. Indirect routes include capturing new market share, developing preferred-supplier status with OEMs, and so on. To maximize value capture, companies need to select a monetization model that is appropriate to their position in the value chain and the criticality of the value at stake.

Take the example of an agricultural-equipment manufacturer selling productivity services to farmers. In general, measuring the improvement in crop yield or quality that can be generated by data-enabled farming equipment is difficult, as it depends on multiple variables over the course of the year. However, on occasions when farmers need to harvest a crop within a short timeframe—as with sugar cane, for example—they want their equipment running at maximum productivity, opening up opportunities to create value by optimizing uptime or output. Meanwhile, a component manufacturer in this value chain may find that its best monetization strategy is to develop a preferred position with the OEM.

How to get started

Most industrial companies are still at an early stage in transforming their innovation and product development through technology. Some hesitate to take the first steps, others are stuck in pilot mode, and still others struggle to build a viable business case in the face of traditional development cycles and limited monetization opportunities. But delay could cost companies dearly: late adopters risk not only leaving value on the table but also losing market share to nimbler competitors. A McKinsey Global Institute survey found that being a first mover conferred an advantage of about 7 percent in earnings before interest and taxes—more than double the roughly 3 percent achieved by average responders.

So where do you start? We suggest five steps:

- *First, listen to your customers.* They know what they want when they see it, even though they may not be able to articulate it in advance. Invest heavily in customer insights to identify pain points in the user experience, and pressure-test your new offerings with customers to ascertain what they are willing to pay for.

- *Second, place big bets.* It's fine to fail fast, but avoid spreading your investment across too many ideas. Successful organizations prioritize a few big bets that get the lion's share of management attention. Having identified your big bets, consider novel ways to organize around them. Some tech-enabled industrial companies use a VC-like governance structure

with a digital unit reporting directly to a "digital board" comprising the CEO, CTO, and CFO. Such a structure ensures that funding is based on reaching milestones, that issues are resolved quickly, and that the core business stays focused on the core.

- *Third, adopt agile product development.* Set up small, autonomous, cross-functional teams that can get close to customers, fail fast, and pivot to the next opportunity. Traditional product development cycles are a recipe for failure, as they can't keep up with advances in technology and data.
- *Fourth, build out your ecosystem.* Commercial as well as technological partnerships are essential to moving fast and scaling effectively. Building and maintaining a robust ecosystem of partners demands dedicated resources.
- *Fifth, establish the right go-to-market capabilities.* Selling tech-enabled products is nothing like selling traditional hardware. It requires knowledge of consultative selling, software bundling, and unfamiliar sales cycles and solution architectures. Expecting your traditional sales channels to convert customers quickly or bolting a digital sales group onto a traditional organization could spell disaster. Instead, develop a clear customer interaction model and overhaul your sales structure, processes, enablement strategies, and incentives.

Tech-enabled innovation and product development has the potential to deliver enormous and much-needed revenue growth in the industrial sector. Companies that take a rigorous approach to finding, quantifying, and capturing value—and then move quickly—can expect to see the greatest impact.

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Making
and
delivering

Photo credit: Getty Images

The next horizon for industrial manufacturing: Adopting disruptive digital technologies in making and delivering

Kevin Goering, Richard Kelly, and Nick Mellors

The key to continued performance and productivity improvement for advanced industrial companies is the use of disruptive technology in the manufacturing value chain.

In the past few years, advanced industrial companies have made solid progress in improving productivity along the manufacturing value chain. In the US, for instance, the productivity of industrial workers has increased by 47 percent over the past 20 years. But the traditional levers that have driven these gains, such as lean operations, Six Sigma, and total quality management, are starting to run out of steam, and the incremental benefits they deliver are declining.

As a result, leading companies are now looking to disruptive technologies for their next horizon of performance improvement. Many are starting to experiment with technologies such as machine-to-machine digital connectivity (the Industrial Internet of Things, or IIoT), artificial intelligence (AI), machine learning, advanced automation, robotics, and additive manufacturing. The impact of this shift is expected to be so transformative that it is commonly referred to as the fourth industrial revolution, or Industry 4.0.

This new wave of technology and innovation offers companies opportunities not only to drive a step-change in productivity and efficiency, but also to capture strategic business value by establishing competitive advantage in the way they operate their entire "make to deliver" value chain. The nature

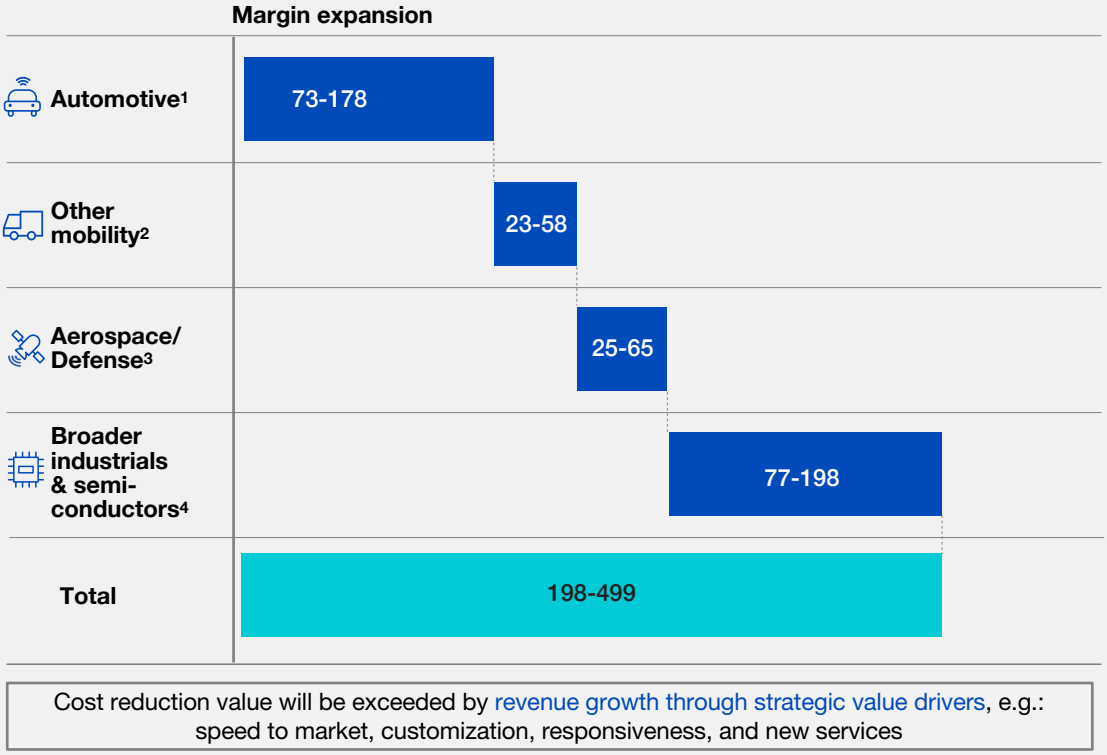
and scale of the opportunities will vary from sector to sector and company to company, depending on factors such as value drivers, market dynamics, and operational maturity. However, we routinely see successful technology-enabled transformations dramatically shifting individual value drivers. For example, an aerospace manufacturer with a reputation for high quality but suffering from high labor costs and slow production implemented augmented-reality work instructions for complex assemblies to decrease error rates from 3 percent to nearly 0 percent while increasing productivity by 30 percent. Similarly, an auto manufacturer that needed to maximize its already highly automated process began analyzing available data for micro-losses in capacity to unlock an additional 3 percent of overall equipment effectiveness. Finally, an electronics manufacturer operating in a high-cost country virtually eliminated material handling labor using automated vehicles for material delivery and robots for palletizing.

For companies that aim well and execute effectively, the resulting cost reductions could be

EXHIBIT 1

The value from tech enablement in product manufacturing and delivery varies by industry segment

$ billions



[1] Whole value chain including tier-one suppliers, automotive OEMs, and dealers
[2] Commercial vehicles and off-highway equipment (e.g., for construction and agricultural use) including tier-one suppliers, equipment manufacturers, and dealers and distributors
[3] Includes tier-one suppliers and equipment manufacturers
[4] Includes industrials, food processing and handling, motion and controls, industrial automation, and electrical, power, and test equipment across the value chain: component suppliers, equipment manufacturers, distributors, VARs, engineering and services providers, and product companies

transformational. We estimate that productivity gains and cost savings alone could deliver near-term impact of 200 to 600 basis points of margin expansion across advanced industries, worth $200 billion to $500 billion (Exhibit 1). In the mid- to long-term, even more value could be unlocked through greenfield plants, network reconfiguration, and upgrades to core IT and operating-technology (OT) architecture.

Substantial though these cost reductions are, we expect them to be overshadowed by new revenue opportunities arising from increased speed to market, product customization, and new services. How much strategic business value they will generate remains to be seen, but we can expect the lion's share of it to go to first movers.

Unlocking the value

To capture the value of digital in manufacturing and throughout the supply chain, leading industrial companies are developing use cases in three main areas: connectivity, intelligence, and automation (Exhibit 2).

Connectivity

After rapidly expanding through the Internet of Things, connectivity has reached global scale, extending to some 8.4 billion connected devices. The ability to link digital devices—shop-floor monitors,

EXHIBIT 2

Connectivity, intelligence, and flexible automation create value across multiple aspects of manufacturing and delivery

Sources of value	Connectivity Enabling the flow of relevant information to the right decision makers in real time	Intelligence Applying AA and AI to an array of data to generate new insights and enable better decision making	Flexible automation Using new robotic technologies to improve the productivity, quality, and safety of operational processes
Optimizing procurement	Advanced spend intelligence and automated sourcing insights	Analytics-enabled tools for optimizing product cost (e.g., part number consolidation, digital benchmarking)	E-sourcing events: eRFX, e-catalogs, e-auctions
Enhancing forecasting and demand planning	Real-time tracking of inventory location	Simulation-based forecasting of market and micromarket demand and inventory management	Automation of production planning processes
Digitizing manufacturing and assembling	Real-time OEE visibility with click-through capability on drivers of downtime	Predictive maintenance to reduce downtime	Vision systems for autonomous quality control
Streamlining distribution and delivery	Real-time visibility of delivery windows	Use of AA and AI to optimize logistics network	Automated warehouse picking and replenishment

remote computers, smartphones, tablets, and so on—to IT platforms and systems enables decision makers to access a flow of relevant information in real time. In production environments, only 15 percent of assets are connected as yet, but change is taking off. Advanced applications now being introduced in industrial manufacturing include digital performance management and the use of augmented-reality smart glasses to communicate instructions and standard operating procedures. In the supply chain, parts are being tracked digitally across supplier networks, and trucks are providing real-time data to enable just-in-time delivery, optimize work planning, and minimize inventory. The technology industry is working on more than 700 IoT platforms for industrial use, and major tech companies are investing heavily in platforms that extend beyond individual companies to whole industries.

One aerospace company struggling with supply issues combined data from purchasing, part tracking, and inventory monitoring in a single platform to enable real-time visibility of each part across the entire supply chain. The results exceeded expectations, with a 20 percent improvement in procurement productivity and a 5 percent improvement in on-time delivery. Another aerospace company took part traceability to the next level by introducing digital tagging. Parts were automatically scanned for minute differences in surface texture at key points in the supply chain, virtually eliminating counterfeiting and ensuring regulatory adherence.

Intelligence

Advanced analytics and artificial intelligence can be applied to large data sets to generate new insights and enable better decision making in predictive maintenance, quality management, demand forecasting, and other areas. Machine-learning algorithms are growing more powerful as computing power advances and big data proliferates. However, the full potential of artificial intelligence has yet to be captured in production environments, which at present use only a small fraction of data for decision making.

One auto manufacturer had difficulty managing growing complexity in its product variants, and sought to improve and automate its decision making. To do so, it installed an enterprise manufacturing intelligence (EMI) system that ingested data from more than 400 IoT sensors, enabling predictive intelligence to be applied to maintenance, quality, and parts supply. Introducing the new system improved overall equipment effectiveness by 10 percent and first-time-right delivery by 15 percentage points.

Flexible automation

Robotics and automation have been commonplace in industrial manufacturing for decades, but we are seeing a new wave of opportunity driven by declining technology costs, growing functionality, and an expanding range of environments in which robotics can be safely and effectively deployed. Introducing new robotic technologies in product assembly, warehousing, and logistics can improve the productivity, quality, and safety of operational processes. Applications include autonomous guided vehicles in distribution centers, automated warehouse management systems, and cobots (collaborative robots) working on assembly processes in conjunction with humans. Estimates suggest that 60 percent of manufacturing tasks could be automated, but industrial robots have yet to achieve widespread penetration even among early adopters. South Korea, for instance, has only 530 robots for every 10,000 production workers.

Deploying automation across the entire product assembly process from material handling to quality testing and packaging enabled one electronics company to reduce direct and indirect labor costs by

more than 80 percent. These savings in turn allowed the company to manufacture its product in higher-cost countries located close to attractive markets, thereby reducing shipping costs while increasing customer responsiveness and speed to market.

Examples of what connectivity, intelligence, and automation might look like at an aerospace manufacturer are illustrated in Exhibit 3.

Overcoming pilot purgatory

McKinsey's research shows that most advanced industrial companies are conducting pilots in all three of these areas (Exhibit 4). In the aerospace and defense sector, for example, all of the top 10 companies and two-thirds of the top 50 have announced digital initiatives of some kind. Most of the business leaders we spoke to recognize that technology can help them navigate complex risk and regulatory environments, make their operations more efficient, and enhance the customer experience they offer.

