Digital Manufacturing
Capturing sustainable impact at scale

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Contents

Introduction

The combined impact of digital connectivity, advanced analytics, artificial intelligence, and new cyber-physical systems on the value chain goes by many names. However, whether titled "Industry 4.0," "Industrial IoT" or, as we use in this report, "Digital Manufacturing," expectations remain high around the benefits these disruptive technologies will create for manufacturers and technology providers.

Many companies are embarking on the journey to integrate digital and production, but approaches to capturing value differ significantly. A few companies have gained senior management attention and committed significant resources to driving progress systemically, including the creation of "lighthouse" facilities as a test bed and future showcase for a range of solutions. The majority, however, seem to be adopting more of an incremental approach, with individual plants or business units selecting pilots in a less coordinated manner. Irrespective of the approaches they have taken, we see many companies now asking, "What comes next? How do we scale up from individual pilots to sustainable impact throughout our entire organization?".

To better understand the different approaches being taken and how progress differs across geographies and sectors, McKinsey has conducted its third Digital Manufacturing Global Expert Survey. In the first part of this publication we draw upon the survey's results to examine how sentiment regarding the potential of, and challenges associated with, Digital Manufacturing is evolving, as well as to look at the different approaches companies are taking to capture value.

In the second part of this publication we build on these insights – along with selected case studies and our own experience from client work – to lay out the three principles of a Digital Manufacturing transformation:

- **"Diagnosis to design,"** i.e., identifying levers to boost operational performance, defining new manufacturing strategies, and designing the target Digital Manufacturing ecosystem.

- **"Data/technology to impact,"** i.e., capturing value from data analytics, superior performance management, and new technology applications.

- **"Capabilities to transformation,"** i.e., transforming the entire organization and building institutional capabilities.

Part 1: Findings from the Digital Manufacturing Global Expert Survey 2017

In the following chapters, we examine the results from the third edition of our Digital Manufacturing Global Expert Survey which was conducted in Q1, 2017. Engaging a panel of 400 industry experts in China, Germany, Japan, and the US, the survey focused on potential changes in attitudes towards progress made in implementation, implementation drivers and barriers, and organizational approaches to scaling impact from disruptive technologies in manufacturing (Text box 1).

Text box 1: Survey respondent profile and key results

Highlights of the respondent profile:

- More than 400 respondents from different companies participated in this year's survey. Besides Germany, the US, and Japan, respondents from China were included in order to reflect trends in emerging markets. Experts surveyed were split evenly across the US, Germany, Japan, and China, representing companies of all sizes (but with at least 50 employees).
- Both technology suppliers and manufacturers are represented in the survey, but the majority of respondents are from manufacturers (63%).
- The experts who participated in the survey came from the following industries: automotive OEM, automotive supplier, chemicals, consumer goods, healthcare, industrial automation, mechanical engineering, paper and packaging, plant engineering, semiconductors, software, and transport and logistics.
- Overall, 80% of survey participants were male. The highest representation of women was in China (31%) and the lowest was in Japan (6%). More than half of all participants were between 20 and 40. People over 40 comprised 46% of the respondent pool, whereas people over 50 represented only 21%.

The survey's key findings are:

- Optimism that the potential of Digital Manufacturing is growing:
    - Survey respondents expect >10% cost reduction and 10% increased revenue potential over the next three years, due to Digital Manufacturing.
    - Labor and yield productivity are the most important factors – up to 40% of respondents expect cost improvements to come from greater labor and machine productivity; up to 20% expect yield improvements to be the biggest benefit.
- Companies are piloting solutions, but rollouts are still limited:
    - Although more than 60% of all respondents report having run pilots of selected Digital Manufacturing solutions, only 30% of respondents report being in the rollout stage for any of the selected solutions.

- Companies and industries focus on different types of use cases to pilot. While, for example, approximately 30 to 35% of mechanical engineering and batch industry companies have been piloting efficiency use cases (e.g., digital performance management), just 20 to 25% pilot innovation use cases (e.g., in situ 3D printing); on the other hand, plant engineering and automation companies focus on piloting both efficiency and innovation use cases to almost the same extent (approximately 35 to 40%).

- The majority of companies still face significant challenges for their transformations:
  - While approximately 40% of respondents report having a clear view on the Digital Manufacturing use cases that will create value for them, only 30% of overall respondents report having a structured road map for how to pilot, roll out, and scale those use cases.
  - The two big challenges for companies are: attraction, management and retention of talent (21% of all respondents), and concerns with regard to data management and security (18% of all respondents).

