



Digital Manufacturing – escaping pilot purgatory

Digital
Manufacturing –
escaping pilot
purgatory

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Executive summary

The global race for innovation leadership in Digital Manufacturing¹ is picking up pace: two thirds of industrial companies worldwide say that digitizing the production value chain is one of their highest priorities. To achieve this goal, companies are actively pursuing a broad range of Digital Manufacturing use cases in three areas:

- **Connectivity.** Enabling the flow of relevant information to the right decision makers in real time. Examples include digital performance management and the use of augmented reality to communicate interactive work instructions and SOPs.
- **Intelligence.** Applying advanced analytics and artificial intelligence to an array of data to generate new insights and enable better decision making. Examples include predictive maintenance, digital quality management, and AI-driven demand forecasting.
- **Flexible automation.** Leveraging new robotic technologies to improve the productivity, quality, and safety of operational processes. Examples include autonomous guided vehicles and using cobots for assembly processes.

Despite this focus and enthusiasm, McKinsey's collaboration with the World Economic Forum on the "future of production" has shown that many companies are experiencing "pilot purgatory" in which they have significant activity underway, but are not yet seeing meaningful bottom-line benefits from this.

To more fully understand how manufacturers across the globe are approaching their Digital Manufacturing transformation and the challenges they are facing, McKinsey has conducted its fourth Digital Manufacturing Global Expert Survey (Box 1). The results of this survey provide interesting insights into how manufacturers' approaches differ across the world, as well as concerning behaviors that are contributing to "pilot purgatory."

In Part I of this report, we share the results our 2018 survey. These show largely continued levels of enthusiasm and prioritization related to capturing benefits from Digital Manufacturing with notable acceleration in China and India and regression in Japan. However, while there is significant importance placed on the topic and many pilots have been launched across a range of use cases, less than a third of respondents cite having moved critical use cases – such as digital performance management – into large-scale rollout. At the same time, more than 90% of surveyed companies believe that they are either at the forefront of Digital Manufacturing in their industry or, at least, on par with the competition.

In Part II, we offer perspectives on six success factors that manufacturers who are demonstrating at-scale impact from Digital Manufacturing are following. These factors span the transformation categories of process, infrastructure, and organization:

Process

- "Approach the opportunity 'bottom-line value backwards' – rather than technology forward"
- "Establish a clear vision and change story for how Digital Manufacturing will create competitive advantage and develop a phased road map and business case"

¹ In this report, we use this term, broadly defined, to encompass similar terms such as Industry 4.0 and Smart Manufacturing.

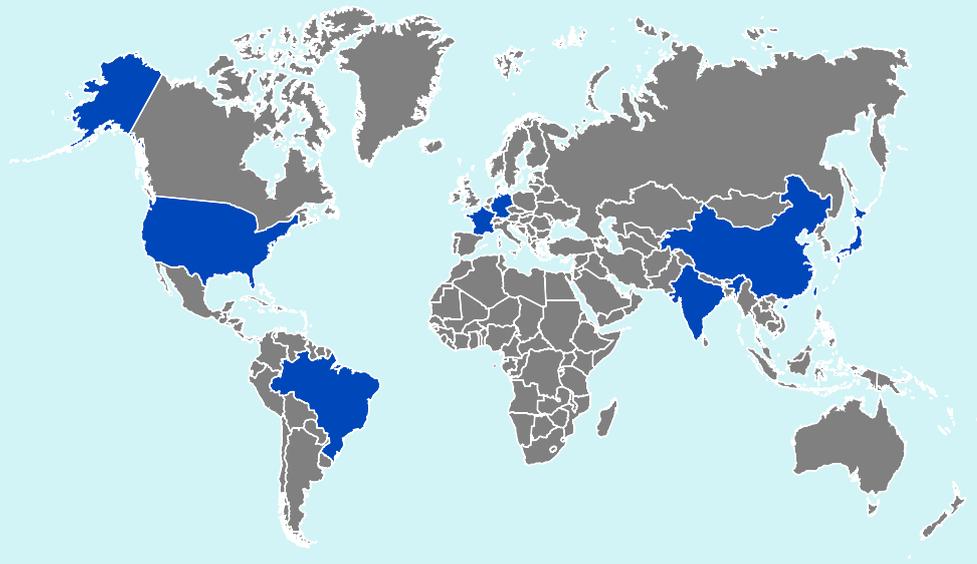
Infrastructure

- “Form an early view on the comprehensive target-state technology stack that is scalable and analytics-enabled and supports the Digital Manufacturing road map”
- “Build and lead a focused ecosystem of technology partners to rigorously manage the building of the stack”

Organization

- “Drive the transformation from the top (and via P&L owners) and coordinate implementation widely – do not treat it as an isolated IT implementation effort”
- “Get ahead of the capability gap – build the skills to achieve impact and the culture to sustain it.”

