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Digital Transformation in Manufacturing

Top Challenges CxOs Face and Proven Solutions

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Part 1

The past 10 years - Progress of digital transformation

It has been nearly a decade since the term “Industry 4.0” was coined to describe the fourth industrial revolution. Efforts to transform the manufacturing industry via digital transformation (DX) are steadily gaining traction. Although not numerous, DX initiatives at the implementation level are being adopted enterprise-wide to start breaking down departmental silos. The COVID-19 pandemic and commitments to carbon neutrality by key countries have significantly increased the demand for industry DX.

The functions required of DX are not limited to traditional forms of value creation, such as improving production efficiency and providing new value and customer experience, but also extend to the realization of resilience, sustainability, and human-centricity for society overall. Many enterprises are struggling to move forward with new, philosophy-driven initiatives, however, even though they are facing various challenges with their existing DX.

In this article, Fujitsu’s Chief Digital Economist, Jianmin Jin, examines and analyzes such topics as the challenges enterprises face in implementing DX; the correlation between expected productivity, resilience, sustainability and human-centricity; and the global lighthouse as a best-practice DX case study. He provides a framework for supporting conventional DX and new initiatives and also suggests strategies to raise the outlook on manufacturing.

The demand for new initiatives in manufacturing DX

How has the manufacturing industry evolved, given the successive digital technologies that have emerged? In the 2000s, next-generation digital technologies such as AI emerged as enablers, in addition to traditional ICT. As we moved into the 2010s, these next-generation digital technologies not only led to new industries, but also drove digital disruption (disruptive innovation through digital technology) in existing industries. Europe, the U.S. and Japan have engaged in smart manufacturing for about 10 years now, as exemplified by "Industrie 4.0" (fourth industrial revolution) proposed by the German government around 2012, the Industrial Internet of Things (IIoT) led by the private sector in the U.S., and the New Robot Strategy and Connected Industries in Japan.

However, according to a survey by the World Economic Forum (WEF), apart from a few frontrunners, the majority of companies are still struggling with DX as they are only conducting PoCs or individual use cases. Moreover, the Smart Manufacturing Institute (CESMII), funded by the U.S. government, has revealed that manufacturing productivity has not increased in America since the fourth industrial revolution began about 10 years ago, and that 98% of the manufacturing industry is still "stuck" in the third industrial revolution[*1]. In addition, a look at Japan's engagement with DX (including in such areas as digitalization and data utilization) reveals that it too is lagging behind expectations, as around 95% of companies, not just in the manufacturing industry but in other sectors as well, are either yet to embark on DX or have implemented DX in only one department[*2]. It is fair to say that manufacturing DX is not as advanced as expected.

Meanwhile, we are faced with cataclysmic changes in the global socioeconomic environment, notably the COVID pandemic and the Ukraine crisis. In the manufacturing industry, there is a need to strengthen our response to supply chain resilience and agility, to improve eco-efficiency including toward achieving carbon neutrality, and to accelerate the transition to renewable energy. Europe is quickly responding to these societal demands. In Germany, the birthplace of Industry 4.0, the newly announced 2030 Vision for Industrie 4.0 and Sustainable production: Actively shaping the ecological transformation with Industry 4.0 focus on Sustainability (including climate change, decent work, and social participation), Autonomy and Interoperability as the three strategic fields of action. The European Commission has also announced a policy entitled Industry 5.0: Towards a sustainable, human-centric and resilient European industry, floating the concept of Industry 5.0 and seeking action from industry. WEF, which is actively working to promote manufacturing DX, has also incorporated sustainability into its goals for smart manufacturing and is encouraging industry engagement.

Manufacturing DX therefore now has a compelling need not only for value creation in terms of traditional production efficiency and the provision of new value and customer experience, but also for value creation that takes account of the resilience and sustainability of society overall. The manufacturing industry is facing new expectations from the global community, even as it struggles with DX. It is not hard to imagine that most CEOs are struggling to cope with this.