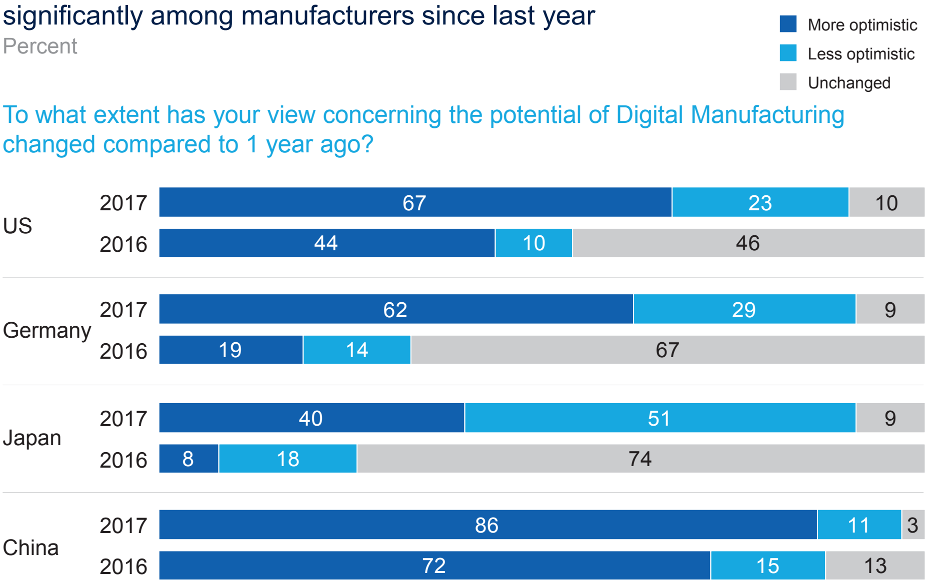
Optimism concerning the potential of Digital Manufacturing continues to grow

The buzz around Digital Manufacturing continues with respondents from all four countries showing a higher degree of optimism than one year ago (Exhibit 1). In China, Germany, and the US, over 60% of respondents are more optimistic regarding the potential of Digital Manufacturing – with a particular surge in China, where more than 80% of respondents are more optimistic. In Japan, only 40% are more optimistic, but it should be noted that in last year's survey the comparable metric was 8%. The main reasons for this global optimism are cited as: greater opportunities than initially expected (cf. Appendix I, Exhibit 8); higher RoI on these opportunities; and less difficulty in capturing this value.

Exhibit 1

Optimism regarding the value of Digital Manufacturing has grown significantly among manufacturers since last year

Percent



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Respondents from the US, Germany, and China expect this potential to translate into double digit revenue and cost improvements over the next three years, although respondents from Japan are more cautious. Increases in machine and labor productivity, delivery performance, and the customer base are some of the more common drivers of improved financial performance. Additionally, significant numbers of respondents also cite reductions in input costs, improved quality, decreased maintenance costs, and lower working capital as important factors behind Digital Manufacturing's performance-improvement potential.

Companies are piloting a broad range of solutions, but extensive rollouts are still limited in number

As companies deploy Digital Manufacturing solutions, most are pursuing multiple use cases. The most common of these, irrespective of geography and industry sector, address quality, performance management, process control, and remote monitoring (Exhibit 2).

Exhibit 2 Adoption of digital quality and performance management and statistical process control has progressed furthest

Percent

What stage are you at regarding adopting specific Digital Manufacturing use cases at your company?

	Use case relevant to company (rollout, pilot, or strategic discussions with thought partners initiated)	**Share of companies in rollout** (out of companies where lever is relevant)
Digital quality management	79	29
Digital performance management	78	33
Statistical process control	78	33
Remote monitoring and control	75	31
Real-time yield optimization	73	26
Predictive maintenance	71	24
Smart energy consumption	67	17
Real-time supply chain optimization	63	22
Human-robot collaboration	62	23
In-situ 3D printing	61	25

SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Beyond these most pervasive solutions, other Digital Manufacturing levers show a more diversified picture across sectors and countries. For example, in situ 3D printing seems more common in China and Germany than in Japan or the US. While one in three respondents from the transport and logistics sector and the plant engineering and automation sector have already initiated pilots, most respondents from the automotive industry, process industries, and software and semiconductor sectors do not consider 3D printing to be relevant for them. Meanwhile, real-time supply chain optimization is seen as highly relevant for automotive and batch industries (including consumer goods and healthcare) but much less so for mechanical engineering companies.

What is also notable, though, is that even among those who state that a particular use case is relevant to their companies, less than one third report rolling out that use case in their company (regarding details concerning the criteria for evaluating the implementation status of use cases see Appendix II, Exhibit 10).