Box 1 Overview of McKinsey’s Digital Manufacturing Global Expert Survey



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

- Over 700 qualified respondents from companies with more than 50 employees and over USD 10 million in revenues, spanning a range of industry sectors from automotive to chemicals to transport and logistics
- Impact, strategy, key solutions, and implementation approach assessed for seven key markets (Brazil, China, France, Germany, India, Japan, and the USA)

Part I: Key findings from the Digital Manufacturing Global Expert Survey 2018

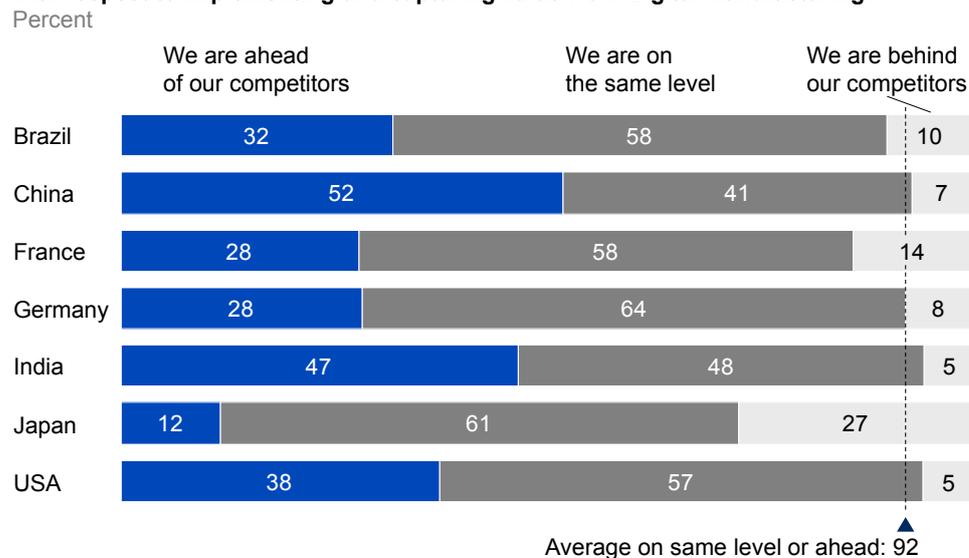
McKinsey’s 2018 survey of global manufacturing companies reveals an interesting mix of organizational commitment and clear progress on one hand and stagnation in Digital Manufacturing on the other hand. Three key findings characterize the industry’s development over the past 12 months.

Most manufacturing companies consider Digital Manufacturing a top priority and themselves ahead of the game

Leaders in manufacturing organizations have identified the importance of digital manufacturing, and for the most part they see themselves as doing rather well vis-à-vis their competition (Exhibit 1). On average, 92% of respondents report that they are either on the same level as or ahead of their peers when it comes to Digital Manufacturing. In other words, very few see themselves as “behind the curve” or, thus, needing to “catch up” to the competition.

Exhibit 1 Most organizations feel themselves ahead or at the same level as competitors

How do you feel you are placed relative to most of the competitors in your industry with respect to implementing and capturing value from Digital Manufacturing?

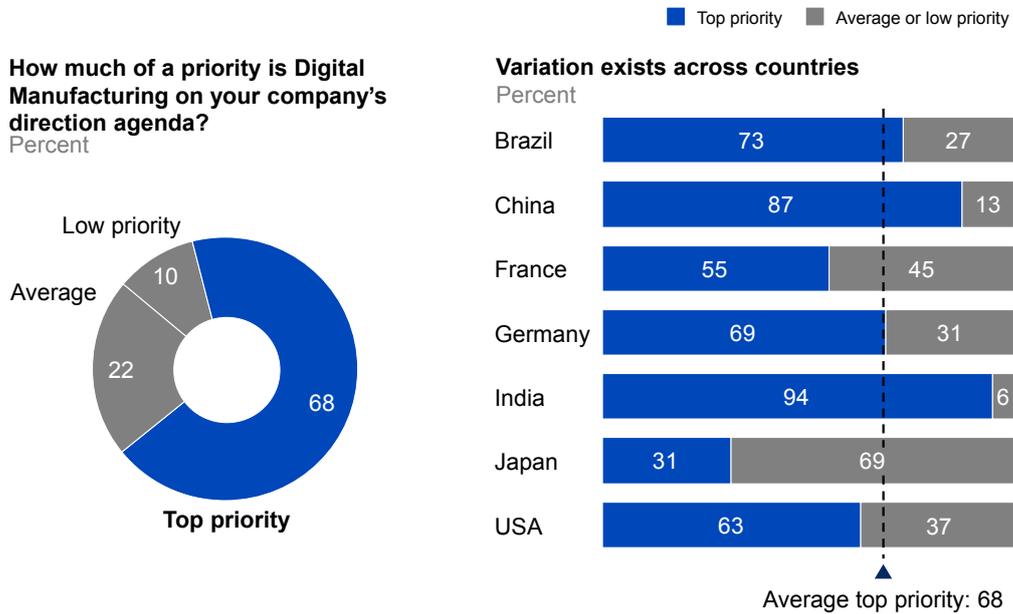


SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

At the same time, the idea of Digital Manufacturing has held its importance among companies in the industry (Exhibit 2). More than two thirds of respondents report that Digital Manufacturing is at the top of their operations-strategy agenda. There is a fair amount of variation by region, but for most, Digital Manufacturing is a global priority. Respondents from Japanese manufacturers are the outliers here. Not only are they the least likely to identify Digital Manufacturing as a top organizational priority, they also are accordingly the least likely to see their organizations as winning the Digital Manufacturing race.

The picture of where manufacturing companies stand today regarding Digital Manufacturing is a useful snapshot, but an understanding of changes in attitude over time is at least equally illuminating. In this context, it is noteworthy that – after an all-time high in 2017 – optimism about Digital Manufacturing’s potential has plateaued for the first time in China, the USA, and Germany. In Japan, enthusiasm has dropped off significantly from what already had been clearly the lowest level of all four countries in which this attitude was measured.