*1. John Dyck (October 2021). Robot revolution & industrial IoT initiative - Partnering to drive interoperability and harmonization.
*2. METI (December 2020). DX Report 2 (Interim Report)

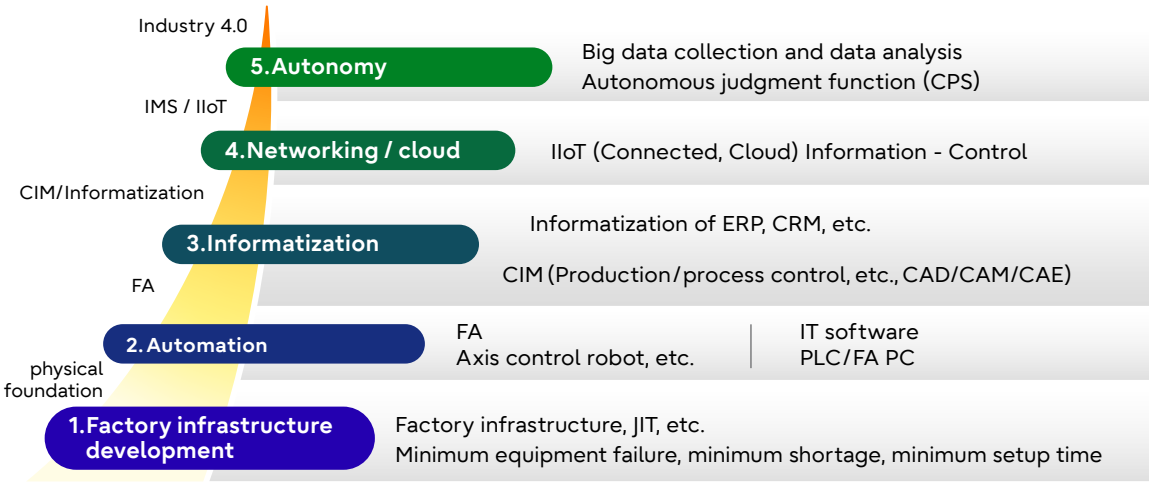
Evolution of smart manufacturing systems

This brings us to the question of what kinds of transformation have occurred in the manufacturing industry to date? Over the decades, the deployment of ICT has generated various changes in the field, in manufacturing systems, and in corporate management structures. In contrast, digital disruption in the manufacturing sector has yet to make headway, despite high expectations that Industry 4.0 and smart manufacturing will be driven by next-generation digital technologies.

Figure 1 is a schematic representation of the evolution of manufacturing systems. The evolutionary process can be divided into the following five main categories:

1. **Factory infrastructure development (optimal physical infrastructure)**
2. **Automation (visible and invisible automation)**
3. **Informatization (ICT and OT systems, digitalization)**
4. **Networking/cloud (data collection, data propagation, computing on data, visualization, modeling, optimization and prediction, etc.)**
5. **Autonomy (decision intelligence and execution, etc.)**

Figure 1 Evolution of manufacturing systems



Source: Created by the author based on an interview with JMA Consultants Inc.

If we organize IT, digital technologies and other related elements into an industrial revolution theory framework, "automation and informatization" (Layers 2 and 3) can be grouped into the third industrial revolution, while "connected and autonomous" (Layers 4 and 5) can be grouped into the fourth industrial revolution. "Automation and informatization" is the infrastructure necessary for the evolution to smart manufacturing, while "connected and autonomous" is the core of what we call smart manufacturing in this article. However, since production and management systems will evolve at varying rates and in varying degrees depending on the company, not all companies will simultaneously advance to "connected and autonomous" after setting the stage for "automation and informatization", and in most cases, progress will be coincidental.

3 key smart manufacturing challenges

As mentioned above, smart manufacturing has captured significant attention for overcoming the conventional limitations of "automation and informatization" which have been in place for decades. In reality, however, smart manufacturing is not progressing as well as expected. The background and impediments vary from country to country and from company to company.

