



Digital machinery

How companies can win the
changing manufacturing game

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Digital machinery – how companies can win the changing manufacturing game

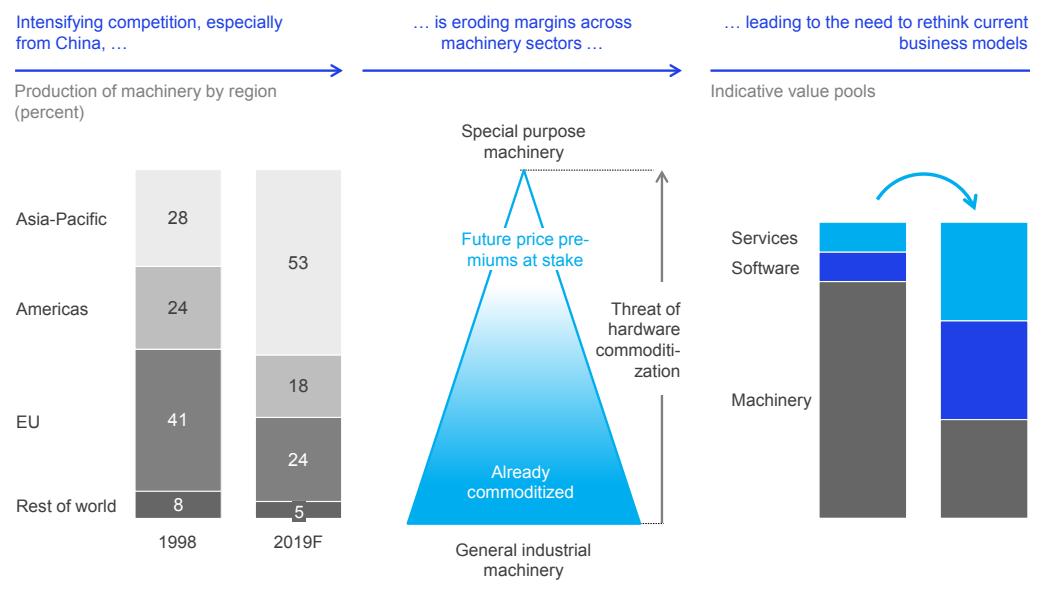
Traditionally, and for good reason, leading machinery and manufacturing companies have focused on selling hardware (e.g., machines, components) and based their business model and success on the outstanding quality of their products. But now it looks as if these days may well be over. Three powerful, mutually reinforcing developments are emerging across the machinery industry, requiring a fundamental rethink of current business models:

Intensifying global competition. For many decades, European and US machinery companies dominated the global machinery market. This balance of power, however, is in the process of tilting towards Asia-Pacific (Exhibit 1). A number of new players emerging from the region in recent years, especially in China, are now growing in strength. The very price-competitive copies of US and European machines they offer along with their own innovation power are positioning Asia-Pacific as the new global machinery powerhouse, which increasingly also includes special machinery. Consequently, machine manufacturers (especially those outside of Asia) are finding themselves with almost no other options when defending their price premium than coming to grips with the all-important topic of the future of digital machinery.

Commoditization of hardware. Hardware – in the sense of machinery and production plants – is becoming increasingly commoditized. Where specialist knowledge used to be a requisite asset, now technical ability – above all the ability to start substituting specialist knowledge with software in certain parts of machine manufacturing – is all that is required to produce today's machinery. In addition, completely new digital technologies, such as additive manufacturing, enable machine or parts manufacturers to produce more complex products, which traditional manufacturing techniques did not support, and also fulfill customer demand faster and at

Exhibit 1

Intensifying global competition across the machinery industry requires fundamental rethinking of current business models



lower cost. As a consequence, manufacturers of standard – and even specialized – machines as well as plant engineering companies are coming under intense cost pressure.