Achieving the next level of operating efficiency is the primary goal of Digital Manufacturing, but business model innovation is also an important outcome

Across industry clusters, respondents are piloting a mix of use-case types (Exhibit 3). On the one hand, we find respondents who focus more on levers for efficiency gains (e.g., digital quality and performance management or remote monitoring). These levers primarily facilitate cost reduction and lead time improvements – and therefore enable companies to make fundamental improvements. Mechanical engineering or batch industries, for example, have a stronger focus on these use cases than use cases fostering innovation (one in three companies pilot efficiency use cases as opposed to one in four or five that pilot innovation use cases).

Exhibit 3 Across industry clusters, companies are piloting a mix of use-case types

Percent

	Pilots of efficiency use cases[1]	Pilots of innovation use cases[2]
Automotive	28	25
Batch industries	29	22
Mechanical engineering	34	25
Plant engineering/ automation	37	35
Process industries	31	29
Software/ semiconductors	30	25
Transportation/ logistics	32	29

1 Including digital quality and performance management; remote monitoring; yield optimization; statistical process control; predictive maintenance; and smart energy consumption
2 Including in situ 3D printing; human-robot collaboration; and real-time supply chain optimization

SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

On the other hand, we see respondents who focus on both piloting efficiency use cases and selectively applying innovation levers, such as in situ 3D printing or real-time supply chain optimization. These levers support innovations in products and services and help companies to increase their customer base. An example of this is the industry cluster plant engineering and automation, where more than 35% of respondents report pilots for both of the two clusters.

The majority of companies still need to overcome several challenges before they can start achieving impact at scale

Achieving impact at scale remains a major challenge for the vast majority of respondents. While approximately 40% of respondents report having a clear view on the Digital Manufacturing use cases that will create value for them, only 30% of overall respondents report having a structured road map for how to pilot, roll out, and scale those use cases. Similarly, less than 30% of overall respondents say they have moved beyond pilots for one or more Digital Manufacturing levers.

Respondents cite that they face major challenges in two areas (Exhibit 4):

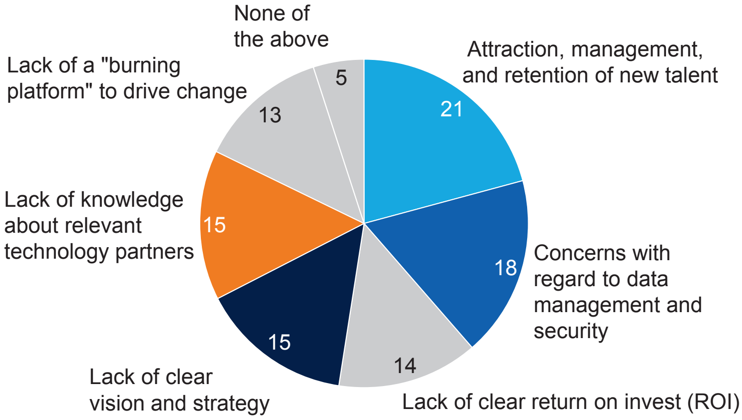
- **"New talent,"** with attracting, managing, and retaining the right talent being the biggest issues.
- **"Data management and security,"** particularly in relation to capturing and aggregating disparate data sources, the ability to analyze large amounts of data, and – notably in Germany – concerns over data ownership when working with third parties. Cybersecurity remains a concern, but seems less of a constraint than capturing value from available data.

Exhibit 4

Challenges concerning talent development and data management are the biggest obstacles to implementing Digital Manufacturing

Percent

What are the biggest obstacles your company is facing when it comes to implementing Digital Manufacturing solutions?



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

The rate of companies' progress on their Digital Manufacturing journey varies by country

Analysis of the survey results suggests that there is no strong correlation between a company's reported progress on the Digital Manufacturing journey and its industry sector. However, there are indications that certain countries are seeing accelerated deployment and value capture (Exhibits 5 and 6).

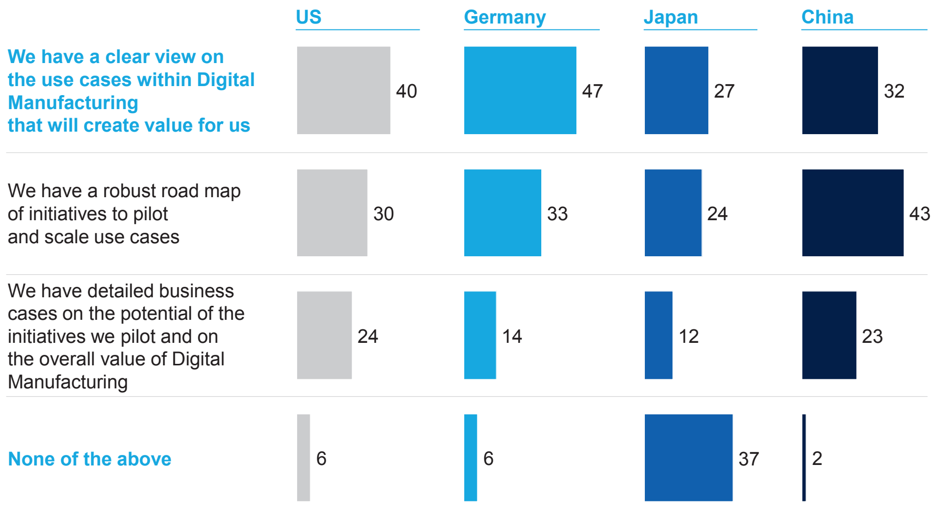
For example, 75% of respondents from Chinese companies cite that they have a clear road map or explicit targets – a significant number. By contrast, only 50% of Japanese respondents report this level of progress – and 37% say their companies have neither a clear view on use cases, nor a Digital Manufacturing road map or associated business cases. In addition, many companies have not set explicit targets for the value they expect to generate from Digital Manufacturing. Along similar lines, Chinese respondents indicate that many formal, corporate level programs have been launched with dedicated resources and funding, which does not appear to be the case in Japan.