In May 2022, CESMII conducted a survey on the challenges encountered in implementing smart manufacturing in the U.S. and compiled a report on its findings[*3]. The main challenges can be summarized into the following three categories:

1. **Lack of smart manufacturing talent, technology, know-how, and system of data governance**
2. **Financial challenges that seriously affect cost and return on investment (ROI)**
3. **Issues surrounding the balance between existing and new business (ambidextrous management), including the handling of legacy assets and business allocation**

Some of these issues are related to digital technology, some to real manufacturing systems (e.g., expertise in manufacturing process improvement, legacy equipment, etc.), and some to business management that has no relationship to digital technology itself.

However, high costs, difficulty understanding ROI, and a lack of digital technology skills and talent are common issues that have been identified in surveys of various companies[*4]. (For example: METI Japan (2022). FY2021 Fact-finding survey on core manufacturing technologies: Challenges and responses in Japan's manufacturing industry - Report)[*5]

*3. BMWi (October 2019). 2030 Vision for Industrie 4.0 - Shaping digital ecosystems globally
*4. Molex (2021). The state of Industry 4.0: A survey of industrial manufacturing stakeholders
*5. METI Japan (2022). FY2021 Fact-finding survey on core manufacturing technologies: Challenges and responses in Japan's manufacturing industry

Part

2

The next 10 years - The challenge to transition to Industry 5.0

As we have seen in Part 1, when smart manufacturing was first proposed 10 years ago the goal was to improve productivity, create new business, and provide new customer value through digital technology. However, with the socioeconomic environment undergoing such massive change, it has become essential to build out the new functionality of smart manufacturing.

Part 2 will introduce the functions that will become indispensable for the future of the manufacturing industry in the next decade, along with examples of forward-thinking enterprises that can serve as role models.

Composability and sustainability required for smart manufacturing in the future

Gartner proposed the concept of a "composable business," based on the success factors of the frontrunner companies that responded quickly to the pandemic. Gartner defines a composable business as one that is architected for "real-time adaptability and resilience in the face of uncertainty." Table 1 shows Gartner's summarization of the functions that are required for a composable business to respond to environmental changes in times of uncertainty.

Table 1 Functions required of a composable enterprise

	Traditional business (Organization)	Composable Business (Organization)
Strategy	Long-term	Continuous (change)
Customer	Siloed	Unified
(Owner of) Value	Enterprise	Ecosystem
Technologies	Static	Composable
Workforce	Human	Human and Machine
Operations	Stable	Adaptive

Source: The Gartner 2022 CIO Agenda: Make Composability Your Superpower

Gartner proposes a methodology based on four principles and three building blocks for transforming a business into a composable enterprise.

Four principles of composability

1. Discovery
2. Modularity
3. Orchestration
4. Autonomy

Three building blocks of composability

1. Composable thinking
2. Composable business architecture
3. Composable technologies

DX focuses on transformation via digital means, but does not delineate the organizational structure to be targeted. The concept of a 'composable business' involves both the vision for a resilient organization and the means to achieve it. A composable business could be described as a developed form of DX.

Compared to so-called integral architecture, composable architecture can also be expected to cut costs, for the following reasons:

Three ways that composability cuts costs

- The entire system can be developed very quickly.
- Components can be arranged in a variety of ways by combining the internal modules.
- The advantages of standardization and reuse can be leveraged.

Especially in the area of software and applications, no-code/ low-code development technologies are increasing in popularity and adoption, along with API development automation needed for collaboration between modules. This makes application development easier and facilitates lower-cost system implementation. These points are considered to have a “two birds with one stone” effect on the spread of smart manufacturing.

In fact, some companies are already putting them into practice. For example, in the FY2022 edition of the Fujitsu Technology and Service Vision (FT&SV), which describes Fujitsu’s transformation and shares insights on building a sustainable society, Fujitsu gives insights in line with trends in composable architecture, writing that “in the future businesses will shift from creating their own new cloud-native applications to quickly connecting and combining various services”. As a DX partner to its customers, Fujitsu has begun to utilize and implement ecosystems with the aim of creating a Component as a Service business model that will deliver applications that grow as a result of reusing know-how and combining components.