However, advancing beyond the pilot phase is still a big challenge for most manufacturing companies. Even among those reporting significant numbers of pilots, most struggled to achieve broader rollout. In fact, the gap between piloting and rollout is considerably larger than that between perceived relevance and piloting, suggesting that scaling is a bigger hurdle than getting the ball rolling in the first place (Exhibit 5).

EXHIBIT 3 Examples of digital manufacturing innovations at an airline manufacturer

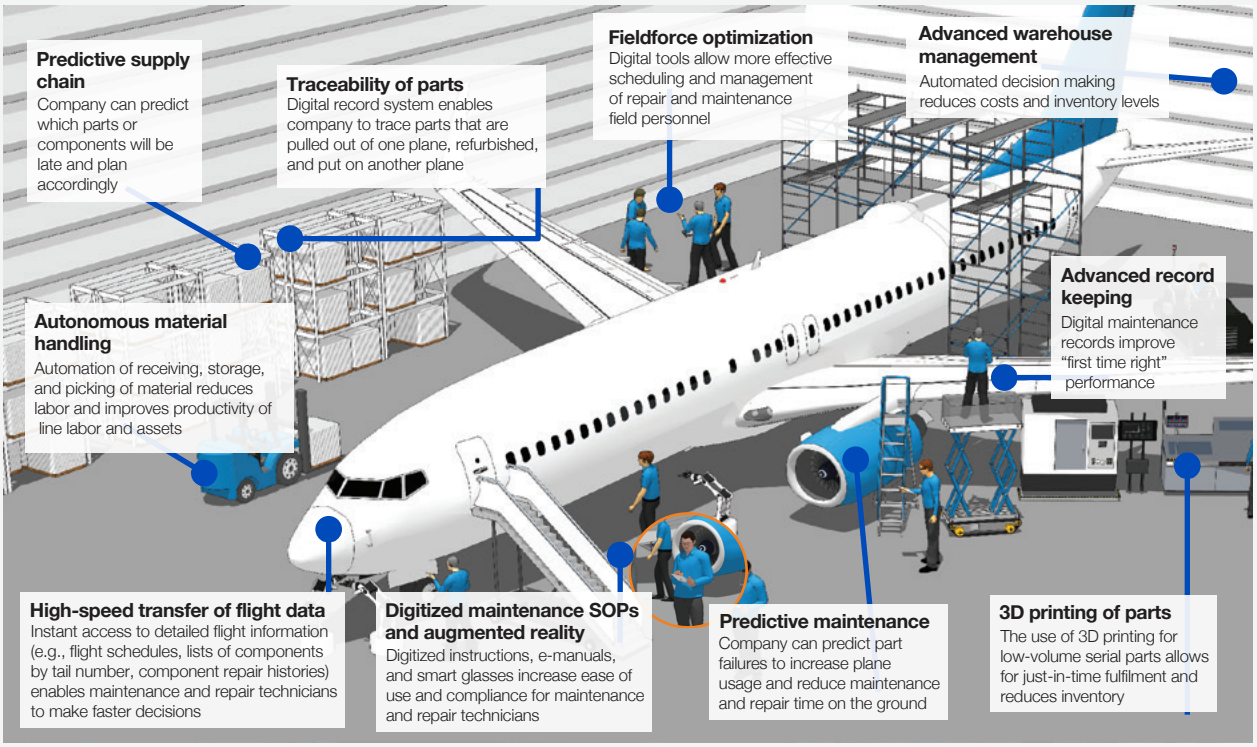
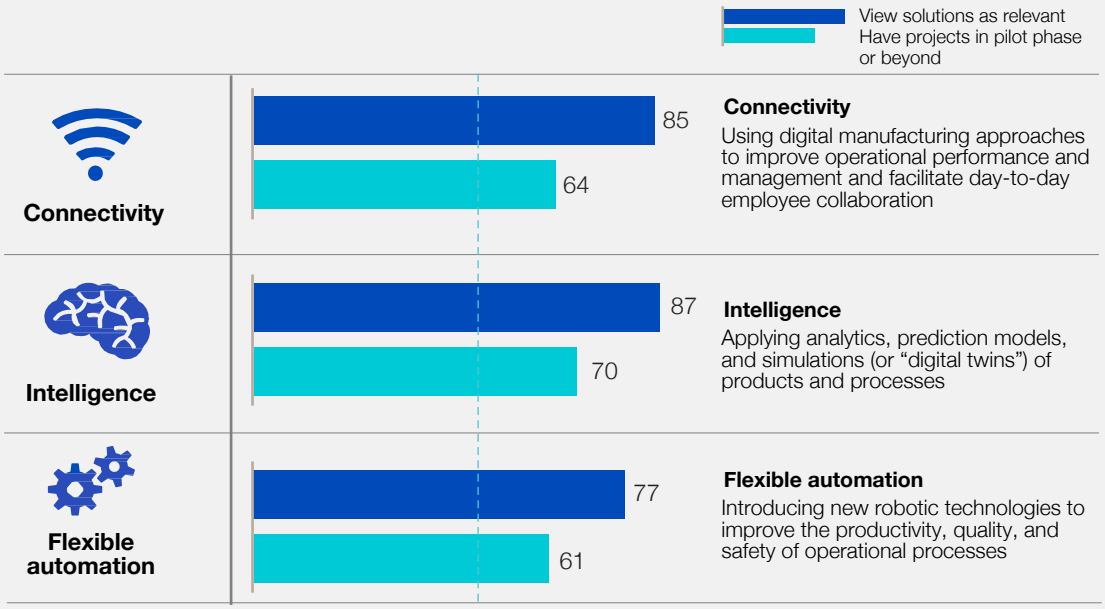


EXHIBIT 4

Most survey respondents regarded digital manufacturing as relevant, and many had pilots under way

Percent of respondents piloting digital manufacturing solutions or viewing them as relevant,
N = 700



Source: McKinsey Digital Manufacturing Global Expert Survey 2018

What we learned from our research—and found reinforced by our client experience and industry observation—is that companies often make the same few mistakes when defining and implementing strategies for technology-enabled transformation in manufacturing and delivery. As a result, they struggle to move beyond what we call "pilot purgatory" and fail to capture sustainable impact at scale. Fortunately, we also found a few real-world examples of companies that achieved effective roll-out by paying close attention to a handful of success factors. These "lighthouse" cases provide inspiration for other manufacturers in developing a vision for how technology can create value, building a solid business case, and charting an effective course for enterprise-wide implementation.

Our research identified six success factors that fall into three categories: strategy, infrastructure, and organization (Exhibit 6).

Strategize the transformation process

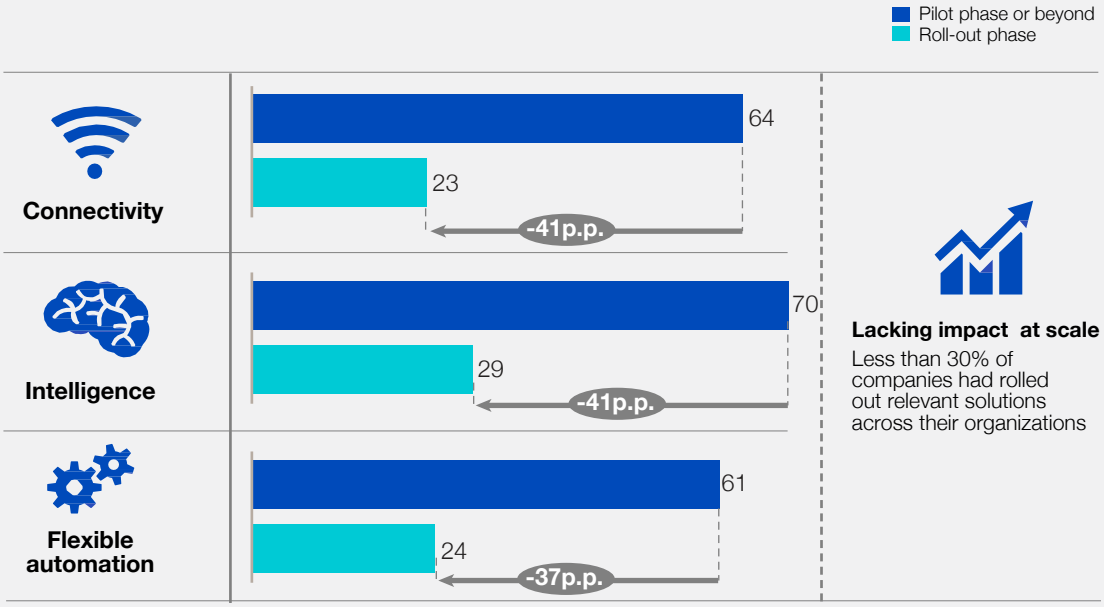
Too many organizations pursue a digital manufacturing journey that ultimately fails to create enough value to justify the cost, time, and management attention involved. To avoid this fate, successful companies establish a solid business case built on two principles:

Start from bottom-line value and work back. With so many digital manufacturing solutions on the market, it's easy—but dangerous—for companies to get sidetracked by what looks exciting. To deliver tangible results, they need instead to begin with

EXHIBIT 5

Answer to question: what stage has your company reached in adopting digital manufacturing?

Percent of solutions applied; percentage point difference



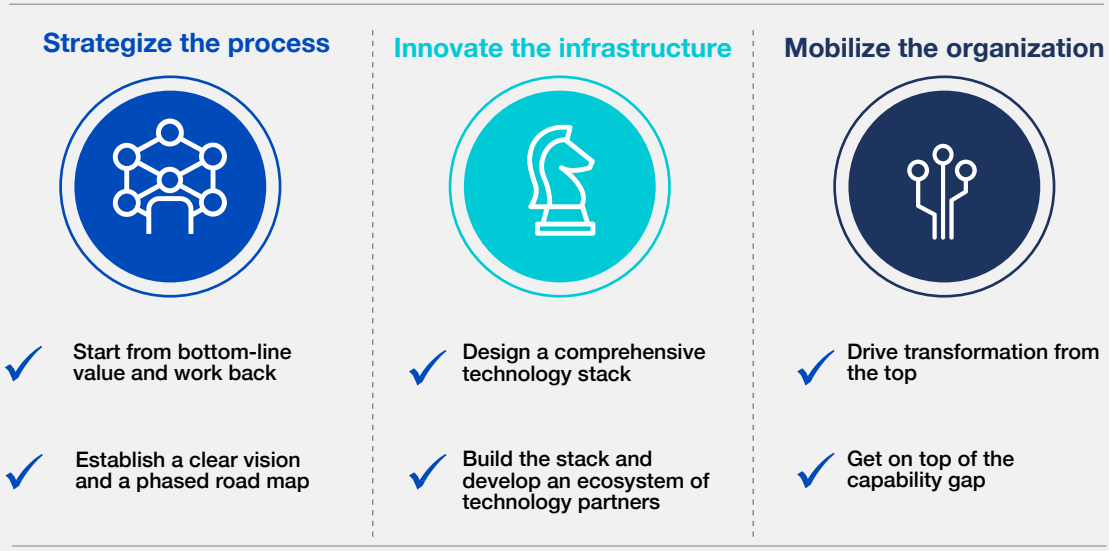
Source: McKinsey Digital Manufacturing Global Expert Survey 2018

a clear view on how these solutions can address operational pain points, create competitive advantage, and drive bottom-line impact. For some companies, for instance, 3-D printing enables competitive differentiation through leading-edge designs that would be impossible to manufacture in any other way; for others, it is no more than an expensive distraction. As a rough guide, asset-heavy companies would be well advised to treat predictive maintenance as their top priority, while labor-heavy companies should focus on digital performance management.

Establish a clear vision and a phased road map. More than half the respondents in our survey (59 percent) saw lack of vision as a significant obstacle to digital transformation, up from just 15 percent reported as recently as 2017. Three principles can help manufacturing companies create a vision for digital manufacturing:

- *Think holistically across the ecosystem over the long term.* Spot solutions may generate excitement to fuel broad-scale change, but tend to leave value on the table. Look past the immediate fix and your own capabilities to develop sustainable solutions that build long-term competitive advantage
- *Showcase early wins to solidify buy-in.* However compelling the vision, it will fail without widespread organizational support. Create one or more "lighthouse" facilities to demonstrate how individual use cases reinforce one another to transform outcomes.

EXHIBIT 6 **To escape pilot purgatory, organizations should act on six key success factors**



- *Create an ROI roadmap.* Scaling up calls for careful management of technologies, use cases, process changes, cultural shifts, and investments. To navigate these complexities, create a road map informed by the size and nature of the business opportunity and your requirements for IT and OT architecture and resources.

Innovate the infrastructure

Having addressed strategy and business benefits, companies can then turn to the critical elements of technology stack and ecosystem.

Design a comprehensive technology stack. Almost half (44 percent) of survey respondents regarded IT deficiencies as a major challenge in implementing digital manufacturing. In defining your optimal technology stack, bear five watchwords in mind:

- *Comprehensive.* Ensure your stack spans collection, connectivity, data, analytics, and applications, and is specific to your operational model.
- *Scalable.* Your stack must enable rapid scaling and support future growth. Pay particular attention to your data-ingestion pipeline and complementary analytic capabilities.
- *Analytics-enabled.* Software and infrastructure systems provide the raw material, but analytics produces the insights that generate value. Only 20 percent of organizations have a data lake that covers more than half their plants, and only 25 percent use an advanced analytics platform at scale. Companies that integrate their data and extract more insights from it will create more value.

- *Integrated.* Integrate data from IT and OT to help you develop digital-manufacturing use cases that meet your business needs.

- *Secure.* Address cybersecurity at every step, taking special care over the connections between legacy and future systems.

Build the stack and develop an ecosystem of technology partners.