Exhibit 5

Almost half of Japanese respondents don't see where their companies are heading with Digital Manufacturing

Percent

Which of the following statements hold true for your company?



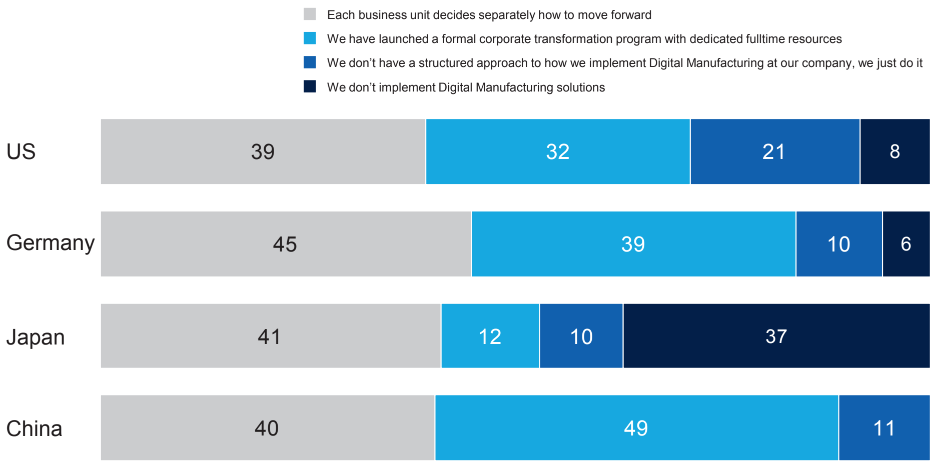
SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Exhibit 6

The US, China and Germany split evenly between corporate programs and rollouts driven by business units

Percent

Which one of the following statements best fits your company in terms of rolling out and implementing Digital Manufacturing?



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Part 2: Three principles for accelerating sustainable impact at scale

The results of our Digital Manufacturing Global Expert Survey clearly indicate that the majority of companies are still struggling with bridging the gap and moving on from piloting point solutions to delivering sustainable impact at scale. Success stories for capturing sustainable impact at scale are still only few and far between.

What can be learned from our client experiences and industry observations (see, for example, Text box 2) is that success requires a focus on three principles of transformation: “diagnosis to design,” “data/technology to impact,” and “capabilities to transformation” (Exhibit 7). In the following, we describe these three principles and discuss the associated activities that give companies the best chance at a successful Digital Manufacturing transformation.

Exhibit 7

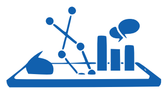
Focusing on 3 principles is essential for ensuring a successful Digital Manufacturing transformation

Success factors for each principle

“Diagnosis to design”

Focus on company perspective in order to identify use cases to boost operations and design the target digital ecosystem

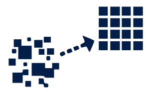
1. Clear perspective on how and where digital will create bottom-line value
2. Multihorizon road map



“Data/technology to impact”

Capture value from Digital Manufacturing use cases

3. Ecosystem of technology partners that are sensitive to cybersecurity
4. Agile approach to developing, piloting, and refining digital solutions
5. Rigorous change management



“Capabilities to transformation”

Create impact by transforming the entire organization and build institutional capabilities

6. Active C-suite sponsorship
7. Adaptation of business processes for a digital world
8. Plan for how to access capabilities needed to develop and implement use cases

SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

“Diagnosis to design”

This principle focuses on identifying the most relevant and impactful levers for boosting operational performance, defining new manufacturing strategies, and designing the target Digital Manufacturing ecosystem. Two success factors are critical here:

1. Forming a clear perspective on how and where digital will create bottomline value, linked to a clear RoI. Which digital use cases will be most relevant and impactful will vary by company and be driven by that company’s industry sector, operating model, competitive context, and operational maturity. It is therefore critical that each company completes its own diagnostic of the most important levers to drive bottomline value, determining how much value can be unlocked and the investment required to do so.