Recent years have seen growth in manufacturing methods that are relatively compatible with digital technology, including industrial structural change in the automotive industry (EVs), manufacturing process innovation through Tesla’s single-piece (unibody) casting, the emergence of digital native manufacturing technologies such as 3D printer technology, and the deployment of AI in manufacturing processes. For example, at Tesla, large-scale casting (megacasting) and integration of components has reduced complexity in production by slashing the 171 parts originally required for the Model 3 to just two parts for the body structure of the Austin-built Model Y vehicle, thereby requiring 1,600 fewer welds. In addition, the number of robots on the production line at the new factory in Austin, Texas, has been reduced by more than 70% per production capacity compared to the number originally required for the Model 3 production line. This simplification or modularization of processes in the real world simplifies IT system interoperability.

As a result, the integration of IT and OT is expected to continue through technological and IT innovations in the real world, lowering the barriers to the future growth of smart manufacturing.

The growing importance of sustainability

Another important requirement of smart manufacturing is the implementation of sustainability. Many factors have contributed to the international community and the business community starting to take sustainability seriously. These include the sense of urgency toward achieving the UN's SDGs, the progress achieved since the declaration of carbon neutrality by many countries and their progress on the Paris Agreement, the rapid response to the pandemic, and social dissatisfaction with the technological monopoly and huge income disparity resulting from the winner-takes-all model that has emerged as a corrupting effect of rapid digitalization. The abovementioned initiatives by Germany, the EU and WEF are a response to these demands. The EU has identified the following six technology areas that support Industry 5.0:

Six technology areas that support Industry 5.0

1. Individualized human-machine-interaction
2. Bio-inspired technologies and smart materials
3. Digital twins and simulation
4. Data transmission, storage, and analysis technologies
5. Artificial intelligence
6. Technologies for energy efficiency, renewables, storage and autonomy

Most of these technology areas are digital technologies themselves or technologies that require digital support. Industry 4.0 and 5.0 both agree on the use of digital technology as a tool.

In terms of technology, the EU's Industry 5.0 concept encourages the use of advanced digitalization, big data and AI for next-generation industries. At the same time, it demands that suitable technologies be deployed for workers and argues that workers should not become 'slaves' to technology. There are many trade-offs between the deployment of advanced digital technologies and their suitability for workers. In this sense, the abovementioned low-code/no-code technologies and composable approaches are truly worker-friendly technological approaches that are in line with the delivery of human-centric value, and further technological innovation is expected in the future.

In this way, society is beginning to look to industries empowered by digital technology to solve the world's problems. Regulators, including the EU, will further encourage industry to redouble its efforts, and will doubtless implement policies with incentives to grant benefits or impose penalties. This move is expected to have a significant impact on global business management.

Role models for smart manufacturing: Global Lighthouses

What would it take for companies to successfully leverage digital to drive smart manufacturing? WEF has remained focused on transforming manufacturing via next-generation digital technologies (4IR technologies) since the 2010s. Given that the global manufacturing industry has been slow to embrace DX, WEF, in collaboration with McKinsey & Company, launched the Global Lighthouse Network in 2018 to identify the world's leading DX companies and create DX role models on a global scale. As of July 2022, the Network had 103 members. In September 2021, WEF also began identifying Sustainability Lighthouses, that is, sustainability pacesetters from across the Global Lighthouse Network, and as of July 2022 had designated a total of six.