Every stage of the process, from developing a technology stack to rolling it out, must be tightly managed to ensure cohesion and seamlessness. We recommend following three guidelines as you move forward:

- *Minimize architecture complexity.* Navigating the complex landscape of solution providers presents many challenges. When building components into your technology stack, make as much use of industry standards as possible to ensure interoperability across the organization.

- *Use external partnerships to access functional and integrative expertise.* Select a few partners with deep functional and integrative expertise and develop solutions with them where possible. Our research shows that more than 40 percent of organizations are either building their own IT/OT systems in house or tailoring externally sourced systems to their needs, creating a wide range of systems that need to be bridged. The right partners can help you ensure seamless integration and functionality.

- *Drive agile execution across organizational silos.* As well as forging external partnerships, break down organizational silos and build your own capabilities for collaborating across functions.

Mobilize the organization

Digitizing an entire production system requires tremendous change that goes well beyond technology. People are critical to success, and harnessing their energies requires you to:

Drive transformation from the top. Capturing the full potential from digital manufacturing calls for a consistent approach in which you:

- *Ensure executive-level leadership and P&L commitment.* Appoint an executive-level transformation leader to drive digital manufacturing—something that only about a third of manufacturers have done so far. Consider taking your whole top team to digital immersion sessions and "go and see" visits to understand the new capabilities and ways of working you will need to develop. Accelerate the pace of your transformation by committing P&L to the effort.

- *Integrate decision making across countries and functions.* Any fragmentation in the way you apply digital technologies could jeopardize the success of your transformation. Coordination across plants, locations, and functions along the value chain is essential, yet far from universal: only a third of companies report having a globally coordinated digital-manufacturing effort.

- *Get on top of the capability gap.* To foster an organizational culture that facilitates individual and team development:

- *Encourage innovation.* Create an environment that promotes creativity and innovation to give your transformation the best chance of success. Consider launching an innovation challenge for your organization, ecosystem, and academic partners to generate ideas and allow you to co-create new offerings with suppliers and external experts.

- *Focus on talent.* More than two-thirds of companies see attracting, managing, and

retaining top talent as the biggest challenge in implementing digital manufacturing. Secure the capabilities you need by combining in-house training with hiring from outside and collaborating with solutions providers, research institutions, and academics.

A holistic approach to transforming manufacturing through technology involves the fundamentals of your organization and your business as much as the technologies themselves. Following the guidelines suggested in this article will help you accelerate implementation, bridge the gap between pilot success and enterprise-wide roll-out, and unlock new sources of value.

Kevin Goering is an associate partner in McKinsey's San Francisco office, **Richard Kelly** is a partner in the Stamford office, and **Nick Mellors** is an associate partner in the Seattle office.


Selling

Photo credit: Getty Images

Why tech-enabled go-to-market innovation is critical for industrial companies—and what to do about it

Venkat Alturi, Satya Rao, and Andrew J. Wong

Companies that overhaul their go-to-market strategy with savvy use of technology improve their revenue growth and customer satisfaction.

Industrial companies face a compelling opportunity to innovate their traditional go-to-market channels and models. The simultaneous rise of digital commerce, powerful digital players, and millennials as the dominant customer segment is disrupting the whole sector and changing the way in which industrial companies need to go to market (see sidebar, "Disruption by numbers").

Yet few of them are managing to adapt quickly enough. Over the last five years, McKinsey has measured the Digital Quotient® (DQ™) of approximately 200 B2C and B2B companies around the world by evaluating 18 management practices related to digital strategy, capabilities, culture, and organization that correlate most strongly with growth and profitability.

The study shows that B2B companies trail consumer companies in terms of their overall digital maturity: the average DQ score for the 47 B2B companies in our study was 28, compared with 35 for consumer companies (Exhibit 1).

While most industrial companies have come to terms with the need to make more strategic use of technology,[1] they are often unsure of how to proceed or are focused on the wrong initiatives, resulting

Disruption by numbers

The rise of digital commerce

x 2 increase in daily US e-commerce spending over the past 5 years

40% expected increase in the next 4 years

90% B2B customers who research purchasing decisions online

46% buyers who view product comparison as the biggest pain point in their buying journey

85% prefer to use digital channels for repeat purchases

The threat from digital players*

$1 billion Amazon's B2B revenues, with R&D investment of $16 billion

$4 billion eBay's B2B revenues, with R&D investment of $1.1 billion

$2.5 billion Alibaba's B2B R&D investments

The behavior of millennial customers

83.1 million millennials in the US (overtaking baby boomers at 75.4 million)

67% of millennials prefer to shop online

8 out of 10 millennials never buy anything without first reading a review

6 hours per week spent on social media

* All data from 2016

in halting action and a failure to build significant value. On the other hand, those companies that move quickly and decisively to transform their go-to-market channels, models, and culture through technology should be able to unlock substantial value: top quartile B2B players generate 3.5 percent more revenue and are 15 percent more profitable than the rest of the B2B field.

Where the value lies

Our detailed analysis has identified a pool of $74 billion to $298 billion in revenue growth that could be tapped through enabling technology in sales (Exhibit 2). The value comes primarily through new customer experiences, refined pricing, and enhanced selling processes.

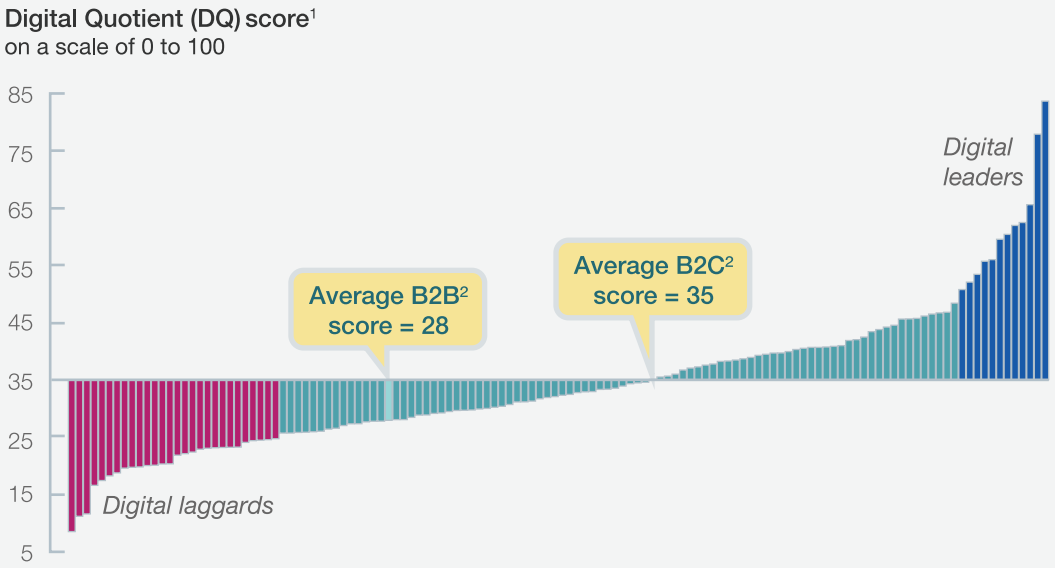
An innovative approach to selling

Our experience in working with dozens of industrial companies has helped to identify where the main source of value is across the four main steps of the selling process: the presales stage, the sales process, the transaction itself, and IoT-enabled selling (Exhibit 3).

Enhancing presales and discovery through digital marketing

Presales covers all customer interactions that lead to the discovery of the brand, product, or service. Industrial companies frequently underestimate the impact of a poor presales experience, such as suboptimal websites or over-reliance on traditional channels for lead generation.

EXHIBIT 1 B2B companies trail their B2C counterparts in progress towards digitization.



[1]DQ score is an average across 4 equally weighted dimensions: culture, strategy, capabilities, and organization.
[2]2016 sample includes 47 B2B and 128 B2C companies and reflects an update from previously published versions.

McKinsey&Company

However, as the customer landscape shifts toward digital channels, and as e-commerce matures, companies need to develop consumer-centric strategies that will drive traffic to their web pages and improve lead generation. Doing so significantly increases performance, as McKinsey analysis shows that companies with strong presales capabilities consistently achieve win rates of 40 to 50 percent in new business and 80 to 90 percent in renewal business, well above the average.

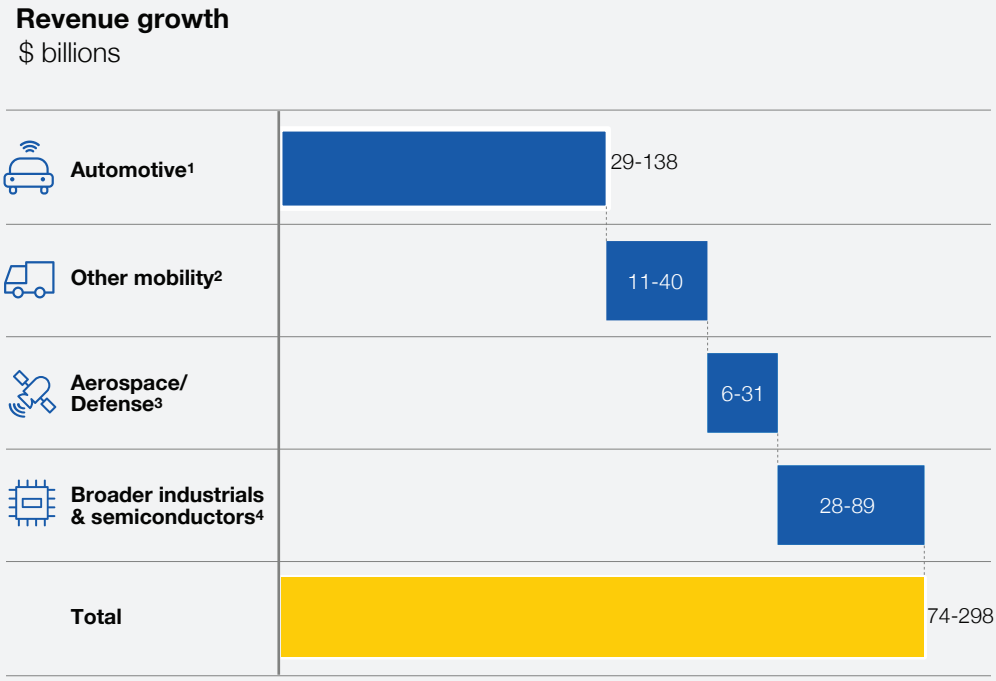
We typically observe four practices that work best: implementing agile digital marketing, optimizing paid search (SEM), maximizing organic search (SEO), and personalizing next-product-to-buy algorithms. These areas often require adopting digital technologies such as advanced analytics and artificial intelligence, and optimizing marketing across traditional and digital channels.

An auto retail company set up an agile digital-marketing war room to manage and analyze effectiveness of all campaigns on a daily basis. As a result, the client learned that paid search (search-engine marketing), organic search (search-engine optimization), and email marketing were most effective in attracting profitable customers. By shifting spend to those digital channels, the company saw improvements in traffic (25 to 35 percent) and conversion (greater than 25 percent) within ten weeks.

Another industrial company developed detailed customer profiles by aggregating multiple data sources such as customer-profile loyalty identifications and historical sales. From this input, a predictive analytical model was created to show sales patterns based on customer purchasing behavior and provide recommendations on next

EXHIBIT 2

$74 billion to $298 billion of revenue growth can be delivered across industrials through innovative approaches to selling.



1 Automotive value chain, including tier-one suppliers, automotive OEMs and dealers
2 Commercial vehicle and off-highway equipment (e.g., construction, agriculture) value chain including tier-one suppliers, equipment manufacturers, and dealer and distribution channel
3 Aerospace and defense tier-one suppliers and equipment manufacturers
4 Industrials subsegments, food processing and handling, motion & controls and industrial automation, electrical, power, and test equipment across the value chain from component suppliers to equipment manufacturers and distributors; VARs, engineering and services providers and players across the semiconductor value chain from suppliers to product companies

SOURCE: McKinsey analysis

product to buy. By sending personalized emails and product recommendations, the company was able to increase email conversion by 30 to 40 percent. This approach also helped identify effective selling processes and profitable customer profiles for future sales.