For example, a US-based consumer health company focuses on a dual pronged approach driving the strategy development and at the same time piloting high-value use cases in their sites. The company has identified more than 50 relevant use cases of which the top 10 drive the majority of the value creation over the next few years. For deployment they are training a central team to do digital site diagnostics to tailor each site implementation to its strategic needs and starting situation.

The survey also shows us, however, that there is still a lot to do. Less than 20% of respondents report having detailed business cases on the potential of the use cases their companies want to pilot.

2. Developing a multihorizon road map. It will take time to deploy high-priority use cases across a network of plants, and companies need to think in terms of operational horizons to create a clear path to impact that takes into account a company's digital manufacturing strategy, implementation timelines and critical technological enablers (such as connecting machines and creating data lakes), and, ideally, creates a self-funding program.

This is not to say, however, that this prioritization is a one-off activity – the pace of technological evolution is such that any road map should be revisited every three to six months and revised using lessons learned from pilots. A desire for perfection should not be allowed to get in the way of pragmatic decision making and forward movement. Compared to last year, there has been an increase in the number of companies with a clear strategy and road map for implementing Digital Manufacturing, with 50% of respondents reporting having a clear road map (up from 20% to 30% in 2016). Nevertheless, 15% still report a lack of a clear vision and strategy as one of the biggest obstacles to their transformation.

A good example of how companies can approach rollout is a mid-sized (less than 20,000 employees) Asia-headquartered automotive supplier. This company has selected a single plant where appropriate solutions with clear business cases are developed and tested before rollout across plants. To gain momentum, their lighthouse plant chooses to involve external providers as early as the design phase and begin short pilots wherever applicable.

Text box 2: Industry example of how to successfully transform a company into a "connected enterprise"

The product mix of global industrial automation players can typically be described as "high mix, low volume" and customer demand is extremely hard to forecast. In 2012, Rockwell Automation had almost 400,000 stockable SKUs and limited integration between information technology (IT) and operational technology (OT). The US-headquartered company faced challenges in achieving delivery performance, productivity, quality control, and inventory management targets. In addition, the company needed to adapt its global footprint to better match demand and was undertaking a consolidation of its nine existing ERP systems into one.

The company chose to address these challenges by driving standardization of its manufacturing execution systems (MES) and associated operational management processes. Here is an overview of the key transformation steps derived from the three principles of transformation introduced earlier on (cf. Exhibit 7):

“Identifying use cases to boost operational performance and design the target Digital Manufacturing ecosystem”

To begin its transformation journey, the company created a high-level business case and road map with three streams – technology, process, and people – in order to drive sustainable impact. The effort was led by operations executives, but with close ties to the IT organization: a core team of subject matter experts from both operations and IT was established.

“Capturing value from Digital Manufacturing use cases”

A manufacturing campus in Mexico, with a representative mix of operation types and products, was chosen as the pilot site to both test the approach and create a show-case for other plant leaders to visit. Implementation drove substantial improvements in quality, customer service, productivity, and available capacity. Central to this was a focus on change management to build an understanding across the campus of the new technology and processes.

“Creating impact by transforming the entire organization and building institutional capabilities”

As the focus moved to the rollout, a team of global process owners was created to drive the effort, develop a standardized implementation playbook, facilitate the internal sharing and integration of lessons learned, lead audit implementation, and manage and monitor an enterprise-wide focus on identified critical business issues, best practices, and innovations. This team was drawn from leading global subject matter experts and is largely remote, as members remain in their home geography.

Given resource constraints, scaling up the impact beyond the pilot plant required a staged rollout. Rockwell Automation thinks of its operations as approximately 450 manufacturing cells. In some cases transformations were sitewide, but in others the focus was on specific manufacturing cells where the need was the greatest and the potential RoI the highest. To enable organizational agility and drive the transformation, control of manufacturing capital was moved from individual plants to a central group. To date, over 400 cells have been transformed and the company aims to complete more – however, only those cells where a clear business case exists.