Exhibit 2 Digital Manufacturing is a top priority for manufacturers

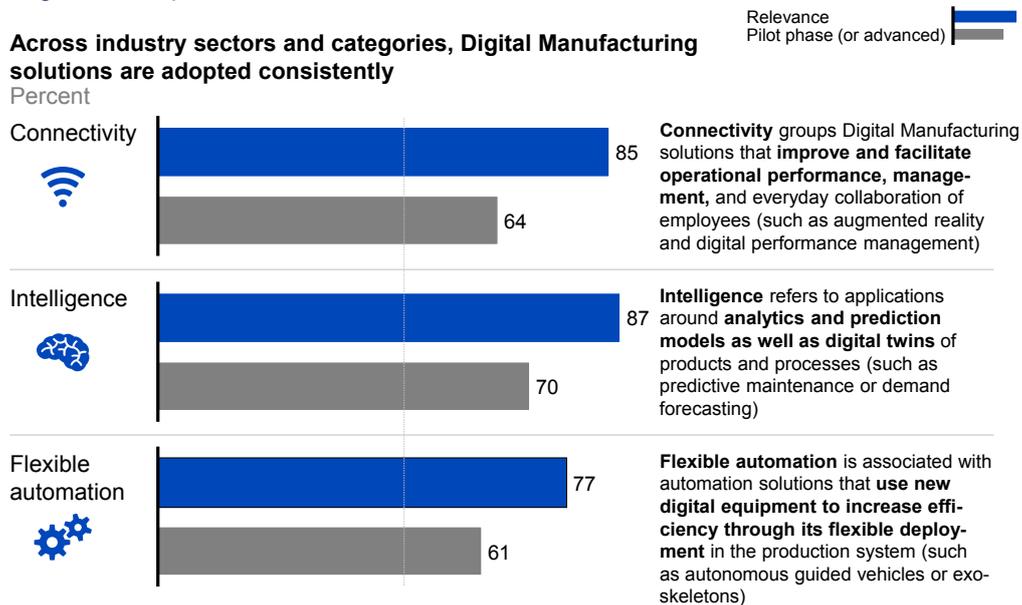


SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

A clear majority of manufacturing companies have already successfully piloted digital solutions

In each area of Digital Manufacturing – connectivity, intelligence, and flexible automation – most of the respondents report (at least) piloting solutions within their organizations (Exhibit 3). There is, however, a sizable gap between the share of respondents who see the relevance in certain Digital Manufacturing categories and those who report that their organizations have piloted solutions in those areas (an average spread of 15 percentage points).

Exhibit 3 High levels of relevance and conducted pilots across all Digital Manufacturing levers – degree of adoption seems to be consistent across levers

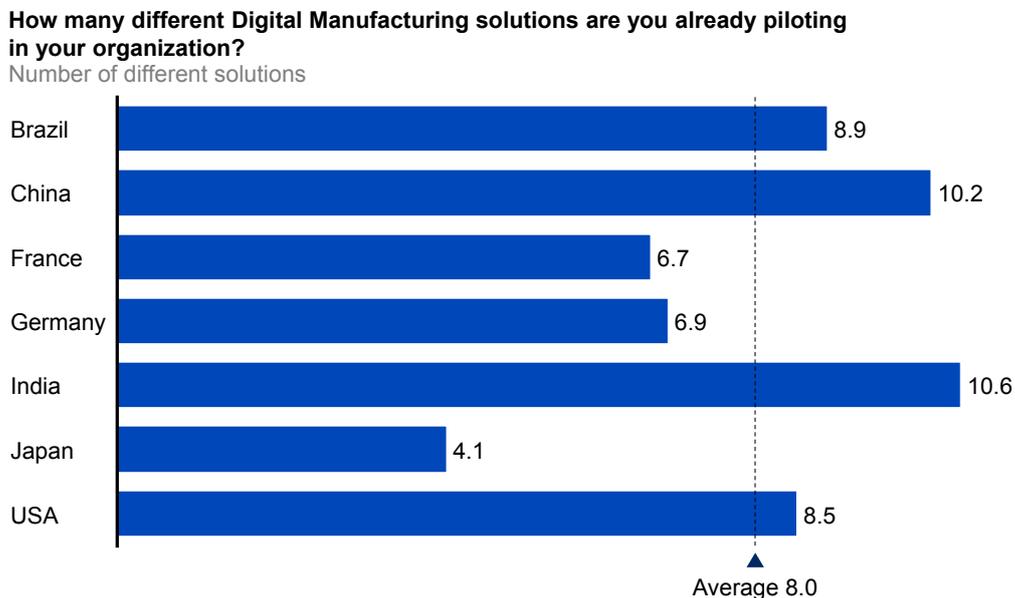


SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

Analytics for quality management and inventory optimization are the solutions most likely to have gone beyond the concept stage, while autonomous vehicles and 3D printing are the least piloted Digital Manufacturing solutions.

In many cases, companies are piloting multiple digital solutions simultaneously (Exhibit 4). The global average is eight solutions, but the number varies widely by country. While Indian manufacturers report, on average, piloting more than ten Digital Manufacturing technologies at any given time, companies in Japan are, on average, piloting only about four.

Exhibit 4 On average, companies are piloting 8 different Digital Manufacturing solutions