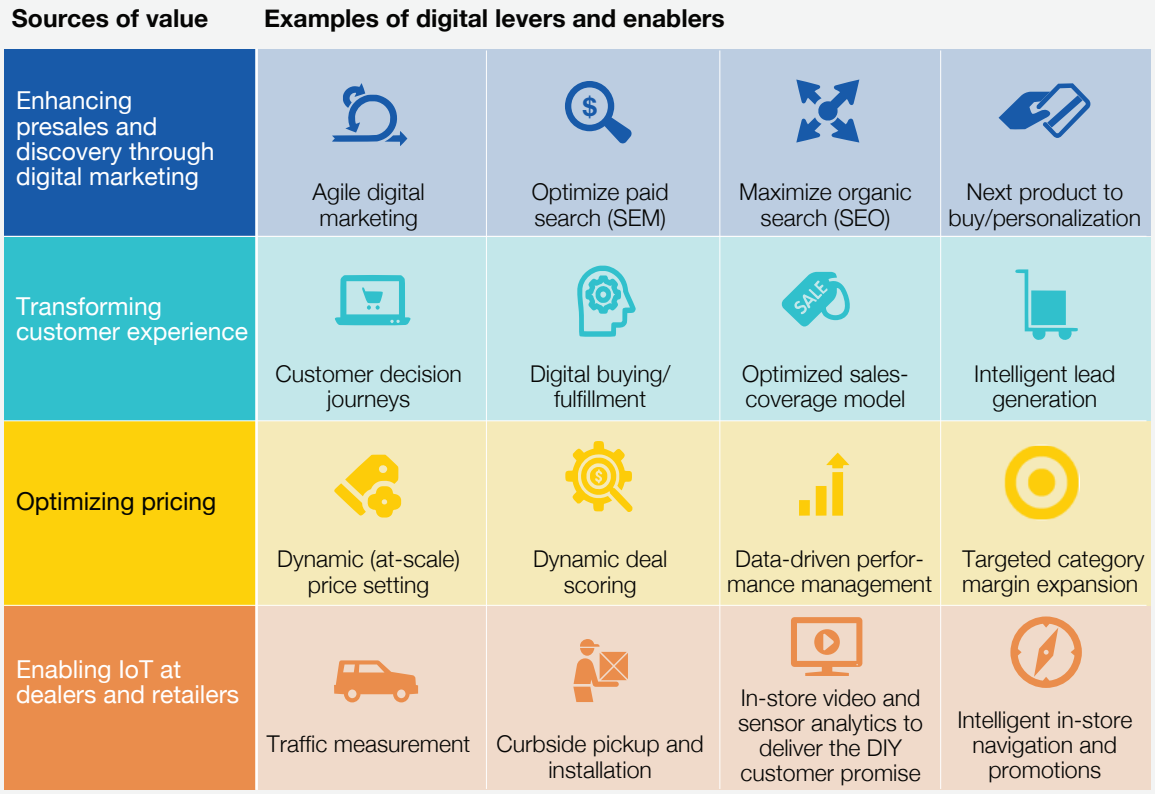
Transforming customer experience

A profitable sales process relies on developing a deeper understanding of how customers are behaving at each step in their decision journey. This helps companies understand at a granular level where customer pain points and opportunities are and then to establish clear priorities for developing digital tools to improve sales productivity and better engage with customers. Levers typically used include digital buying/fulfillment, optimized sales-coverage models, and customer decision journeys.

For example, a large equipment manufacturer conducted customer decision journey (CDJ) research, interviewing and surveying end customers to understand the biggest pain points in their journeys (Exhibit 4).

Many industrial companies miss this step, putting them at risk of investing in digital tools that don't meet genuine customer needs. One

EXHIBIT 3 Value drivers in tech-enabled selling



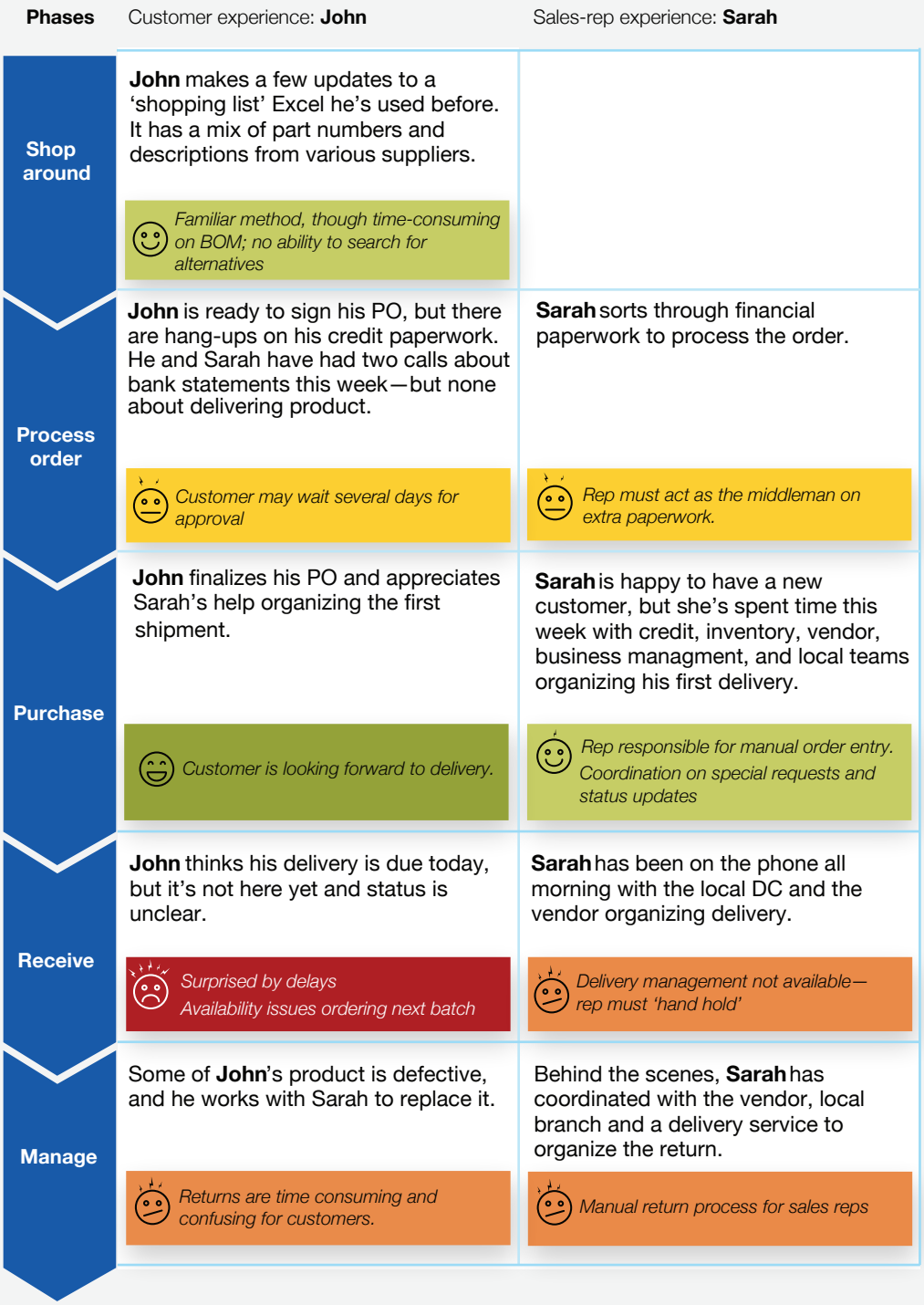
company discovered that customers spent a significant amount of time understanding product specifications and matching them to their requirements during the quote stage. That led to them starting quotation requests for products that were not optimized for their needs.

Insights like these allowed the organization to focus its energies, leading to the development of a minimum viable product prototype with a well-defined feature set to address prioritized pain points. One example was the creation of a web tool that allowed end customers to browse and compare products by specs, a core customer need. This approach and rapid iteration reduced the time needed to develop a full solution from three years to nine months, and the prototype development phase from nine months to six weeks. By creating improved experiences, we estimate that it is possible to increase customer engagement and conversion by 30 to 40 percent.

In another company, CDJ analysis revealed two major customer pain points. One, customers were having difficulties in comparing and getting quotes for products. Two, it was cumbersome for customers to track and monitor open orders, because all processes had to be done manually and required multiple interactions between customers and sales reps.

Based on these findings, sales leaders developed a web-based platform prototype to allow customers to research products, build their bill of materials

EXHIBIT 4 Breaking down key pain points in the customer decision journey



(BOM) and receive an initial quote with minimal sales support. Additionally, the platform allowed sales reps and customers to collaborate on requests, share the status of orders, and exchange proactive notifications of any changes. Finally, on the back end, the platform allowed sales reps to have full visibility of the accounts, view open invoices, and flag potential delays or anticipated issues. The implementation of the platform generated significant improvement of customer experience and increased sales productivity by 10 to 15 percent.

Based on our experience, technology solutions based on CDJ analysis typically lead to a 3 to 5 percent increase in revenues and increased customer engagement and loyalty to the brand.

Optimizing pricing

The development of digital and analytical tools in transactions, such as dynamic deal-scoring models and data-driven performance management, has significant benefits: our experience suggests significantly improved operating income, optimized B2B product pricing to specific customer segments, maximized value capture in each transaction, and end-to-end pricing-process management throughout the lifetime of products and contracts.

Improving price capabilities is also critical given how rapidly e-commerce players can adjust prices and capture opportunities. It is not uncommon for eCommerce players to use dynamic pricing algorithms for individual stock-keeping units (SKUs) on a daily basis. Although such algorithms might be harder to apply in a B2B setting due to constraints on data collection and frequency of transactions, they offer a vision of what is possible as B2B companies' digital and analytical capabilities mature.

One impressive source of value comes from reducing unexplained variability in discounting. A dynamic deal-scoring tool can provide objective guidance for sales reps at the time of deal making. Analyses at a large wholesale distributor, for example, showed that several similar customers received significantly different levels of rebates and discounts due to circumstantial factors, such as sales rep underperformance or unjustified customer requests.

To address this issue, a dynamic deal-scoring model was developed using historical data, relevant parameters, and advanced analytical techniques to provide an assessment of expected profitability for each incoming deal (Exhibit 5). The tool delivered results to the sales rep during the quotation phase of the process through an app. Empowered by this information, sales reps clearly understood the performance potential of each incoming deal request and could make a real-time assessment of which levers, such as payment terms or add-on services, could be used to improve deal performance and provide better value for customers.

The implementation of a dynamic deal-scoring solution significantly improved gross profits (1 to 3 percent) through more targeted discounting and effective use of rebates, and reduced the quoting process from months to a week, creating a much better buying experience for customers and potentially improving win-rates.

Industrial companies also have the opportunity to use analytical tools to dynamically set prices at scale and continuously improve pricing performance to drive business objectives. The potential impact can be significant, typically a 2 to 7 percent return on sales in value to the bottom line. However, because sales leaders in industrial companies tend to approach each deal as a unique one, they have been slow to implement advanced analytical techniques to unlock pricing opportunities.

(Technology has a significant role to play in the postsales process as well. For more on that, please

EXHIBIT 5 Steps to implement a dynamic deal-scoring solution

read "How disruptive technologies are opening up innovative opportunities in services" in this collection).

Enabling IoT at dealers and retailers

Original equipment manufacturers (OEMs) and consumer packaged goods companies (CPGs) have started to work with dealer and channel partners to use technology more effectively in sales. IoT-enabled innovations are an area with great potential.

Typically, IoT-enabled innovations can unlock value by improving real-time traffic measurement, curbside pickup, intelligent in-store navigation and promotions, and inventory management. To better understand the potential, we reviewed automation opportunities across ten major work-flow activities in retail, including shelving and replacement, pricing and promotion, and checkouts, and identified six major use cases where technology and algorithms can be deployed to increase store performance.

One opportunity identified by our research was combining sensors with smartphone technologies such as Bluetooth to map customers' positioning within the store and then provide tailored offers and information to increase the propensity to buy.

Another possible opportunity was to develop a fully automated, nonstop checkout, using a combination of video-surveillance technology and machine-learning algorithms to accurately charge customers >99.9 percent of the time. Another interesting use case developed was to leverage radio-frequency ID (RFID) tags, whose price has declined significantly in recent years, to automate the inventory monitoring process, freeing up store staff to focus on customer-facing activities.

Our analysis shows that the total value generated by these improvements can be significant, with estimated increases in revenue of 3 to 10 percent, reductions in operating costs of 15 to 25 percent, and a 5 to 10 percent increase on average in operating profit.

At a dealer network, a system of sensors was installed to reliably capture store traffic. The data generated was analyzed through advanced analytics to directly measure several indicators, such as store performance, marketing ROI, effect of store initiatives, and the effect of weather, among others. With this analysis in hand, the team identified several initiatives to improve performance and maximize return on investment by eliminating underperforming marketing campaigns, for example, or refocusing promotions. Furthermore, there was an opportunity to adapt the system to enable the detection of loyalty customers, and create targeted and tailored experiences for them such as matching them with the most experienced staff.

Getting started

No two industrial companies face the same opportunities and challenges in enabling sales through technology, but all companies need to tackle a few key things:

Invest in understanding your customer at a granular level. Begin by understanding the areas most in need of improvement along your customer decision journeys. This requires getting closer to your customers and understanding the channels they use to research and buy, research through advanced analysis as well as close observation. This process is best when it is continuous and based on frequent communications through dedicated channels between sales and product-development teams.

Construct one source of truth for your selling data. To fully capture the revenue uplift from selling, it is critical to combine transactional data across channels and systems into a single data lake. This establishes a single source of insight for your sales and tech teams. This may sound trivial, but it's often the hardest thing to accomplish, given the multiplicity of data sources in many companies.

Define a big opportunity. With insights into customer buying behaviors in hand, the best companies go for big opportunities. These are comprehensive across a range of levers including churn reduction, incremental sales from enhancing the share of wallet, pricing opportunities, and sales from new channels such as e-commerce.

Link your technology roadmap to identified value. Your technology investments should be in lockstep with the opportunity you're going after. For example, if there are significant shifts to e-commerce in certain kinds of transactions, then establishing the right corresponding channel and right presales infrastructure is critical to capturing that opportunity. Similarly, if the variations in pricing practices are significant for similar transactions, then it is critical to invest in dynamic deal-scoring tools. The roadmap should

focus on near-term horizons (one to two years) given constantly evolving innovations and customer needs.

Deploy the technology so you can be responsive. You should deploy solutions using agile methods so that you can rapidly respond to sales and customer feedback. The traditional waterfall approach often results in lost momentum and in a solution that is not in tune with customer needs.

Invest in a "transformation structure." Your technology investments need to be tracked and managed as a major change initiative. Sales and customer training is critical to ensure adoption. Granularity in performance management linking the investment to expected results helps to ensure the value is being captured, and allows the business to adjust quickly if necessary.

Technology isn't a panacea for digital transformations in sales. It is a core component of a holistic change program that requires effective and deliberate management. But sales organizations that find that balance can deliver massive value to their businesses.

[1] "How B2B digital leaders drive five times more revenue growth than their peers," McKinsey.com, October 2016.