“Data/technology to impact”

Once a multihorizon road map is in place, the “real work” of capturing value must begin – with a focus on sustainably implementing new technologies and ensuring benefits flow to the bottom line. Three success factors are critical here:

3. Building an ecosystem of technology partners. The nature and breadth of Digital Manufacturing solutions means that companies will be unable to capture the full potential benefit by developing solutions in-house or relying on a single technology vendor alone. Manufacturers will rather need to develop an ecosystem of technology partners who can support them in their efforts (while also ensuring adequate cyber-security is in place). These technology partners will likely focus on both upgrading the IT/OT infrastructure to support high value use cases, and developing specific solutions for the use cases themselves. Many countries are seeing the development of consortia or public-private partnerships that are bringing together manufacturers, large technology suppliers, and smaller technology-based start-ups. For example, in the US the Digital Manufacturing and Design Innovation Institute (DMDII) has established an ecosystem of more than 50 technology providers, through which manufacturers can stay abreast of the latest Digital Manufacturing use cases and solutions. Another company, a German technology group, focuses on an approach where its plants individually cooperate with different start-ups and universities who are invited to test and refine innovations at their sites.

Our survey respondents also think that cooperation is key for identifying valuable use cases and driving implementation – they either foster exchange with players within the industry (mostly Germany: 23%) or work with research institutes (mostly China: 27%) or consulting companies (mostly Japan: 33%); only one in ten report collaborations with start-ups, universities and/or players outside the industry.

4. Adopting an agile approach to developing, piloting, and refining Digital Manufacturing solutions. As digital disrupted industries such as financial services, we saw many companies leveraging agile methodology to rapidly develop and test new applications and solutions. We expect the same approach to yield benefits in manufacturing, particularly in relation to solutions that focus on improving labor productivity and performance transparency rather than transforming the core manufacturing process. A global mining player, for example, uses a two-week "agile sprint" methodology to develop minimum viable products (MVP) for specific use cases, such as predictive maintenance or workforce planning. These MVPs are rapidly deployed and tested at a pilot site. The company continues to refine the solutions and typically requires five to six further releases to achieve a "minimum mature product" that can be rolled out across a broader set of sites.

5. Fully engaging the workforce to ensure successful adoption and change management. While Digital Manufacturing innovations and solutions are technology-driven, it is critical to remember that value capture relies on full adoption by the workforce. Change management is therefore critical. Employees need to understand why new ways of working are beneficial, and those benefits need to be consistent with financial incentives. Training for using the new tools needs to be provided, and leaders need to be role models for new ways of behaving. For example, the global mining company mentioned above has established a user council comprised of frontline operators and supervisors to provide feedback on early versions of solutions, and uses these to both inform product development and gain acceptance. Other companies are creating showcase facilities (the "lighthouses" described earlier) where cutting-edge solutions are implemented in an integrated manner to demonstrate to operational leaders through the "art of the possible" that fundamental change is relevant and practical.

"Capabilities to transformation"

Capturing and sustaining the full potential from technological disruption in manufacturing requires companies to embark on a transformation that stretches across, and indeed beyond, all aspects of the manufacturing process. In this context, we consider three success factors as critical to achieving sustainable impact at scale:

6. Ensuring active C-suite sponsorship – and that the success of the transformation is wired into individual KPIs. Companies have different options for placing responsibility for leading their Digital Manufacturing transformation. Some choose to have operations drive the effort, others look to technology, while a third group opts for the creation of a new chief digital officer role. Similarly, company context and culture will inform whether a more centralized approach is better, or if each business unit should drive its own transformation. Clearly, there are pros and cons to each model/approach, yet in our view there are also three nonnegotiable elements:

- **The effort must be driven from the very top of a company –** it will not work if it is a mid-level technology project.
- **The leader must have the power to bridge functional silos** and also integrate the project across information and operational technology (IT/OT).
- **Success must be wired into individual and organizational incentives** to ensure alignment and motivation.

The survey results are in line with our perspective: compared to last year, there has been a clear shift of responsibility from CIO and business unit level to the CEO/C level in the organization – with shares of 27% (US) and 26% (Germany) this year compared to last year's 21% (US) and 19% (Germany). Having a distinct CDO role is also a growing trend; in China nearly one in five companies reports having a CDO; in the other countries this is the case for approximately one in ten – which still, however, represents an increase over last year. Japan mostly focuses on the individual responsibility of business unit heads (cf. Appendix I, Exhibit 9).

An international mining company that is leveraging Digital Manufacturing solutions and agile principles to improve their operations provides an example of how to embrace C-suite sponsorship successfully. The company's CEO mandated Digital Manufacturing as a priority for the company and created a clear vision of a digital reinvention. He also created a CDO role within the executive leadership team and an investment committee to make funding decisions. With strong C-level support, the company has embarked on a companywide digital transformation. Dedicated resources are assigned to the program to set up an organization, including new roles and responsibilities to drive and sustain the change. The CDO role was created as the owner of all digital solutions and is responsible for driving operational improvements. Owners of digital solutions directly report to the CDO, which allows for fast decision making and escalation and enables rapid transformation progress. To achieve further impact and create a fully digital enterprise, the CDO's responsibilities will be further increased to connect different areas and disciplines in the long term.