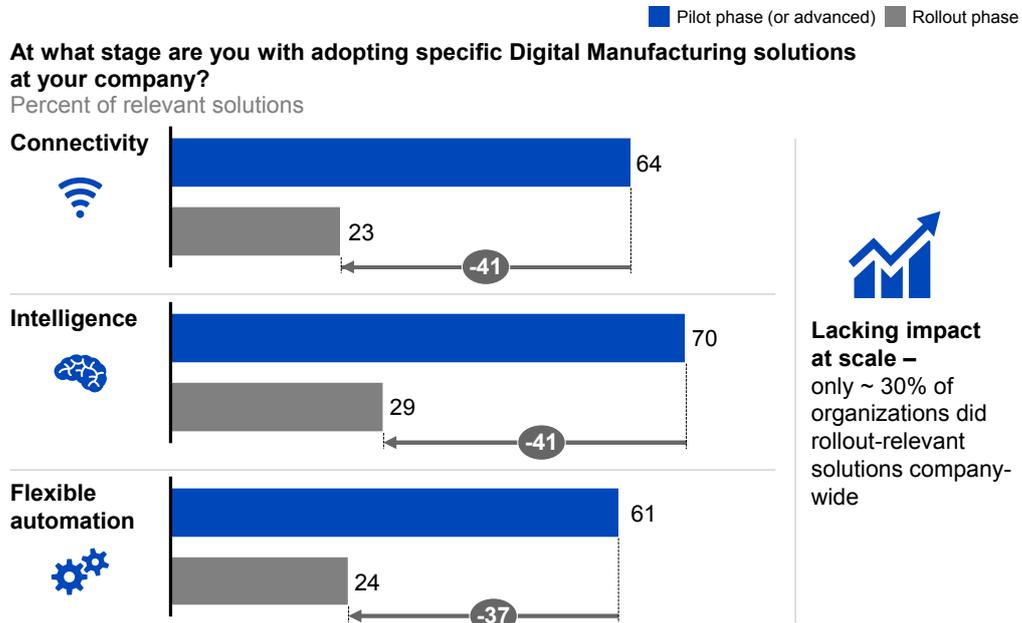
SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

What's more, an analysis of implementation success over time reveals that significantly more companies are reporting successful piloting. Yet while success rates in implementing Digital Manufacturing solutions increased rather strongly in China, the USA, and even Japan, piloting success among German companies has stagnated.

For most manufacturing companies, advancing beyond the pilot phase is still a big challenge

Even when companies report significant numbers of pilots, most cite significantly less progress in terms of broader rollout (Exhibit 5). In fact, the gap between piloting and rollout is significantly larger than the gap between perceived relevance and piloting, suggesting that scaling is a bigger hurdle than getting the ball rolling.

Exhibit 5 While pilots are common, companywide rollout is still rare



SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

An analysis by sector shows that the newer, more technologically advanced areas of the manufacturing sector (for example, industrial automation) are further ahead in the implementation of Digital Manufacturing than older, more established areas such as paper and packaging (Exhibit 6).

Exhibit 6 Technologically advanced industries are leading the digital transformation

Industries	Pilot phase (or advanced)	Rollout phase
Industrial automation	78%	34%
Software	77%	34%
Semiconductors	73%	20%
Consumer goods	70%	26%
Automobile manufacturing (OEM)	66%	23%
Mechanical engineering	65%	24%
Plant engineering	64%	23%
Supplier of automotive components (OES)	64%	20%
Transportation and logistics	61%	26%
Healthcare	60%	22%
Chemicals	59%	25%
Paper and packaging	56%	20%
Average	66%	25%

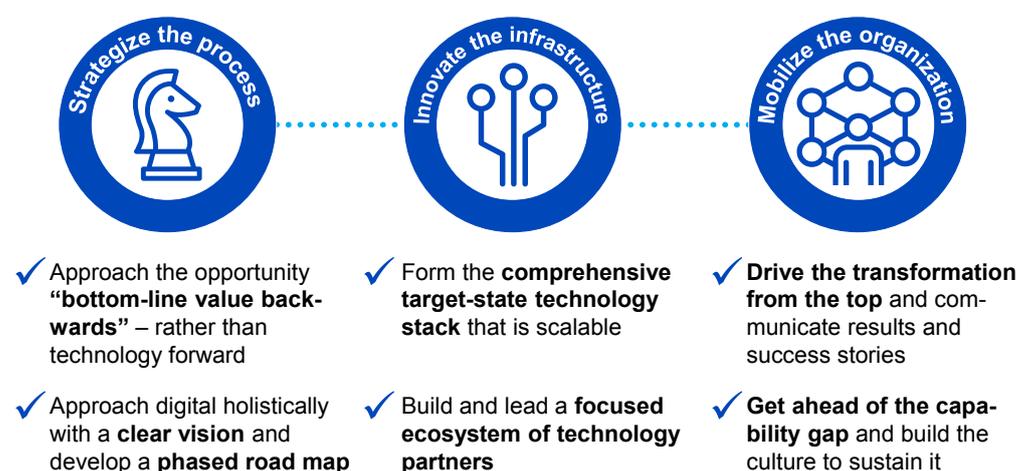
SOURCE: McKinsey Digital Manufacturing Global Expert Survey 2018

Part II: Our perspective on the three principles of escaping pilot purgatory

The results of our Digital Manufacturing Global Expert Survey 2018 clearly indicate that most companies are still struggling to move successfully from the piloting of point solutions to delivering sustainable impact at scale. Success stories for capturing sustainable impact at scale are still few and far between.

What we have learned from our research – which is also supported by our client experiences and industry observations – is that companies often make the same missteps when it comes to Digital Manufacturing strategy and implementation. In order to escape pilot purgatory and to capture and sustain the value from digital technologies, we recommend that organizations focus on six success factors across three categories (Exhibit 7).

Exhibit 7 To escape pilot purgatory, organizations should keep 6 key success factors in mind



SOURCE: McKinsey

Strategize the process

Without a focus on solutions that have a high impact on the bottom line, organizations end up pursuing a Digital Manufacturing journey that is financially not feasible. The following success factors are directly tied to the ability of manufacturers to establish a solid business case for the implementation of their Digital Manufacturing solutions.

1 “Approach the opportunity ‘bottom-line value backwards’”

With the plethora of Digital Manufacturing solutions on the market, it is easy for companies to be led by what is exciting. Beginning with a clear view on how Digital Manufacturing solutions can address operational pain points, creating competitive advantage and driving bottom line impact is key to ensuring tangible returns:

Determine the value-creation potential. Implementation costs are only justifiable if the payoff is significant. 61% of respondents see lack of ROI as a major obstacle when implementing Digital Manufacturing solutions at scale. Understanding the company-specific situation will be key in determining the potential value at stake of an Digital Manufacturing transformation.