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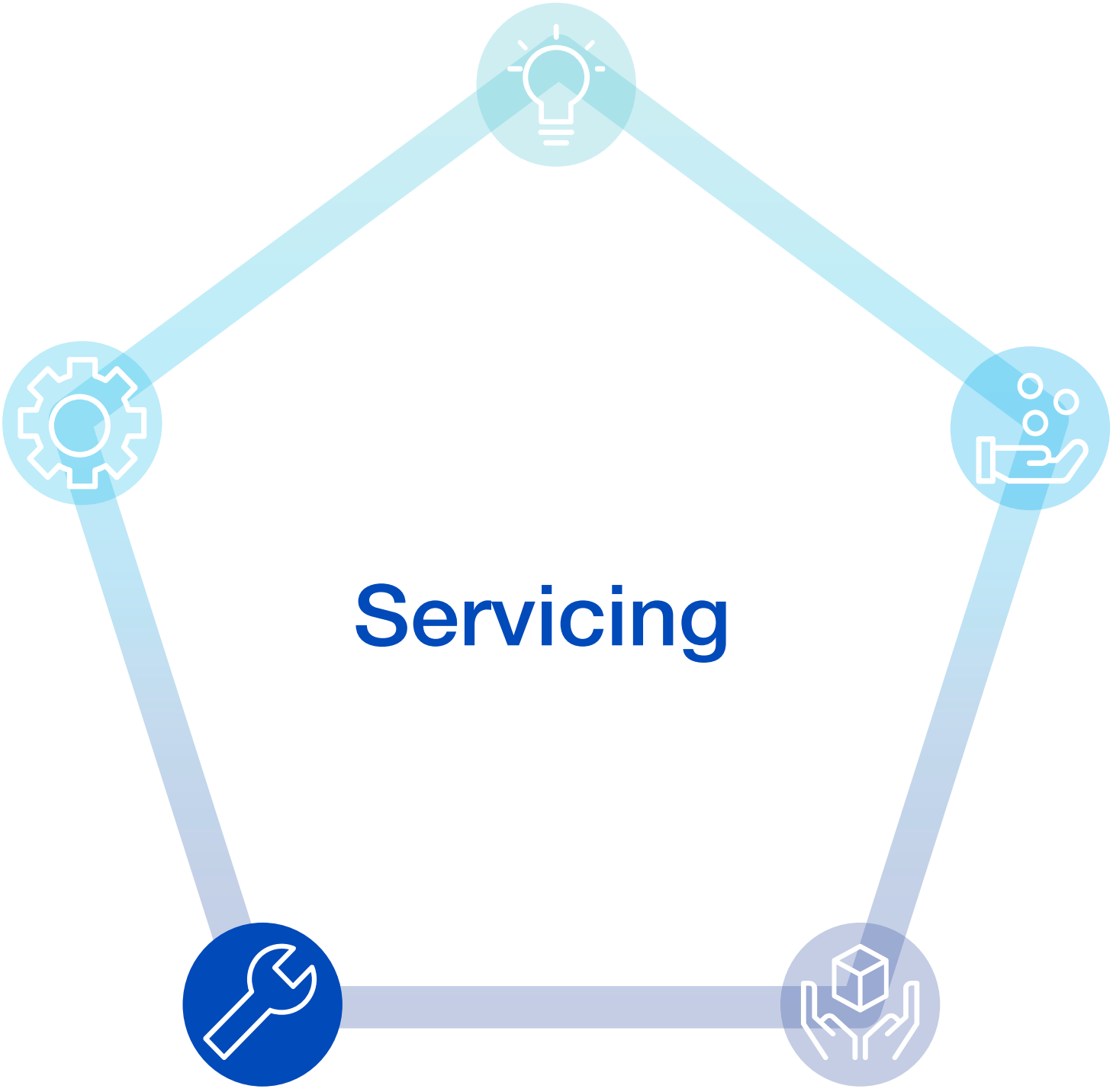

Servicing

Photo credit: Getty Images

How disruptive technologies are opening up innovative opportunities in services

Barathram Ananthakrishnan, Venkat Atluri, Harsha Krishnamurthy, and Senthil Muthiah

Technology and advanced analytics are revolutionizing services—and creating new sources of value for industrial companies that know how to use them. Here's a roadmap that works.

In search of sustainable ways to grow, industrial companies are turning to their vast installed base as a source of recurring revenues and profits. Revenues from servicing, especially aftermarket services and parts, are generally more stable than those from equipment sales and have shorter lead cycles, so they offer a way to counter the cyclical nature of capital investments. In some subsectors, such as flow control, services tend to generate higher margins than equipment sales. What's more, pursuing new servicing opportunities can transform a company's relationship with its customers by giving it deeper insight into how its products are used.

The proliferation of connected devices and sensors, coupled with a thousand-fold increase in computing power over the past decade, is opening up new ways to deliver services and interact with customers (Exhibit 1). For instance, the IoT (broadly defined as a combination of sensors, analytics, and connectivity) allows industrial companies to monitor equipment health remotely and develop new commercial offerings, such as outcome-based contracts in industries with high downtime costs. Industrial companies have started building technology-enabled capabilities to take advantage of these opportunities. United Technologies, for

EXHIBIT 1

Disruptive trends are reshaping servicing

Key trends	Description		Impact
• By 2025, 50% of workers will be freelance • By 2035, 40% of productivity improvements will be driven by AI • By 2021, the augmented-reality market will reach $108 billion	**Digital offerings led by IoT, AA,**	• Use devices that accurately report reason for failure to reduce diagnostic time • Use augmented and virtual technology to help technicians complete complex repairs more quickly	**10–25%** reduction in mean time to repair
	Workforce as a service	• Workforce is available whenever and wherever needed to help reduce spend on full-time employee	**5–20%** reduction in labor cost
	Dynamic dispatching	• Use dynamic dispatching to reduce idle time and improve field technicians' productivity	**10–20%** improvement in productivity
	Reactive to proactive service	• Next-generation digital, analytics, and IoT tools support shift from reactive to proactive service	**30–40%** reduction in mean time to repair
	Proactive fulfillment of customer needs	• Anticipate service needs before incident and reduce unplanned downtime	**10–20 pp** improvement in customer

instance, acquired analytics firm Predikto in 2018 to enhance its predictive-maintenance offerings and scale its digital and analytics capabilities.

Many other companies are starting to apply advanced analytics (AA) and digital tools to derive instantaneous insights into field operations and use them to optimize deployment in real time through techniques such as dynamic field dispatching and remote servicing. These technologies are allowing industrial companies to deliver a step change in impact through improved technician productivity, reduced mean time to repair, and higher customer satisfaction.

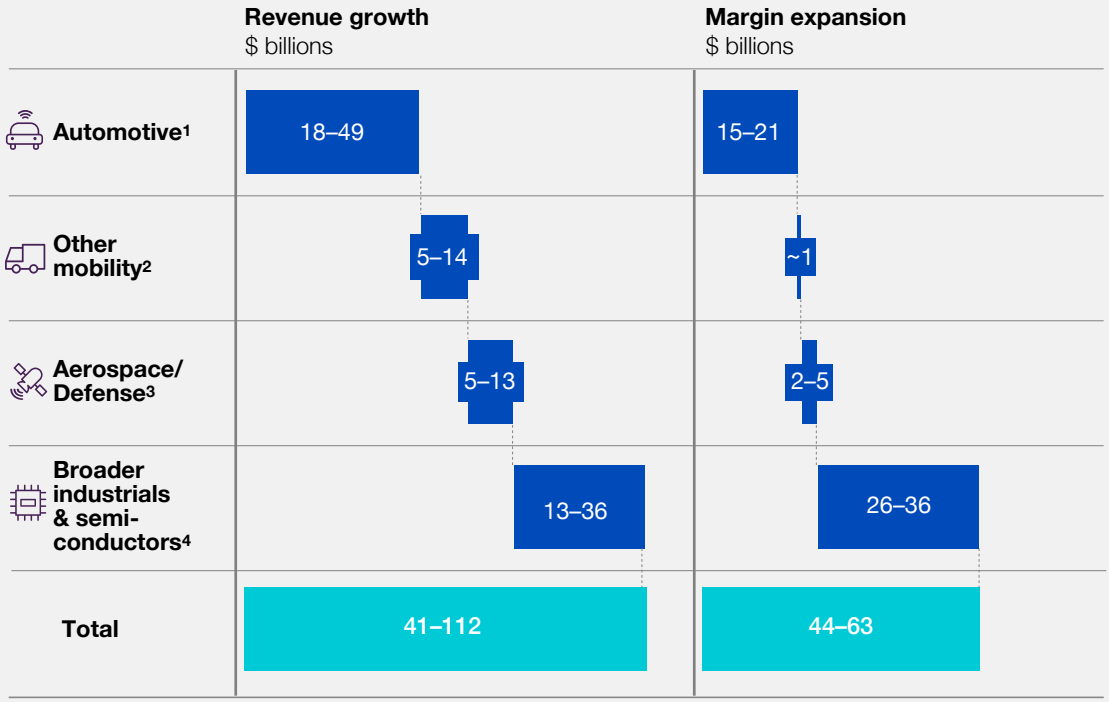
Below, we outline the enormous opportunities that tech-enabled servicing opens up, consider the value potential it unlocks, describe what a successful approach looks like, and review the steps leaders can take to begin their servicing transformation.

Where the value lies

Our analysis has identified a pool of approximately $40 billion to $110 billion in revenue growth and $40 billion to $60 billion in margin expansion that could be captured through tech enablement in industrial services globally (Exhibit 2). This value comes from four main sources: a 1 to 3 percent revenue uplift from cross-selling, upselling, and new business models; a 3 to 10 percent increase in service revenue from smarter pricing of aftermarket parts and services; and a 20 to 30 percent reduction in field-service personnel costs from optimizing demand and labor management.

A few leading companies are already achieving considerable success from efforts like these. One OEM reduced troubleshooting steps for its technicians by 50 percent and increased first-time fixes by 15 percent, enabling it to cut costs and increase market share. And an industrial-technology

EXHIBIT 2 **The value from tech enablement in servicing varies by industry segment**



[1] Whole value chain including tier-one suppliers, automotive OEMs, and dealers
[2] Commercial vehicles and off-highway equipment (e.g., for construction and agricultural use) including tier-one suppliers, equipment manufacturers, and dealers and distributors
[3] Includes tier-one suppliers and equipment manufacturers
[4] Includes industrials, food processing and handling, motion and controls, industrial automation, and electrical, power, and test equipment across the value chain: component suppliers, equipment manufacturers, distributors, VARs, engineering and services providers, and product companies

provider that turned its field force into a lead-generation engine saw five to ten percentage points of incremental revenue growth.

The scale of servicing opportunities is best assessed by lifetime value, defined as the total revenue an OEM can receive from servicing its installed base. When McKinsey analyzed aftermarket lifetime value in more than 40 Fortune 500 companies ranging from wind-turbine providers to truck manufacturers, we found striking variations from one subsector to another (Exhibit 3).[1] In some industries the lifetime value of the aftermarket was almost equal to the price of the initial product, while in others aftermarket revenue was virtually nonexistent.

An innovative approach to servicing

With a successful tech-enabled service strategy, a company can not only gain a deeper understanding of how customers use its products but also increase the number of customer touchpoints, giving it more opportunities to explore and respond to customer needs. Our experience of working with dozens of industrial companies on technology transformations shows that new value can be created from all parts of the servicing process: managing customer demand, optimizing field labor,

EXHIBIT 3 **Service revenues vary widely by sector**

Equipment	Aftermarket lifetime value	= Product lifetime	x Lifetime penetration[2]	x Average annual service
	%	Years	%	% of sales price
Gas turbines	75%	20–50 years	29–77%	4–6%
Helicopters	53%	18 years	32%	4%
Data storage[1]	43%	4–5 years	70–80%	10–15%
Electric drives	35%	20 years	21–27%	7%
Wind turbines	34%	25 years	78%	1–3%
Heavy-duty trucks	30%	10 years	21–42%	107–367
Passenger cars	16%	13 years	42%	4–10%

[1] Mainly reflects spare parts
[2] Lifetime penetration is a function of attach rate, and typically shows wide variation between industries

SOURCE: Aditya Ambadipudi, Alexander Brotschi, Markus Forsgren, Florent Kervazo, Hugues Lavandier, and James Xing, "Industrial aftermarket services: Growing the core," McKinsey.com, July 2017

managing parts, and delivering superior customer experience (Exhibit 4).

Managing customer demand

Traditionally, the difficulty of predicting and managing customer demand has led to high equipment downtime and poor service. Two drivers of this unpredictability are the limited use of scheduled servicing and the low penetration of condition-based monitoring, in which equipment is monitored while in operation. Industries vary in their approach to scheduled servicing, but out-of-warranty assets typically suffer lower adoption and more unplanned repairs. A few industries—such as aviation, renewable energy, and mining—have started to adopt IoT-enabled condition monitoring to prevent asset breakdowns, but few OEMs as yet have the infrastructure and technology to offer their customers monitoring services.

Leading companies are using four methods to manage customer demand more actively:

- *Remote monitoring.* By taking advantage of IoT and real-time connectivity, companies can continuously monitor the health of individual assets and entire facilities to predict potential problems and manage demand. For instance,

EXHIBIT 4

The value in servicing comes from four main sources.