7. Adapting business processes so that they match the digital world. Achieving a Digital Manufacturing transformation also requires companies to adapt their business processes to a more dynamic and, to some extent, more uncertain environment. This will not be a journey where all the details of a road map and business case will be known upfront, and so funding and resource allocation processes need to be much more agile than the typical annual cycle. Several companies are adopting more of a venture capital style approach to funding, with initial “seed funding” for good ideas and then stage gates for releasing additional funds. These approaches need to be coupled with robust value assurance processes to ensure operational improvement translates into bottom-line financial value in order to sustain impact and generate returns.

For example, a European automotive supplier mimics the American venture capital TV show “Shark Tank” and organizes “innovation nights” to which selected technology start-ups are invited. These start-ups then have time for a 3-minute pitch on their technology and idea, and in some cases have 12 hours to install their solutions and present how they work. If a promising use case is identified, the respective start-up is given the chance to pilot (and potentially scale) the use case for real; this allows the auto supplier to rapidly identify and test new innovations, and cultivates and institutionalizes a culture of innovation, as described earlier.

Procurement functions may also need to evolve to be better able to interact with technology start-ups unused to working with the requirements of large corporations. They may also need different payment terms to retain liquidity. Similarly, IT functions typically need to improve their ability to more rapidly integrate third-party solutions without compromising cybersecurity.

8. Developing a talent and capability management plan. In order to scale up not only quickly but also sustainably, companies need to think more about how they plan to build the capabilities needed to develop and implement new technologies. The exact capabilities required and optimal approach will depend on the nature of the Digital Manufacturing use cases adopted, and whether solutions are purchased from technology vendors or developed in-house. However, they are almost certain to include raising organizational capability around IT/OT convergence, data analytics, advanced robotics, and agile solution development.

Given the dynamic nature of this transformation, some companies may choose to adopt a “let a thousand flowers bloom” approach and test multiple operating models before selecting the best. For example, a European technology producer established a model in one of its German plants where IT/OT capabilities were drawn from the corporate IT team on an as-needed basis, and relied on technology start-ups to provide analytical skills at a plant level.

However, in a French plant the company decided to build all of the required capabilities in-house – with a local and decentralized advanced analytics and programming unit on the shop floor and functional skills established with the working crew on an as-needed basis. Elsewhere, a global tool producer created a global Center of Excellence to house a small team whose responsibility it is to remain on the cutting-edge of new technologies, such as automation and additive manufacturing, and steer the business towards relevant use cases. While some institutional capabilities will be filled through partnering or recruitment, others will need to be filled by building capability in the existing workforce. The survey shows that talent attraction, management, and retention remains the biggest obstacle (21% of all respondents) for companies during transformations, regardless of location.

Outlook

The 2017 Global Expert Survey reveals interesting realities about Digital Manufacturing. On the one hand, manufacturing companies around the world are increasingly optimistic about integrating digital and production, and the overwhelming majority have identified use cases that are relevant to them. On the other hand, a relatively small number of these companies have made sufficient progress towards implementation. With a focus on design, data, and capabilities, these companies can close the gap between awareness and action and position themselves for the efficiency gains and/or differentiation-by-innovation that come with Digital Manufacturing.

What's more, "getting your hands dirty" by kicking off the digital transformation in your company and testing the first prospective applications of digital manufacturing does not require long preparation or a large up-front investment. Simply jumping in and getting started holds the benefit of producing early results and helping your company make quick progress on its journey to becoming an organization that embraces the full potential of digital manufacturing.

What are you waiting for?

Appendix

I. Further findings from the McKinsey Digital Manufacturing Global Expert Survey 2017

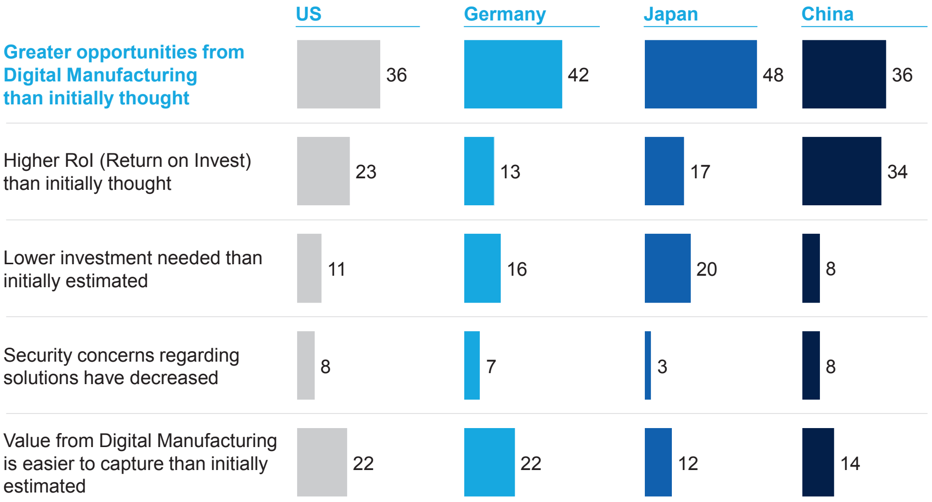
The survey included 28 questions on Digital Manufacturing. Since not all the results could be explicitly mentioned in the report, Exhibits 8 and 9 provide some additional important detail.