Seismic shift in technology stack value pools. Together, the market trends mentioned above are causing a shift in value concentration within the digital technology stack from the hardware layer to hardware-software-services offers (for further details on this, see Exhibit 2 on page 5). Inasmuch as these offers are less reliant on hardware, which had been a barrier to market entry, the new and increasingly more valuable software and services domain is now becoming the battleground and entry point for new tech players, further complicating and intensifying the competition already described. These players are light on knowledge specific to the manufacturing domain but possess superior software and analytics know-how. They are using their competencies in collecting and analyzing data to offer attractive as-a-service IoT business models (e.g., predictive maintenance based on smart machines, data collection, and analysis) and even outcome-based business models. Because they understand the data such machines produce better than others, tech players are in a position to develop a range of completely new products and offers. For example, the power of data analytics can set tech players up to sell guaranteed turbine power – as opposed to actual turbines – because predictive maintenance can make turbine power 98 percent reliable.

Digital machinery as a growth opportunity in challenging times

Against this backdrop of rising competition, commoditization, and the accompanying price pressure, digital transformation is a no-regret move for all machinery and production plant manufacturers. Digital-based business models provide attractive opportunities for growth and efficiency. Before explaining why this is the case, we will first define what “digital machinery” actually means.

Digitization is comprised of the set of actions that help organizations use the power of digital in products and services, customer experience, analytics, and automation. The process takes on many forms, but in almost every industry undergoing digitization we are seeing the evidence of five distinct digital-related themes:

- Borders between sectors are blurring. Organizations are moving into new playing fields, and they are finding that companies that were once siloed off from them are now their newest competitors.
- Channel conflicts are arising between new digital channels and old channels.
- Digital can unlock big potential in internal processes and increase efficiency dramatically.
- New technologies and new customer behavior are driving new business models.
- New capabilities need to be built, and IT/tech, organizational, and leadership challenges need to be tackled.

These themes are no truer for the machinery industry than they are for many others. Their growing importance in manufacturing, however, is driven by additional, industry-specific

disruptions. “Digital machinery”, or “Industry 4.0” (the latter understood as the ecosystem focusing on digitization in manufacturing), is built from four trends related to the digital themes discussed above, making digitization in machinery a unique phenomenon:

- The power of the Internet of Things (IoT), along with the dramatic decrease in prices for IoT nodes and the astonishing rise in data volumes, computational power, and connectivity, especially new low-power wide-area networks
- The emergence of analytics and business intelligence capabilities
- New forms of human-machine interaction, such as touch interfaces and augmented reality systems
- Substantial improvements in transferring digital instructions to the physical world, such as advanced robotics and 3-D printing.

Digital machinery presents manufacturing companies with the opportunity to build their own smart factories or sell smart machines that help their customers digitize theirs. Beyond this, digital machinery also means a shift from “hardware only” to “hardware, software, and services” that enables the development of new business models. For example, on top of its own smart factory, an engineering company might also establish a smart-machine-based new business model, enabling new service offers, such as predictive maintenance. Digitization also makes output-based business models possible, which would be the basis for offers such as guaranteed machine performance.

In the latter model, instead of selling a turbine engine to an airplane manufacturer or a wind turbine to a utility, manufacturers would guarantee a certain performance and only sell and price the power or energy output based on specific, mutually-agreed-upon performance indicators that can be measured continuously.

What all of this amounts to is the inevitability of digitization and the urgency of opportunity in the new machinery and manufacturing landscape. This sentiment is perhaps perfectly summed up in Jeff Immelt’s famous words: “If you went to bed last night as an industrial company, you’re going to [have to] wake up this morning as a software and analytics company.” (Jeff Immelt, GE CEO, 2016).

How to become a digital machinery company

Before conceiving digital machinery business models, manufacturers need to make three fundamental decisions and determine the minimum role for their organization to play in the arising Industry 4.0 digital manufacturing ecosystem:

How to use digital technology to increase efficiency and improve operational excellence.