Sources of value	Examples of digital levers and enablers			
Managing customer demand	Remote monitoring and notifications	Predictive maintenance	Flexible asset-specific planned repairs	Upstreaming and remote resolution
Optimizing field labor	Flexible workforce management	Dynamic dispatch optimization	Next-generation diagnostics	Performance management 2.0
Managing parts	Predictive demand forecasting	Virtual parts depot and real-time inventory	Network and logistics management	Dynamic parts pricing
Delivering superior customer experience	Lead generation and management	Churn and retention management	Digital self-serve applications	Digitized order-to-cash process

makers of heating, ventilation, and air conditioning systems can connect remotely to building-management systems to evaluate the performance of their equipment. By connecting data from meters, sensors, and control panels and adding an AA-driven intelligence layer on top of existing building-management systems, they can continuously monitor and model energy usage and provide recommendations for appropriate energy-saving measures. The IoT specialist Enlighted has taken this approach a step further by using its lighting sensors to identify occupied and unoccupied spaces and offering innovative space-utilization services.

- *Upstreaming and remote resolution.* After identifying issues through remote monitoring, companies can use digital and analytic tools to automate delivery and support services, dispatching field technicians promptly to jobs when they are needed and reducing service-delivery costs and inefficiencies. One company saw demand for simple repairs fall by 17 percent after using technologies such as automated incident-resolution systems to provide remote support for some 23 percent of service calls.

- *Predictive maintenance.* A few companies are taking asset productivity to new levels by

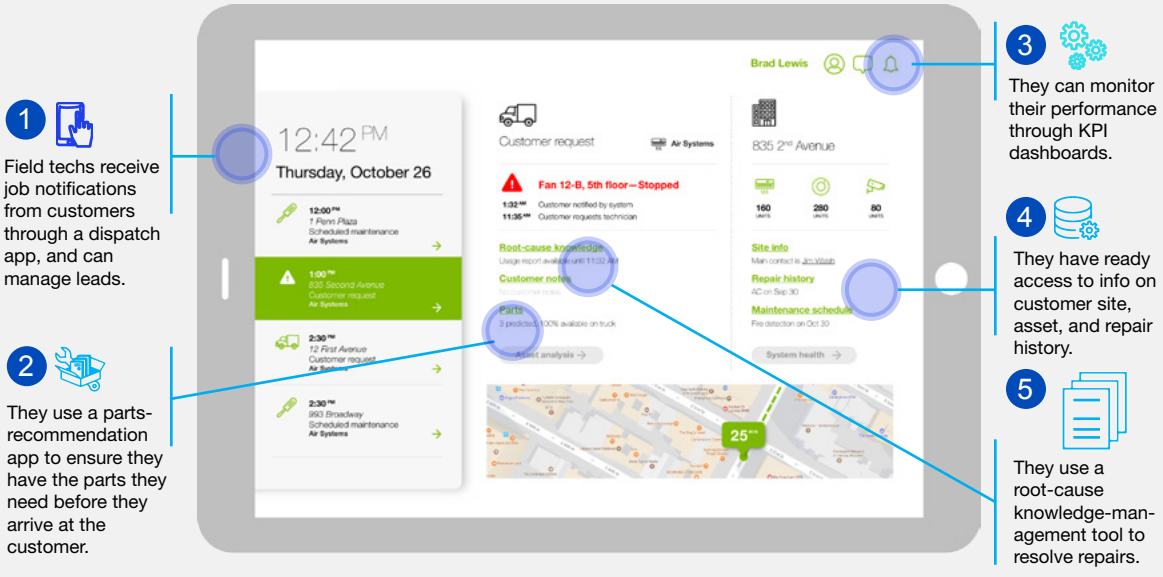
applying advanced analytics to an array of structured, unstructured, machine-based, and nonmachine-based data to predict when and how equipment may fail. They use insights from this process to optimize the time their technical help desk spends resolving issues and to deploy field technicians more efficiently. One oil-and-gas equipment manufacturer reduced downtime from its gas compressor by 70 percent through such an approach.

- *Planned maintenance.* Industrial companies are also using technology to combine repairs that would previously have been performed separately on different schedules. When an asset is down, they use analytics to diagnose other potential problems, allowing the technicians in attendance to perform unscheduled repairs and thereby reduce unplanned demand. Companies are also taking advantage of data and analytics to move from milestone-based maintenance to condition-based maintenance with tailored planned-maintenance schedules.

Optimizing field labor

Although field labor represents the largest share of cost in most service organizations, it is often undermanaged. Companies have little or no visibility into employees' work or schedules, resulting in wasted time, poor service, and lost revenue. In one industrial OEM, we found that more than 40 percent of a typical technician's working day was wasted, with two to three hours of idle time, up to an hour of unnecessary driving time, and one to two hours of avoidable visits. Few companies codify knowledge effectively, and a customer's service experience often depends more on the technician than the company.

EXHIBIT 5 **A one-stop solution helps field techs manage service requests**



Four practices can help companies to optimize field productivity:

- *Flexible workforce management.* To ensure sufficient capacity and enable effective demand forecasting and schedule planning, companies are using digital tools that connect demand and supply in real time. By using digital scheduling tools to seamlessly manage an efficient mix of internal workers and subcontractors, companies can be responsive to customer needs without incurring large fixed costs. One industrial-services company estimates incident rates and service volumes with the help of real-time external data feeds such as weather patterns, then uses this expected demand to schedule appropriate workforce capacity. Another industrial company that introduced flexible scheduling was able to reduce overhead by $35,000 per technician and cut overall technician costs by 50 percent.

- *Dynamic dispatch optimization.* In our experience, field-management systems rarely provide accurate visibility, and job-booking allocations seldom reflect task times. It's not unusual to see more than a third of each day lost through late starts, early finishes, and other unproductive time. By using sensor data and fleet telematics to track technicians' schedules in real time, companies can add 20 to 30 percent to the working day. One leading telecom provider introduced an automated job scheduler that allocates technicians all their jobs for the day and adjusts their schedules dynamically to maximize productive use of time.

- *Next-generation diagnostics.* To perform a robust diagnostic, technicians need the right tools. Ideally, a diagnostic kit would cover model year, repair history, customer questionnaire, suggestions for diagnosis, detailed problem-solving manuals, and lists of parts needed. A mobile one-stop solution like that illustrated in Exhibit 5 can help field techs schedule service requests, check that they have the right parts, and understand the root causes of a breakdown. Some automotive OEMs have begun to diagnose issues remotely using telematics signals sent from vehicles. A central team uses the signals to give technicians a preliminary diagnosis, saving them time and reducing wait time for spare parts.

- *Performance management 2.0.* Robust performance management helps companies pinpoint where service labor needs improvement. By combining optimized scheduling with technology-driven process improvements, they can improve wrench time (the time a technician spends actually performing necessary tasks). One industrial company introduced real-time dashboards with granular data and was able to boost field productivity in its regions by 7 to 20 percent.

Managing parts

A badly managed spare-parts operation can not only hurt revenue but also damage customer satisfaction and loyalty. When a part required for a repair or service isn't available, repair time increases, the customer's experience is poor, and future revenue from that customer may be jeopardized. Getting a part shipped to the repair point causes delay; meanwhile, technicians get reassigned to other tasks and the job goes to the back of the queue, often taking days to complete. When a part isn't essential to a repair or service, not having it in stock could mean the company loses revenue—and upselling and cross-selling opportunities as well—if the customer doesn't return to buy it later.

Companies optimizing parts management tend to focus on four areas:

- *Predictive demand forecasting.* Most demand-management systems still rely on historical sales patterns, but the introduction of technologies

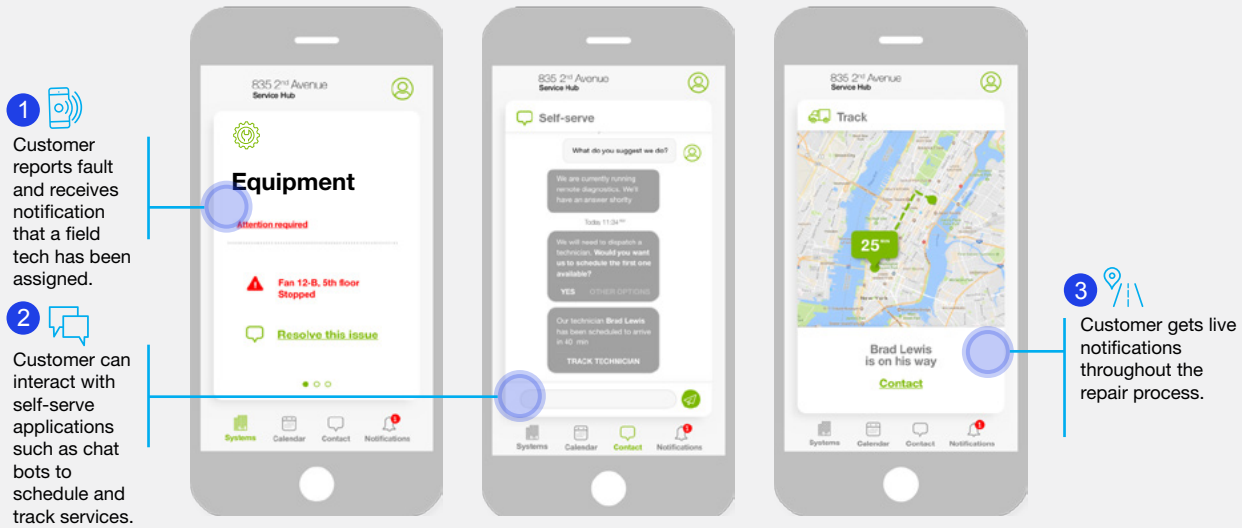
such as radio-frequency identification (RFID) alongside big data and advanced analytics allows companies to move to predictive forecasting instead. By anticipating when an event is likely to happen and predicting what parts will be required when it does, companies can increase first-time fix rates and improve customer satisfaction.

- *Virtual parts depot and real-time inventory.* In a distributed field organization, the sheer size of the installed base and range of potential repair locations makes inventory management challenging. One solution is to convert every technician's truck into a virtual repair location by combining predictive forecasting with a real-time inventory-management system that uses RFID or similar technologies to track the parts carried by each technician. Companies seeking real-time visibility of inventory and data across their network will need to invest in digital tools to keep track of inventory and advanced analytics to support flexible allocation. In one industrials distributor, we found that using analytics to manage stock at the level of SKUs and repair points increased stock-on-shelf by more than 50 percent.

- *Network and logistics management.* Supporting a distributed field organization requires a well-managed fleet, something companies often struggle to achieve. To unlock value, they need to harvest and integrate large sets of granular fleet data—GPS tracking, routing histories, and the like—that often go untouched because of resource constraints or the proliferation of data warehouses. In one industrial OEM, we found that the use of digital and analytics can typically reduce fleet costs by 7 to 12 percent and spare fleet by 10 percent, while improving availability by 5 to 10 percent.

- *Dynamic parts pricing.* Another area where tech enablement helps companies create value from parts management is pricing. Once a robust technology infrastructure is in place, companies

EXHIBIT 6 **A self-serve app gives customers transparency throughout the repair process**



can apply advanced analytics to probe supply and demand at the level of individual parts and introduce dynamic pricing. This involves replacing standard prices with prices tailored to individual customers, locations, and parts or kits based on variables such as price elasticity, competition, product uniqueness, and customer bargaining power. After introducing dynamic pricing, some OEMs have been able to capture pricing improvements approaching 10 percent.

Delivering superior customer experience

Great customer experience comes from delighting the customer at every stage in the service process, not just at one or two touchpoints.

Companies that excel at customer experience use tech-enabled capabilities in three areas in particular.

- *Digital self-service applications.* One of the biggest pain points for industrial customers is an opaque servicing process that leaves them with unanswered questions: What is the problem with their equipment? What caused it, and how can it be prevented in future? What is the breakdown of the service cost? Which stage has servicing reached? When will it be finished? Through a combination of sensors, GPS technology, app-enabled field technicians, and digital check-in and checkout tools, industrial companies can now keep customers informed of progress and any changes to plan through automatic updates. Exhibit 6 illustrates a reimagined customer experience in which digital and mobile tools provide visibility at every step in the service process.

- *Churn and retention management.* As in any industry, it costs much more to acquire a new customer than to retain an old one. By analyzing data across multiple customer touchpoints, industrial companies can predict which customers are at risk of churn and which offers are most likely to help retain them. One industrial company aggregated data from contract, sales, product, and customer records into a data lake, mined it using advanced techniques, and then applied predictive analytics to estimate churn and evaluate the effectiveness of personalized customer offers. This enabled it to introduce a differentiated sales strategy that increased the attach rate for service contracts by 90 percent.

- *Digitized order-to-cash processes.* Accurate and timely billing is critical in servicing, yet few companies do it well. Customers frequently complain about inaccurate billing and unresponsive customer service. Companies can address these challenges by adopting technologies such as robotic process automation to manage tasks across the order-to-cash process.

Getting started

Growing service revenues through technology enablement requires different approaches in different circumstances, but all industrial companies would do well to take a few basic steps:

- *Don't solve complex data problems; find simpler ways to get the data you need.* For companies with disparate systems and a distributed workforce, building a comprehensive, reliable data source is no mean feat. Service data is often unstructured, and integrating data from multiple sources is difficult. Some companies compromise by using partial or observational data. But advanced data-extraction technologies and data lakes now allow companies to build a rich granular database in a matter of weeks, while cheap data storage enables them to store data in any format or volume indefinitely. Thus equipped, they can rapidly analyze granular data at low cost and in a scalable manner.

- *Define technology-enabled service offerings.* Develop a deeper understanding of your end customers' economics at subsegment level across your business units, brands, and revenue and profit pools. Segment service needs and identify where technology could be a key differentiator. Design a service strategy that uses data generated—now or in the future—by the installed base for your equipment. To craft a new value proposition, create technology-enabled offerings for both your customers (such as remote monitoring) and your field technicians (such as digital diagnostic tools).