Exhibit 8

Respondents from all countries see greater opportunities from Digital Manufacturing than initially thought

Percent

Why are you more optimistic about the potential than a year ago? Please select all that apply



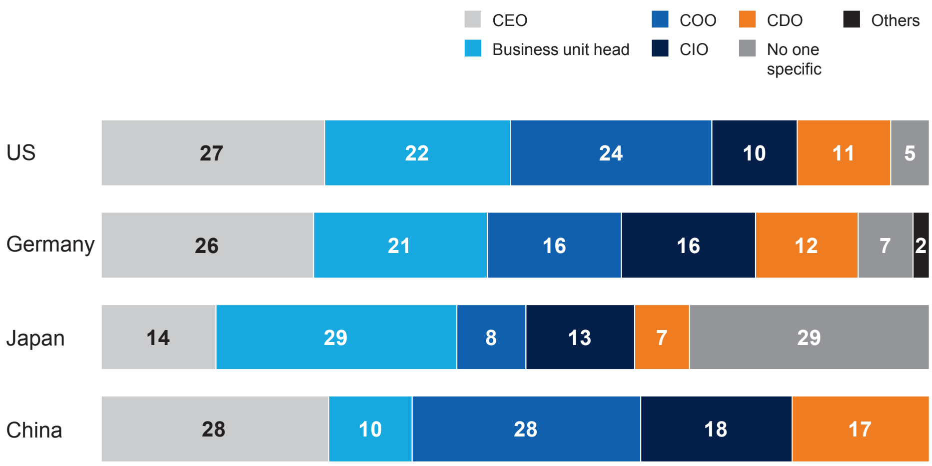
SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Exhibit 9

CEOs are most often tasked with Digital Manufacturing – except in Japan

Percent

Who is mainly responsible for driving the Digital Manufacturing strategy at your company?



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

II. Overview of the criteria for evaluating the implementation status of use cases about which respondents were queried

Exhibit 10

The survey asked respondents about their implementation status for 10 Digital Manufacturing use cases

Smart energy consumption: using real-time information, machines are automatically shut off during breaks or downtime to save energy

Real-time yield optimization: sensors constantly measure all KPIs. This includes automated statistical analysis and a direct feedback loop to the machine, input-output optimization, optimization of formulations, mass-balance optimization, and optimization of production/storage conditions (e.g., temperature, for the chemical industry)

Remote monitoring and control: a machine can be monitored and steered from anywhere, ideally using easy-to-use interfaces, such as touch-based displays, and easy representation of outcomes with apps

Predictive maintenance: constant monitoring of machine KPIs and condition-based planning of maintenance are performed to avert any damage; condition-based maintenance is based on statistical comparison with machines at other sites, enabling tailored prediction and resolution of breakdowns

Human-robot collaboration: machines, e.g., robots, substituted for workers for certain production steps. Furthermore, robots and humans work closely together (e.g., in direct interaction without the need for a safety fence; machines can be steered via gestures in highly complex production steps)

Digital performance management: digital performance dashboards/action boards are installed; real-time, automated fine-tuning and optimization is possible

In-situ 3D printing: tools and spare parts (for a company's own production and clients) are printed instead of sourced, especially where volumes are low (and/or if the value is high)

Real-time supply chain optimization: transparency is created in your supply chain by tracking material and equipment, which also requires full transparency on current stock levels of finished goods, sourced parts and raw materials; reactions to finished goods/sourced parts/raw material shortages and delivery failures are swifter, even at short notice

Digital quality management: digital quality measurement of materials and production processes is carried out. Additionally, digital documentation of safety-relevant production processes is performed, that is partially based on the automation of knowledge work

Statistical process control: this involves the continuous monitoring of relevant parameters. Rather than the mere identification of statistical derivations within defined limits, statistical methods are used to identify real problems

SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2017

Global key McKinsey contacts for Digital Manufacturing

Inspired by the critical role of its model factories in supporting lean transformations, McKinsey has launched a global network of Digital Capability Centers with locations in Aachen, Beijing, Chicago, Singapore, and Venice targeted at building Digital Manufacturing skills across multiple levels of an organization, from executives to the shop floor.

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