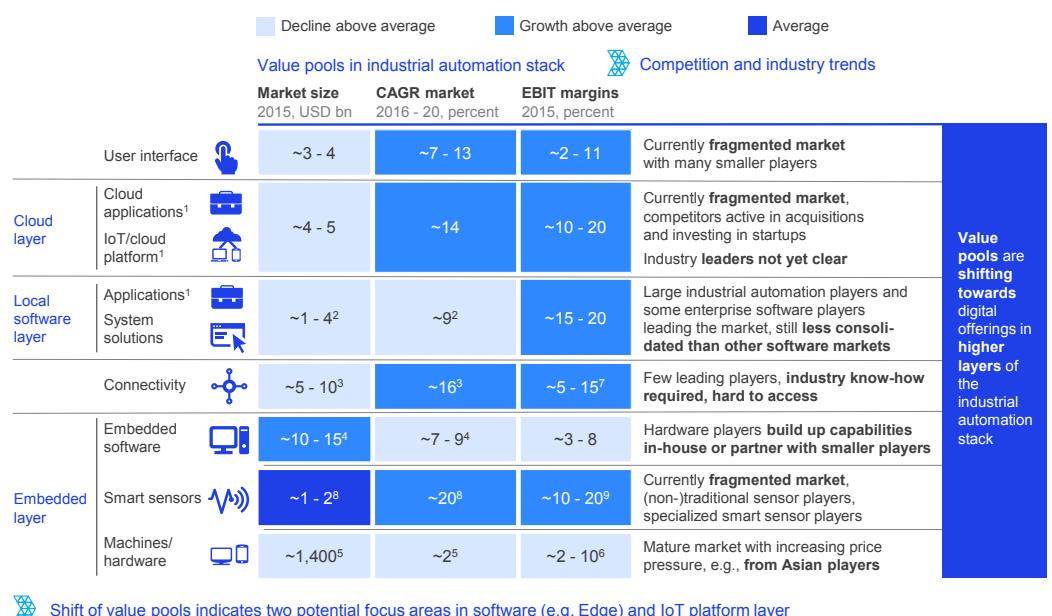
The main task here is identifying which digital use cases add the most value and how digital technologies can be applied throughout the entire value stream to increase efficiency and decrease costs. In order to do so, machine manufacturers should set up a cross-functional team tasked to deliver three end products:

- A clear understanding of current pain points and waste-causing activities along the value stream that can be addressed with digital technologies
- A set of digital initiatives targeted to address these pain points (prioritized by impact, ability to execute, and investment needs)
- A high-level road map balancing quick wins and longer-term, high-impact initiatives with clearly identified IT requirements.

How to move upward in the industrial automation stack and transform from a hardware player into a “hardware, software, and services” player. As described above, value pools in the traditional industrial automation stack are undergoing a seismic shift towards software applications and cloud/IoT platforms (Exhibit 2). For a machinery company, this introduces the strategic imperative to “move up” the technology stack towards including these new profit pools. A machinery company’s ability to successfully do so will largely depend on its experience with IoT, its software development capabilities, and its footprint in its customers’ value stream. Thus, companies supplying entire plants or engineered solutions of high strategic importance stand a better chance of convincing customers of the value of their software solutions than those supplying machines of only limited strategic importance. Also, machinery companies have to define their IoT strategies, with the major decisions being whether to join or build an ecosystem (and which one) and whether to offer a value-add platform and related services or to found one of their own.

Exhibit 2

Value pools have shifted across the digital technology stack



1 Requires back-end infrastructure
4 Total embedded software market
8 Based on smart sensor and sensor fusion market; assumes that industrial share is similar to total sensor & actuator market (~7%)

2 MES market for discrete industries, CAGR for 2014-19
5 Special-purpose machinery market
6 Based on 12 machinery players
7 Based on players for connectivity hardware (switches, routers, etc.)
9 Expert estimations based on traditional sensor market financials

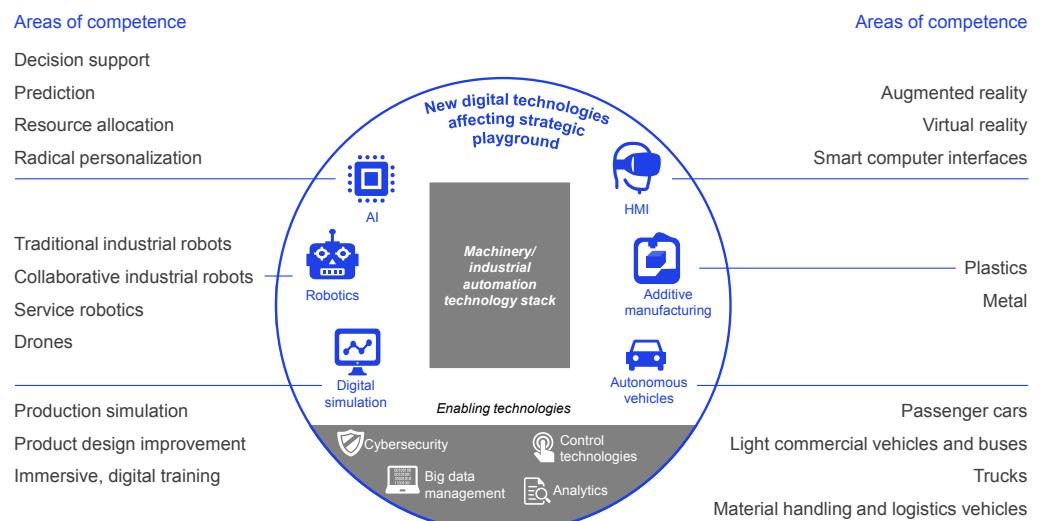
How to expand or amend businesses' existing portfolios with newly emerging digital technologies such as additive manufacturing, AI, robotics, or sensors. Lastly, machinery companies – of which many have a strong history of being technology leaders – can consider digital technologies as completely new and very attractive opportunities to enter new businesses and evolve their business from a hardware-/service-centric model towards a more software-centric model.