- *Enhance your digital, analytics, and technology capabilities.* Taking into account your customers' needs and your technicians' pain points, work out which capabilities you require, which you have already, which you need to develop, and how differentiated you are from competitors. Form an integrated view of the capabilities you need, and build them in phases. Look at the broader technology ecosystem, evaluate data and analytics solution providers, and partner with them where necessary.

- *Integrate your commercial strategy across field tech, inside sales, and direct sales channels.* Tailor your sales approach to drive aftermarket sales. Provide incentives for sales teams to drive services as well as OEM projects. Equip sales support staff with analytics tools to help them mine your installed base for leads and drive contract renewals. Reward field technicians for parts revenues and sales leads, and enhance their digital tools so they can easily pass leads on to commercial teams.

- *Balance cost with customer experience using digital tools.* Field technicians usually represent the lion's share of costs and offer the greatest scope for improvement. Develop initiatives such as real-time tracking tools to drive dynamic dispatching, optimize time-and-task and first-time-fix rates, and reduce performance variability through granular analytics. Enhance customer experience by offering more self-help capabilities.

- *Follow a phased approach with a clear roadmap that ties technology to your service strategy.* Adopt a two-speed approach to technology: quickly deploy capabilities that support the customer experience while you work methodically to integrate back-end functions. Rapidly pilot new tools and analytics, and refine your technology roadmap as you go. Schedule the rollout of initiatives, the high-level investment plan, and quick wins. Determine what performance-management mechanisms you need to sustain impact.

The next wave of service transformation is here, and it is being driven by technology. Industrial companies that can fundamentally reimagine service technology as a core component will be well positioned to achieve above-market growth and superior cost position.

[1] See also Aditya Ambadipudi, Alexander Brotschi, Markus Forsgren, et al., "Industrial aftermarket services: Growing the core," McKinsey.com, July 2017.

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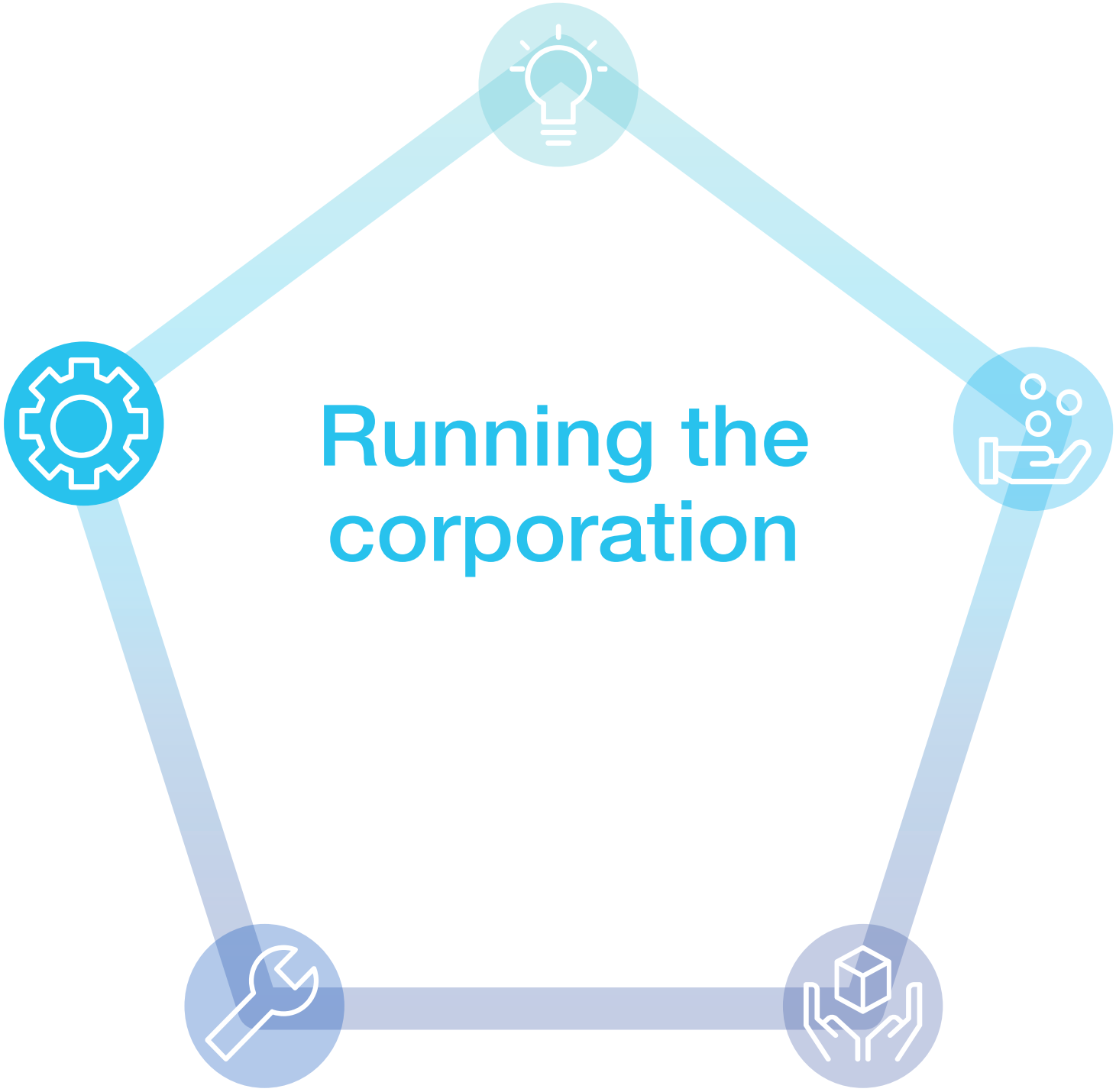

Running the corporation

Photo credit: Getty Images

How bots, algorithms, and artificial intelligence are reshaping the future of corporate support functions

Alexander Edlich, Fanny Ip, and Rob Whiteman

Industrial companies are discovering additional sources of value in applying advanced technology to general and administrative support functions. The results can be impressive for businesses that can adapt to the disruption of legacy systems.

As advanced industrial companies continue to grow, support functions are coming under more and more pressure to deliver value, manage complexity, and reduce cost. Many organizations have already tapped the potential of traditional levers such as centralization, offshoring, and outsourcing. To succeed, today's leaders are turning to digital solutions and automation to improve performance and reduce costs across finance, human resources, and IT.

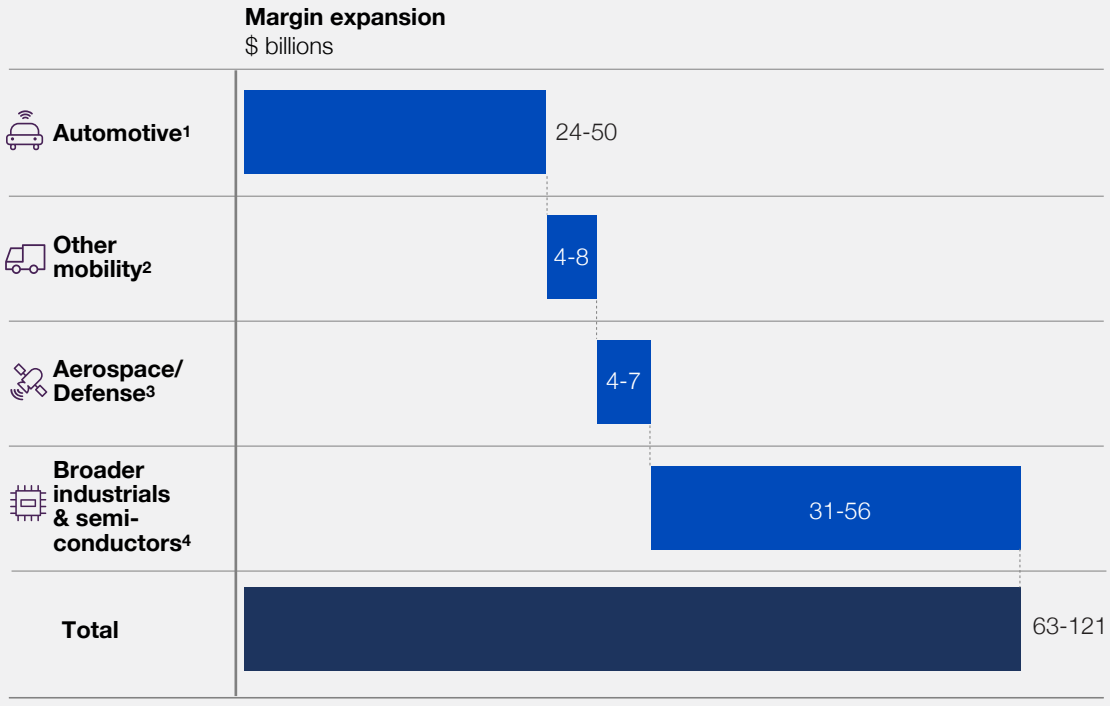
As technologies such as robotic process automation (RPA) mature, an increasing amount of the work done by people will be transferred to bots and algorithms. Our experience shows that companies following a systematic approach to tech-enabled transformation can reap substantial efficiency gains in their general and administrative (G&A) functions. The resources freed up in this way can then be deployed in more valuable activities such as business counseling and scenario analysis. This article explores: the value that can be created through tech enablement in administrative functions; looks at real-life examples from finance, HR, and IT; considers key success factors; and suggests how companies can make the best start on their transformation journeys.

Sources of value

Today's better, faster, and cheaper technology is set to reshape support functions—and will do so without the years of pain often associated with traditional tech initiatives such as enterprise resource planning systems. Early results in other industries show that companies can achieve 5 to 10 percent cost savings in as little as 18 to 24 months, with long-term savings of more than 30 percent.

Across the advanced industrial sector, the median spend on G&A expenses accounts for 4 to 8 percent of revenue. Our estimates indicate that the value that could be created from tech enablement is in the region of $60 to $120 billion globally, albeit with considerable variation between segments (Exhibit 1). Although the direct cost savings may appear small when compared with those in areas such as procurement or manufacturing, McKinsey analysis indicates that a company's ability to deliver productivity improvements in G&A is one of the biggest predictors of its ability to outperform its industry in total returns to shareholders. Approached in the right way, then, automating routine G&A tasks through a tech-enabled transformation can deliver substantial impact to the whole organization.

EXHIBIT 1 **The value from tech enablement in G&A activities varies by industry sub-segment**



[1] Whole value chain including tier 1 suppliers, automotive OEMs, and dealers
[2] Commercial vehicles and off-highway equipment (e.g., for construction and agricultural use) including tier 1 suppliers, equipment manufacturers, and dealers and distributors
[3] Includes tier 1 suppliers and equipment manufacturers
[4] Includes industrials, food processing and handling, motion and controls, industrial automation, and electrical, power, and test equipment across the value chain: component suppliers, equipment manufacturers, distributors, VARs, engineering and services providers, and product companies

Modernizing the finance function

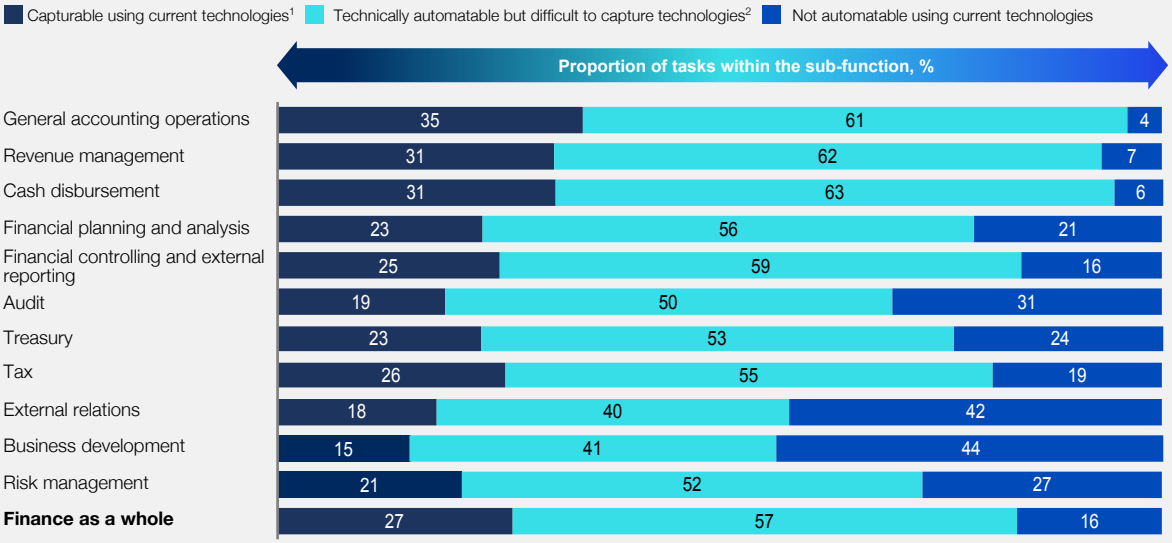
At many organizations, the finance function is beginning to evolve toward a more integrated consultative model that supports value-based decision making. However, companies often have difficulty devoting enough attention to the analysis required to support this model because of the demands of day-to-day transactional activities. The sheer scale of these activities makes them ripe for automation: in fact, our analysis shows that 27 percent of finance activities could be automated using technologies already available (Exhibit 2).[1] About a third of this opportunity could be captured using basic technologies such as robotic process automation (RPA), a type of general-purpose software that can sit on top of existing IT systems. Capturing the remaining two-thirds of the opportunity requires advanced cognitive automation technologies such as machine-learning algorithms and natural-language tools.