61% of manufacturers see insufficient ROI as a barrier to implementing Digital Manufacturing at scale

2 “Establish a clear vision for Digital Manufacturing and a phased road map to get there”

The concern that a lack of vision is a significant obstacle to digital transformation has grown over the last year. In 2017, only 15% of survey respondents saw a lack of vision as a significant obstacle. Today, that share has climbed to 59%. Three principles can help manufacturing companies create a real vision for Digital Manufacturing:

Think holistically. Look down the road – i.e., past an immediate fix – and beyond your company – i.e., into the context of the entire ecosystem – and make technology decisions based on what will build a long-term competitive advantage.

Showcase the benefit. No matter how comprehensive or holistic, a vision without organizational buy-in will likely fail. Making the benefit of a particular technology clear to all is critical, yet only 25% of respondents have set up Digital Manufacturing integrated pilots as showcases to train and inspire the organization. By creating one or more “lighthouse” facilities that showcase the integrated picture of how individual use cases combine to create truly transformative outcomes can help companies build a clear and unified vision for Digital Manufacturing. Selecting subsequent use cases that generate the desired value can solidify a company’s buy-in around the aspirational vision for Digital Manufacturing.

Lack of vision is a barrier to Digital Manufacturing success for 59% of manufacturers, but only 25% have set up lighthouses to make the benefits clear

Create an ROI road map. To achieve the highest ROIs that come from scaling, the complexities of the technology and use cases, the level of process and cultural change needed, and the sizable investment required must be carefully managed. To this end, transformation requires a road map. The road map should be based on both a clear definition of the size and nature of the business opportunity and a precise understanding of the IT and operational technology (OT) architecture and resourcing requirements. The good news is that today, more than 58% of respondents report that they have a robust road map for implementation – compared to only 33% in 2017.

Industry case: Developing the digital vision and approach for a holistic digital transformation of an automotive tier-1 supplier

Situation

A tier-1 automotive supplier requested McKinsey's support in its digital transformation, specifically to enable it to address and adopt the megatrends in the industry related to products, services, and processes

Approach

The approach to supplier's Digital Manufacturing goals was based on the four pillars of a digital transformation: strategy, organization, product development, and change management

Vision

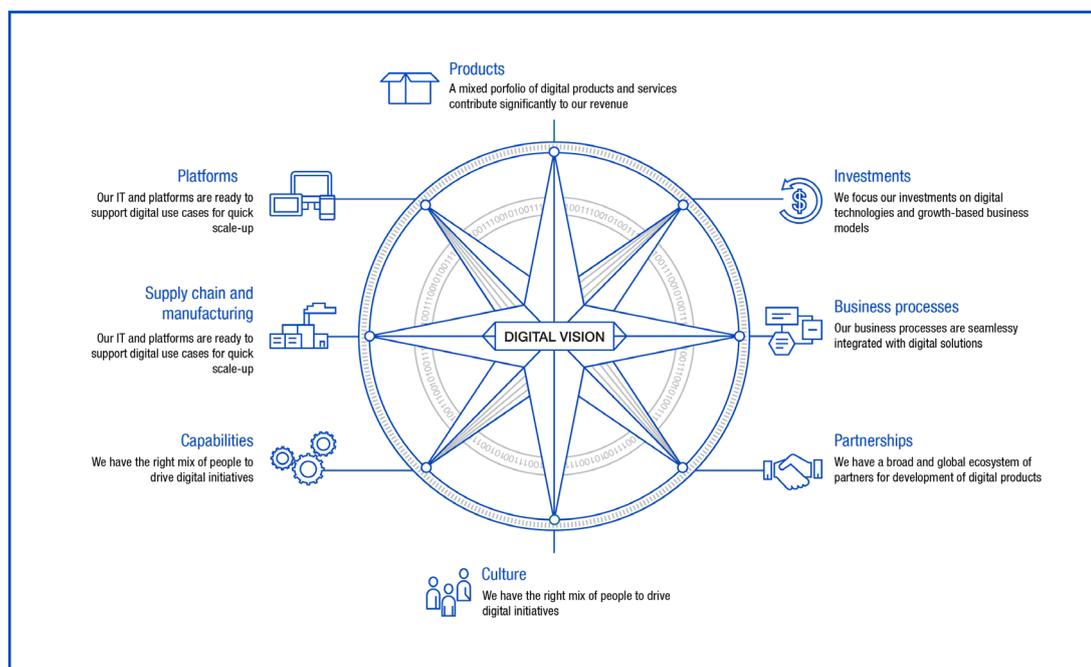
A comprehensive outlook for the supplier included a perspective on how eight aspects would contribute to its Digital Manufacturing vision:

- Digital products that boost revenue
- IT and platforms that support rapid scale-up
- Digital supply chain for end-to-end efficiency
- Capabilities to drive digital initiatives
- Organizational culture that embraces digital transformation
- Investments focused on growth-based digital models
- Business processes seamlessly integrated with digital solutions
- Global partnerships that complement in-house capabilities

Impact

The transformation equipped the supplier with the tools and structures it needed to reap the value of Digital Manufacturing:

- A digital road map charted the course to 10% in additional revenue and a 15% cost reduction
- A digital factory facilitated the scale-up of Internet of Things (IoT)/digital use cases
- A digital ecosystem of partners supports ongoing innovation



Innovate the infrastructure

With the strategy and business factors sufficiently addressed, companies can focus on both the critical influences of the technology stack and the importance of an effective technology ecosystem.