To start this discussion, companies should first draw their “technology map,” beginning with technologies that are directly adjacent to their current core business. Once the technology map has been drawn (see Exhibit 3 for an example), a strategic evaluation should be undertaken to assess the attractiveness of various technologies/markets and the company’s ability to enter these markets. Here is a snapshot of recent technology moves made by a few manufacturing companies that have successfully entered new markets:

- **3-D printing.** DMG Mori decided to add 3-D printing to its operations and acquired additive manufacturing company Realizer.
- **Robotics.** ZF specializes in AI and has leveraged partnerships (e.g., with NVIDIA) to enhance autonomous driving solutions.
- **Sensors.** Intel is continuing its expansion beyond semiconductor manufacturing with investments in sensor technology (e.g., acquisition of Mobileye), enabling offers in digital vision technologies and autonomous vehicles.

Exhibit 3

Mapping highlights the digital technologies closest to a company’s core business



SOURCE: Digital McKinsey

The three cornerstones of building a digital machinery company

Once the direction is clear, several actions within three fundamental areas of change will guide the transformation from a traditional machine manufacturer into a digital machinery company (Exhibit 4).

Clearly, “developing the business architecture” is the key step here, as “deciding on which new ecosystems to build” and “strengthening the foundation” are, by comparison, enabling but not mission-critical steps. For this reason, the following focuses most heavily on the implications of developing business architecture.

Deciding which new ecosystems to build

The range of digital-machinery-enabled options is wide, so companies will need to be strategic about where to play, which offers to develop/augment, and for whom. Accordingly, they should first determine which ecosystem to focus on (e.g., Industry 4.0, digital mobility, digital logistics) and then decide whether to:

- Develop new offers for current and new customers
- Digitally extend and augment services and products, e.g., digital-twin-related services
- Explore new delivery models, such as partnering
- Adapt business model(s) to capture shifting value pools, such as as-a-service business models, platforms, intellectual-property-rights-based models, or data-driven business models.

Exhibit 4

Actions in 3 change categories guide the digital machinery transformation

Emerging ecosystems				
Build new ecosystems	Industry 4.0	Digital commerce	FinTech	Digital health
	Connected buildings	Digital utility	Digital media and telecoms	Digital logistics
	Smart city	E-government and e-education	Digital agriculture	Smart mobility
Marketing and sales 4.0				
Develop business architecture	Digital front-end processes and multichannel	Digital development and release management	Yield/energy/throughput optimization	Digital quality management
	Customer relationship and lifecycle management	Digitized R&D and open innovation	Digitally enabled services, e.g., predictive maintenance	Predictive-analytics-based demand planning
	Digital marketing and social media	Product design	Additive manufacturing	No touch order management
Product 4.0				
Strengthen foundations	Integrated physical & digital experience		Digital performance management	Real-time performance management
			Automation and robotics	Digital purchasing
				End-to-end finance
Operations and Services 4.0				
Administration 4.0				
IT and technology				
Strengthen foundations	2-speed IT architecture	Big data and advanced analytics	Digital leadership	Organizing for digital (agile, culture)
	Cyber security	Embedded software	Digital talent management	Partner management
	Devices and connectivity	IoT	2-speed organization: agility and waterfall	
Organization and culture				

SOURCE: Digital McKinsey.