At one company that was trying to verify whether employees were reporting vacation time accurately, the internal audit function developed an algorithm that compared declared vacation days with data from badge swipes and computer-usage data. Another company reengineered every part of its record-to-report process by redesigning activities and organizational structures around a portfolio of technologies. Managers introduced RPA for tasks such as preparing journal entries and applied machine learning to reconcile differences between accounting records. Having demonstrated that natural-language tools could be successfully deployed to produce report commentary, the

EXHIBIT 2

Many sub-functions in finance can be automated using current technologies. . .

Potential for automation using proven technologies



[1] Taking into account the relative complexity and expense of different types of automation technology: robotic process automation, machine learning, smart workflows, cognitive agents, and natural-language processing
[2] Because of investment requirements and technological complexity

company has redesigned processes to enable this technology to be introduced later. Overall, the company expects to see cost savings of 35 percent over the next two years from implementing its automation road map.

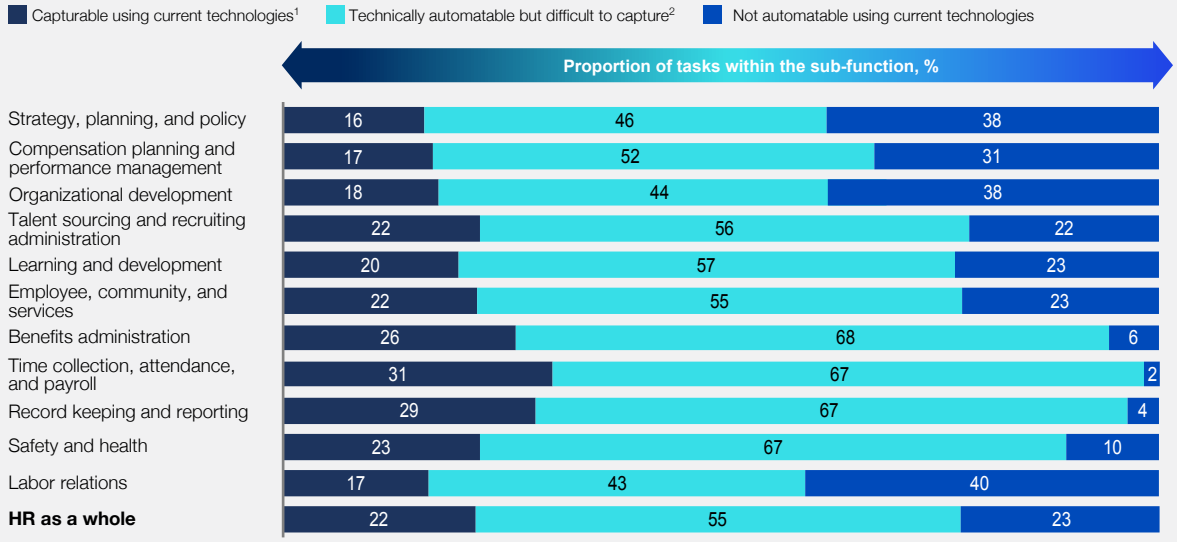
As the finance function becomes the hub for enterprise data, automation efforts need not be limited to finance processes alone. One agricultural equipment manufacturer successfully automated its sales and operations planning process by turning a handful of data scientists loose on financial and operational data managed within the finance function. By introducing machine algorithms into the process, the company not only improved efficiency but also enhanced its ability to react to natural business cycles.

Optimizing workforce deployment (Human Resources)

As expectations evolve, HR needs a tech-enabled transformation of its own. The possibilities are legion (Exhibit 3). Bots can act as a "third arm" for the HR organization by supporting transactional activities such as time collection, payroll, and record keeping. Activities such as talent sourcing offer huge scope for algorithm-based technologies. Meanwhile, conversational AI platforms such as chatbots and cognitive agents are beginning to manage inquiries previously handled by HR service centers including benefits administration and record-keeping activities. Such platforms provide 24/7 coverage and operate alongside the human workforce.

EXHIBIT 3 **. . . as can many sub-functions in HR. . .**

Potential for automation using proven technologies



[1] Taking into account the relative complexity and expense of different types of automation technology: robotic process automation, machine learning, smart workflows, cognitive agents, and natural-language processing
[2] Because of investment requirements and technological complexity

Finally, predictive analytics can be used to improve hiring, retention, and succession planning. One company undergoing a restructuring was trying to identify promising employees to lead its new organization, but found that HR and company data was scattered across the enterprise. Using machine-learning capabilities, the company aggregated demographic, performance, and organizational data to identify the key drivers of employee performance, identify the individuals with the greatest potential, and find roles in which they would succeed. Leaders then transformed the recruiting process to focus on early markers of success and redeploy talent in new roles. These measures enabled the company to achieve improvements of 80 percent in the conversion of new recruits, 26 percent in productivity, and 14 percent in net income.

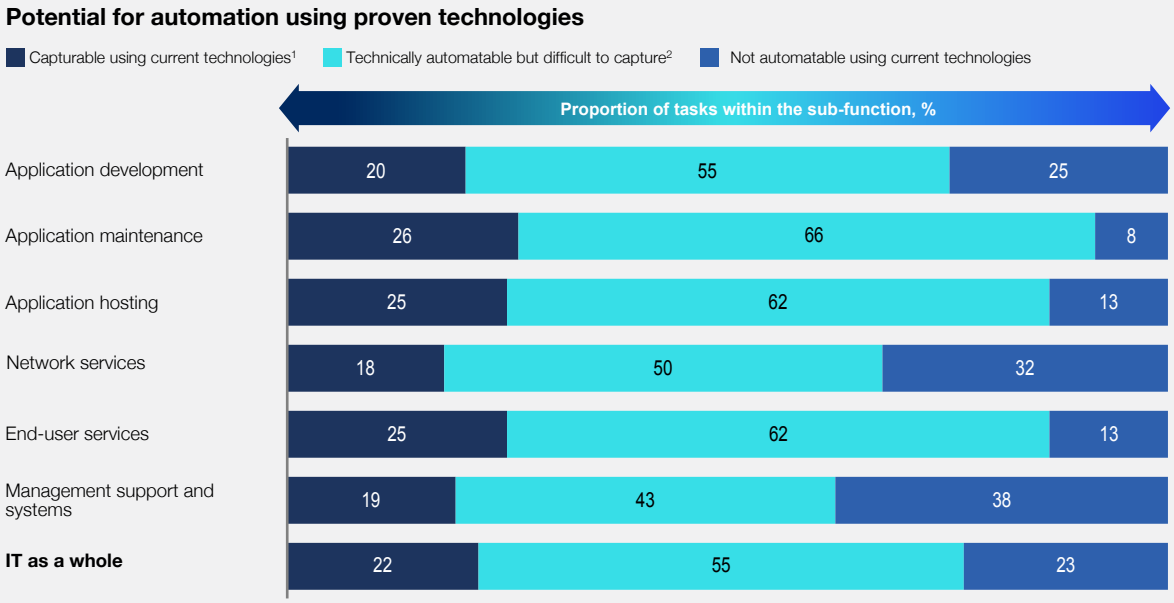
Building a scalable technology backbone

In addition to supporting the deployment of automation technologies in other functions, IT can take advantage of bots and algorithms in its own operations (Exhibit 4). Our analysis shows, for example, that 40 to 80 percent of the basic activities required to resolve service desk tickets can be automated through RPA and related technologies.

When one company analyzed incident tickets, for instance, it found that between 25 and 35 percent of them were requests for "password reset" or "access." To resolve these tickets, it introduced RPA bots that connect with multiple applications via the user interface or application programming interfaces. By adopting automated ticket resolution, the company

EXHIBIT 4

. . . and many sub-functions in IT



[1] Taking into account the relative complexity and expense of different types of automation technology: robotics process automation, machine learning, smart workflows, cognitive agents, and natural-language processing
[2] Because of investment requirements and technological complexity

instantly freed up employee capacity and reduced outsourcing contract costs for helpdesk support, as well as reducing resolution times and improving performance. Alternatively, service desk automation tools exist that support automation of repeatable IT operations workflows such as user provisioning, password resets, and event log monitoring.

Similar use cases exist in areas such as application testing, data migration, and network administration. Automating transactional activities like these can enable IT to free up capital and resources to focus on strategic activities such as modernizing ERP platforms, migrating to the cloud, and developing new digital solutions for the business.

Lessons learned in capturing value

Even the most successful companies face challenges in capturing value from tech-enabled transformations. We have identified a few common keys to success from automation leaders' responses to our recent survey:

Make automation a strategic priority. Organizations whose automation efforts prove successful are more likely than others to have designated automation as a strategic priority.[2] Among advanced industrial companies, about three-quarters of successful automation programs had been prioritized as part of the strategic-planning process.

Deploy automation technologies systematically. Whether companies achieve success through traditional top-down deployment or flexible agile methods, following a systematic rather than ad hoc approach is vital. Our survey found robotic process automation to be the most commonly adopted automation technology. In addition, successful companies were more likely than others to cite the use of advanced technologies such as machine learning, cognitive agents, and natural-language processing to supplement RPA.

Decentralize governance. Traditional transformation efforts tend to follow centralized models, but technology-enablement programs favor decentralized options. In our survey, respondents from successful organizations were more likely than peers to say their functions or business units were accountable for delivering automation efforts, with or without support from a central team. Conversely, less successful organizations were more than twice as likely as successful ones to say a central team had sole responsibility for delivering automation.

Ensure IT is involved. Automation programs stand or fall by the engagement of the IT function. The IT teams at successful organizations are more likely to have automated their own processes and taken part in initial discussions and planning for automation projects prior to the pilot stage. Among advanced industrial companies, 69 percent of successful organizations involved IT early in the automation planning process.

Internalize costs and benefits. Leaders of successful efforts had a deep understanding of the total cost of ownership for automation projects. Across all programs, the most common benefit cited was reduced costs.

Prioritize workforce management. Many large organizations predict their companies will face automation-related skill gaps in the future; successful organizations make addressing this gap one of their top five priorities. They also agree that acquiring employees with the right skills is their biggest automation-related challenge in the next three years.

How to get started

A tech-enabled G&A transformation journey typically involves three phases: start-up, launch, and scale.

Start-up

In this first phase, a company typically tackles:

Assessment and roadmap. To decide which sub-functions, processes, and locations will benefit most from tech-enabled transformation, start with a clear understanding of your organization and the activities it performs. Assess the potential for automation by combining top-down analysis with task-by-task validation, then use your findings to inform decisions about which technologies to invest in and where to deploy resources. Finally, translate all this into a roadmap to guide your program.

Proof of concept. To demonstrate feasibility and potential for impact, build a practical application such as a simple bot or algorithm in weeks, not months. This gives you early experience with technology and a chance to create presentations, videos, and other communications to generate excitement for your broader program.

Vendor selection. Selecting the right technologies to support your transformation is a balancing act between maintaining a simple architecture and maximizing impact. Most companies start with an RPA platform and add complementary technologies such as business-process management or optical character recognition within the first three to six months. More complex automation tools, such as natural-language processing, are typically added after about a year. Emerging technologies, such as cognitive agents, are usually confined to pilots during the early stages of a transformation.

Launch

Areas of focus in the launch phase usually include:

Domain sprints. Companies typically build solutions through multiple rapid, intense working sessions or sprints. A sprint usually consists of five or six use cases relating to a specific "domain": a sub-function, process, or location. Sprints employ agile methods and follow standard IT phases from preparation and design through to build, test, and refine.

IT support. Even when sprints are led by other functions, involving IT early is critical to securing the right infrastructure and environment and standardizing processes for deployment and maintenance. Successful leaders establish clear lines of accountability between functions, automation resources, and IT support groups to avoid confusion.

Center of excellence (CoE). Most companies choose to set up a tech-enablement CoE to provide governance, build capabilities, and maintain assets. This will typically follow a centralized model initially with some development capacity embedded in functions, before moving to a federated model as the transformation matures.

Scale

In the last phase, transformations typically complete:

Additional sprints. Once you have conducted a few sprints, it's time to scale up systematically and rapidly deploy technologies in further sprints. As each new process is deployed, maintenance and support teams can resolve issues and manage changes while continuing to refine their support model.

CoE scale-up. The speed at which you scale up your CoE depends on the number of opportunities in your pipeline. As your program scales, the CoE's interaction model with other teams will evolve to shift more responsibilities to the business, and in turn the business will start to undergo a culture shift with employees seeing technology as a source of support, not competition. Ongoing capability-building and change- management efforts will help to build support for the new way of working.

Fueled by the promise of productivity gains, technology-enabled transformations are beginning to reshape the future of work in support functions. Bots and algorithms are already at work alongside humans, but adapting to the disruption can be challenging even for an industry familiar with physical automation. Even so, advanced industries are well positioned to capitalize on lessons from other industries that are further ahead in the journey, such as banking, while capitalizing on internal capabilities already embedded in the organization, such as lean. ■

[1] For details of the analysis, see Frank Plaschke, Ishaan Seth, and Rob Whiteman, "Bots, algorithms, and the future of the finance function," McKinsey & Company, January 2018.

[2] "The automation imperative," McKinsey & Company, September 2018.

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Our capabilities

McKinsey has built up a significant track record of driving impact across industrial companies to transform their businesses and take advantage of the value from technology offers. Notably our experience of 200+ digital and automation engagements in the last 3 years has spanned the entire industrial value chain—from suppliers in industrials to larger OEMs—providing us with a unique understanding of how to manage the dependencies and complexities of a successful tech-enabled transformation.

We have developed a holistic set of use cases and tools to help our clients do three things: 1) rapidly identify the value from technology across a range of industrial companies; 2) deploy the relevant technologies in an agile manner; and 3) manage the change and build capabilities to realize and sustain the impact.

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