3 “Form the comprehensive target-state technology stack”

Digital Manufacturing is, by definition, “technology driven,” but more than 44% of respondents point to IT deficiencies as a main challenge in successfully implementing those initiatives. In defining the optimal technology stack, manufacturing companies should keep five principles in mind:

Comprehensive. Definition should include a look at all five layers: collection, connectivity, data, analytics, and applications. It should also be specific to your operational model.

Scalable. A critical element for scalability is the data ingestion pipeline complemented by analytic capabilities.

Analytics enabled. Systems (software and infrastructure) provide the material, but analytics provides the insights that, ultimately, generate the value. Only 20% of organizations have set up a data lake across their network in more than 50% of their plants, and only 25% use an advanced analytics platform at scale.

Among the IT deficiencies, only 20% of manufacturers have built network-wide data lakes in more than half of their plants

Integrated. Digital Manufacturing implementation requires that the relevant information from operational (OT) and information technology (IT) be integrated. Successful IT/OT convergence creates the delivery engine that will develop use cases that meet a manufacturer’s business needs.

Secure. Cybersecurity must be actively addressed by, for example, analyzing the connections and adaptability between legacy and future systems.

4 “Build and lead a focused ecosystem of technology partners”

The entire technology stack process – from development to rollout – must be tightly managed to ensure cohesion and seamlessness. Manufacturing companies should keep sight of three aspects of the process as they move forward:

Architecture complexity. Manufacturers face challenges navigating the complex landscape of solution providers. When building in the necessary components to the technology stack, machinery players will want to leverage industry standards as much as possible to ensure cross-organization interoperability.

Partnerships. Select a few partners that go deep in both functional and integrative expertise; co-developing when possible. More than 40% of respondents prefer to build their IT/OT systems in-house or tailor them based on external sources. This contributes to the need to bridge a wide range of systems that includes ones developed in-house, purchased from vendors, or co-developed.

Partnerships can help manage complexity, but more than 40% of manufacturers prefer to build their stacks in-house

Agile execution. Manufacturing companies should drive execution of their Digital Manufacturing initiatives with an agile mindset across software and analytics. Beyond building the right external partnerships, they need to build the capability for internal collaboration across functions and break down organizational silos.

Industry case: Optimizing the technology setup of a leading electronics manufacturer

Situation

A leading electronics manufacturer asked McKinsey to support in conducting Digital Manufacturing pilots and make the organization fit for the digital production system

Approach

After analyzing the technology setup reference, current and target architectures were designed and a pilot road map made of two phases was developed. The first phase addressed blocking issues on critical design and infrastructure, the second phase addressed the comprehensive stack for a scalable foundational IT/OT platform

Findings

Blocking issues were identified in two of the five areas of critical design and infrastructure

- Data collection
 - No flexibility: each device has different collection mechanisms, meaning data cannot be properly ingested and stored for analyses
 - No scalability: some of the point solutions, specifically in scanner data, will prevent scaling to significantly larger data volumes
 - Data delay: data delayed up to 30 to 45 minutes across the plant
- Data structure
 - Data inaccuracy: some miscalculations in jobs get repeated and exaggerated, affecting the accuracy of reports
 - Lack of data history: neither consistent data archiving strategies nor mechanism to store historic data for future modeling

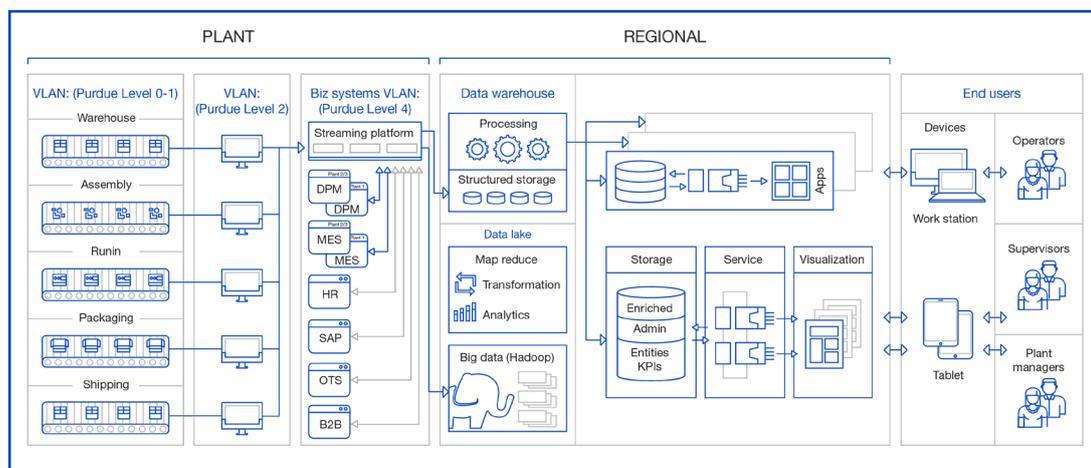
Impact

To address these data-related barriers to Digital Manufacturing implementation, the company pursued two main initiatives

- Data/design centralization
 - Consolidate infrastructure
 - Ensure reusability of solution across all sites
 - Begin perpetual storage of operational data for big data analytics
- Service-oriented architecture
 - Create set of five to six services to be used globally
 - Create dynamic visualizations based on Web-based (microservice) application that will decouple page creation for data storage

These initiatives resulted in

- Reduced setup and maintenance cost by 90%
- Reduced application development cost by 50% of current model



Mobilize the organization

Digitizing the production system represents tremendous change. While technology is the obvious tool of a digital transformation, two success factors speak directly to the importance of people in the success of the change initiative.