Depending on their individual circumstances, strengths, resources, and overall strategy plan, companies may choose one or any combination of the following options.

Developing the business architecture

Companies will need to (re)design the structure of the business through the lenses of marketing, product, operations, and administration:

Marketing and sales 4.0. Digital leaders focus on the customer, so digital machinery companies need to refine their approach to customer interaction and strive for digital marketing excellence. In order to get there, they should implement the latest digital technologies to increase the efficiency of customer interaction processes, particularly those related to marketing and sales. A customer pain-point analysis will also help them enhance their customer journeys by achieving, for example, higher conversion or lower churn.

Product 4.0. Companies have to radically rethink their ways of using digital to evolve their traditional products as well as to develop new products, services, and business models. This means integrating the latest digital technologies into R&D and innovation to speed up processes and dramatically reduce costs as well as being willing to partner others in these processes and use open development methodologies.

Operations and services 4.0. Companies will need to define and build up the structure on which they operate as a digital machinery organization. This includes arriving at a decision as to how they can optimally:

- Become a smart factory, e.g., by eliminating inefficiencies across the digital thread (i.e., better use of information not captured/made available/used today)
- Achieve end-to-end digital integration of operations (e.g., raw materials to consumer)
- Leverage digital technologies across all functions (open innovation, additive manufacturing, multichannel, pricing, purchasing, back office, etc.)

Administration 4.0. Companies will need to implement digital technologies to increase operational excellence, especially within the back-office functions. This goes far beyond implementing IT tools and increasing the level of automation. Next-level administration means using advanced analytics and artificial intelligence to not only increase efficiency but also improve and speed up management decision preparation (e.g., using predictive forecasting).

Strengthening foundations

IT and technology capabilities as well as organizational and cultural changes will be fundamental to the new organization and its digital machinery offers. Companies are thus recommended to:

- Strengthen these assets, e.g., implement two-speed IT architecture (such as distributed architecture, including edge, etc.), deploy state-of-the-art connectivity (including smart sensors) and cybersecurity, develop advanced analytics and software capabilities (UX/UI, embedded SW, etc.)

- Transform their existing organization and culture into a digital and agile environment characterized by digital leadership and digital talent management, two-speed organization, and partner management.

Pragmatic recommendations for starting a digital transformation

There is certainly no one, standardized approach to getting started and transforming a manufacturing organization into a digital machinery company. However, our findings concerning digital machinery as well as our observations of the most successful players in both manufacturing and adjacent industries with similar digitization challenges reveal effective approaches and perspectives that aspiring manufacturing companies might adopt:

- **Accept the challenge.** Digitization is a matter of “how,” not “if.” Still, only a few machinery and plant manufacturing companies have fully realized and accepted the digital challenge and are proactively trying to move the future development of their organization in this direction.
- **Move quickly.** Accept that speed beats synergies in the first round. Start with the basics – i.e., connectivity and smart sensors – in order to make moves early.
- **Make an informed choice.** Decide whether (and how far) to grow in the industrial automation stack: as far as reaching the MES integration layer, to building on sophisticated analytics, or all the way up to offering an IoT-based cloud platform. Alternatively, or additionally, companies can look out for attractive new digital technology fields (e.g., autonomous driving, robotics, AI) and make one of these their next playing field of choice (as Intel has done).
- **Always maintain a customer-centric perspective.** Never forget the customer and – starting with a pain-point analysis – begin thinking through all of the possible changes along the customer journey. This is especially important for manufacturing or machinery companies that may be inclined to build their new digital journeys on their strength as technical engineers but overlook the significance of the customer relationship.
- **Grow the opportunity** through the following two principles: keep working on new business models – i.e., models based on the potential of digitization in Industry 4.0/digital manufacturing environments – and continue to challenge existing ones. Also, think big, and move away from selling hardware to selling services (e.g., predictive maintenance) and selling and guaranteeing outcomes (instead of products).



“Getting your hands dirty” by getting the digital transformation of your enterprise going and testing the first prospective applications of digital machinery in your company does not require long preparation or a large up-front investment. Jumping in holds the benefit of producing early results and helping your company make quick progress on its journey towards becoming an organization that embraces the full potential of digital machinery. What are you waiting for?

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