5 “Drive the transformation from the top”

Capturing the full value potential from Digital Manufacturing requires a consistent approach. Two principles help ensure this outcome:

Executive-level leadership and P&L commitment. Top teams should appoint a clear, executive-level transformation leader and consider taking the whole top team to digital immersion sessions and “go-and-see visits” in order to acquire the necessary capabilities and adopt new ways of working. In this regard, manufacturing companies have a way to go, given that only about one third of respondents report that their organizations have appointed a C-level individual responsible for driving their Digital Manufacturing efforts. Ensuring a sufficient pace and widespread adoption of Digital Manufacturing also requires the commitment of P&L owners.

C-level leadership is responsible for Digital Manufacturing efforts at only 36% of manufacturers

Integrated decision making. A fragmented or disjointed application of digital technologies will undermine the ultimate success of Digital Manufacturing. Coordination across all plants, geographic locations, and functions along the value chain is essential. At this point, only one third of respondents report having a coordinated Digital Manufacturing effort globally.

Only one third of manufacturers have a globally coordinated Digital Manufacturing strategy

6 “Get ahead of the capability gap”

Successful companies recognize the importance of new skill sets in their approach to digital transformation as well as the importance of an organizational culture that facilitates development:

Encourage innovation. A digital transformation has the best chance of succeeding in an environment that encourages creativity and supports innovation. To this end, companies can, for example, leverage the innovation challenge concept to foster and accelerate the creation of new ideas. Comprising the four modules of “pitch night,” “innovation challenge,” “partner challenge,” and “academy challenge,” this concept relies not only on leveraging a company’s external ecosystem to generate ideas or on tapping into the ideas of its employees but also on ideation and co-creation with suppliers and external experts as well as on promoting innovation by organizing a challenge with academic partners.

Focus on talent. Building among staff the capabilities to address the challenges of Digital Manufacturing is linked to both individual Digital Manufacturing use cases as well as to the overall transformation. Ensuring the necessary skills and capabilities can come through a combination of internal training, the acquisition of new talent, and collaborations with tech-solutions providers and research and academic institutions. More than two thirds of respondents see attraction, management, and the retention of top talent as the main challenge about Digital Manufacturing implementation.

Talent issues are the main Digital Manufacturing challenge for 69% of manufacturers

Industry case: Building the foundation of the first digital-enabled steel plant in the world

Situation

A state-of-the-art steel plant in the Netherlands was looking for the next S-curve in continuous improvement and planned to fully digitize their operations.

Apart from piloting new and promising technologies in isolated projects, the client wanted to follow a holistic approach to digitally transform the whole organization.

Two considerations, among others, have been capability building and the creation of a guiding vision to excite the organization from the beginning

Approach

After analyzing the status quo, we jointly defined a vision for the digital-enabled steel plant. Then, a road map was developed to chart a robust implementation plan and direct the transformation.

In a second step, use cases were prioritized, built, tested, and scaled in multiple waves to ensure quick impact and excite the organizations.

In parallel, three imperatives helped lay the foundation of the digital transformation: develop capabilities, build the IT infrastructure, and create the advanced analytics ecosystem

Findings

As capability building is central to digital transformations, the client's digital capability building is fundamental. We thus decided to follow three main steps:

Create the analytics academy with a focus on intensifying the capability building of the project team and continuous improvement.

Define and establish the three required roles for the organization's successful transformation: advanced analytics translator, data scientist, and data engineer.

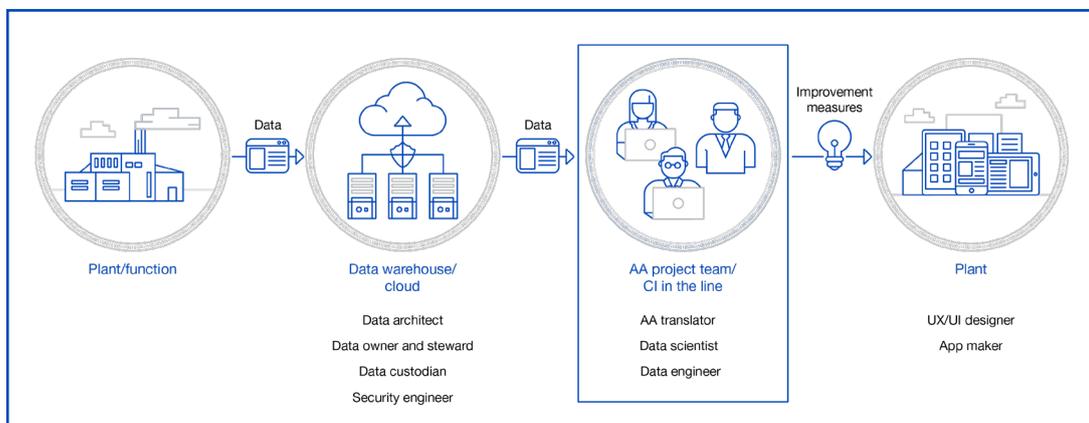
Develop for each role the required tailored learning journey with its specific internal and external modules, such as cleaning and structuring data.

Impact

Throughout the digital transformation, 200 practitioners were trained from all parts of the organization – from senior management at the executive level to individual work units, including maintenance and local IT as well as nontechnical functions

What's more, a digital ecosystem was created to ensure the transformation's sustainable impact. Setting up this ecosystem comprised establishing and formalizing, amongst others,

- An internal networking community on digital topics
- Collaborations with knowledge institutions
- A valuable proposition for digital talent and access to corresponding talent pools
- Partnerships with start-ups and spin-offs



Outlook

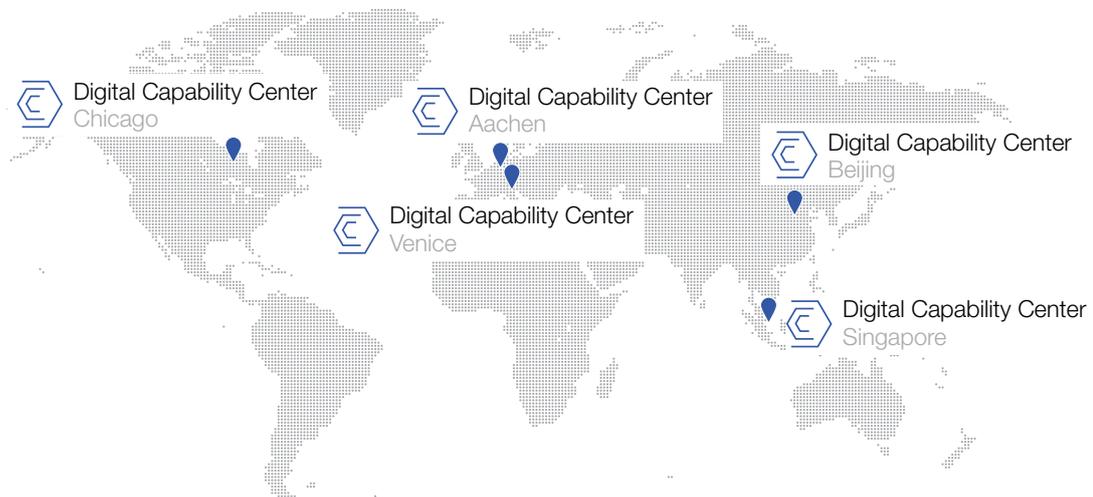
The move from the “current version” of factory production to Digital Manufacturing holds the promise of significant value, and according to the results of McKinsey’s 2018 survey, this shift is a top strategic priority for manufacturers across the globe. Despite the importance placed on it, most manufacturers are struggling to take the Digital Manufacturing successes they have experienced in limited pilots to a scale that would bring the full benefit of the technology.

A holistic approach to Digital Manufacturing – one that considers the fundamentals of the organization and the business as much as it focuses on the technology-related factors – can help manufacturers get over the hurdles that stand between pilot success and company-wide rollout.

The good news is that, as demonstrated by several real-world cases, a rollout is not a mystery, and successes exist. These “lighthouses” have the power to help unify a manufacturer’s vision of Digital Manufacturing. The knowledge from these case examples can also help build a solid business case and chart the course for companywide implementation.

McKinsey's global Digital Capability Center network

Our Digital Capability Centers (DCCs) provide a unique environment for companies and their managers to see, touch, and better understand Digital Manufacturing in real life. Learning to master core technologies such as IOT, advanced analytics, robotics, and additive manufacturing, managers can eyewitness here the end-to-end transformation of a simulated organization – from lean excellence into an industry leader with fully digitized production processes. What's more, the DCCs show live why and to what extent addressing technical, management, and people systems in concert is crucial for the success of digital transformations in general and for escaping pilot purgatory in particular.



Contact e-mail addresses for the DCCs

General e-mail address
for all 5 DCCs

Global_DCC@mckinsey.com

 Digital Capability Center
Aachen

DCC_Aachen@McKinsey.com

 Digital Capability Center
Beijing

CCOE_inquiry@McKinsey.com

 Digital Capability Center
Chicago

DCC_Chicago@McKinsey.com

 Digital Capability Center
Singapore

DCC_Singapore@McKinsey.com

 Digital Capability Center
Venice

DCC_Venice@McKinsey.com

Global 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.

Interested in learning more? Please contact our regional Digital Manufacturing knowledge leaders:

USA

Richard Kelly
Partner, Stamford
Richard_Kelly@mckinsey.com
+1 (203) 977 6939

Germany

Andreas Behrendt
Partner, Cologne
Andreas_Behrendt@mckinsey.com
+49 (221) 208 7262

China

Karel Eloot
Senior Partner, Shanghai
Karel_Eloot@mckinsey.com
+86 (21) 6132 3040

India

Kunwar Singh
Partner, Delhi
Kunwar_Singh@mckinsey.com
+91 (124) 661 1021

Brazil

Björn Hagemann
Partner, São Paulo
Bjoern_Hagemann@mckinsey.com
+55 (11) 5189 1613

Japan

Kenji Nabeshima
Partner, Tokyo
Kenji_Nabeshima@mckinsey.com
+81 (3) 5562 2690

France

Valerio Dilda
Partner, Paris
Valerio_Dilda@mckinsey.com
+33 (1) 4069 4275

Contributors

Content

Andres Aramayo-Prudencio
Associate Partner, Mexico City

Michael Coxon
Associate Partner, Cleveland

Enno de Boer
Partner, New Jersey

Dondi De Ocampo
Director of Engineering, Chicago

Andras Kadocsa
Partner, Budapest

Bernhard Mühlreiter
Associate Partner, Vienna

Joris van Niel
Senior Expert, Amsterdam

Editorial team

Andreas Behrendt
Partner, Cologne

Alexandra Duron
Engagement Manager, Montreal

Richard Kelly
Partner, Stamford

Simeon Mußler
Specialist, Hamburg

Raphael Rettig
Junior Specialist, Düsseldorf

Sebastian Stoffregen
Associate Partner, Munich

Production team

Frank Breuer
Media Designer, Berlin

Jörg Hanebrink
Senior Communications Specialist, Düsseldorf

Martin Hattrup-Silberberg
Senior Communications Specialist, Düsseldorf

Christian Johnson
Senior Editor, Hong Kong