Global Lighthouse characteristics

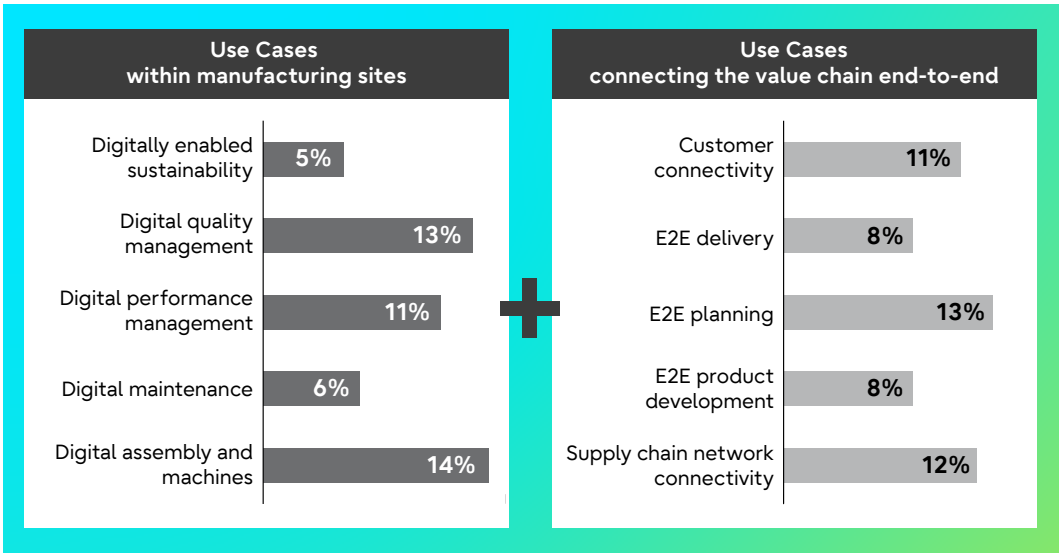
What types of company are chosen as lighthouses? To be designated a Lighthouse by WEF, companies must first self-apply for selection. While WEF does not publish quantitative criteria for selection, it does publish the following qualitative criteria:[*6]

> A Lighthouse is a factory that has adopted fourth industrial revolution (4IR) technologies, from pilots to large-scale integration, and as a result has achieved significant financial and operational results (results are quantitatively verified against the KPIs discussed below).
>
> To be designated a Lighthouse, a factory must meet a high standard in the following four categories:
>
> - Has achieved a significant impact
> - Has successfully integrated several use cases
> - The technology platform is scalable
> - Has demonstrated strong performance in key drivers such as management transformation, capacity building, and collaborating with communities in the fourth industrial revolution

Actual selection is conducted by a committee of stakeholder private sector organizations, university academics, and renowned 4IR technology experts, and includes site visits.

The 103 lighthouses mentioned above are deploying approximately 143 use cases (excluding duplicate cases). Figure 2 categorizes the use cases deployed by the lighthouses, dividing them into two types of deployment: those within manufacturing sites and those that connect the value chain end to end (E2E).

Figure 2 Classification of use cases deployed by WEF Lighthouses (within manufacturing plants; throughout the value chain)



Source: Calculated and created by the author based on WEF (March 2022) The Global Lighthouse Network Playbook for Responsible Industry Transformation and WEF (September 2021) Global Lighthouse Network: Unlocking Sustainability through Fourth Industrial Revolution

*6. WEF (January 2019). Fourth Industrial Revolution: Beacons of Technology and Innovation in Manufacturing.

Smart manufacturing shifting focus to the entire value chain (E2E)

The number of E2E deployments (about 75 use cases) is larger than the number of deployments within manufacturing plants (about 68 use cases). This would seem to indicate that smart manufacturing has shifted from an approach centered on improving productivity in manufacturing plants to an approach centered on creating value for the entire value chain (E2E), plants included. The following three factors are considered to be behind this shift:

1. **Digital native consumers have become the primary form of consumer. Their needs have shifted from wanting to experience the traditional quality of goods to experiencing design, smartness, and other forms of value, requiring total value provision throughout the value chain.**
2. **Growing uncertainties (e.g., pandemic and geopolitical risks) clouding the business environment have increased the need for resilient E2E supply chains.**
3. **Digital technologies such as AI, cloud, blockchain and 5G, which are enablers of E2E connectivity, are in the diffusion phase.**

Against this backdrop, activities to drive smart manufacturing have been elevated from the dimension of in-factory management to that of business management and have become a theme that should presumably be addressed by the entire management team rather than a single factory manager or the IT department.

In fact, frontrunner companies are maximizing the effects of DX by simultaneously adding in factory floor use cases and E2E use cases. For example, Johnson & Johnson Vision Care bundles the following main five use cases:

Johnson & Johnson Vision Care use cases

1. **Digital customer collaboration**
2. **E2E visualization and real-time tracking**
3. **Process automation/Logistics/AGV**
4. **Adaptive process control and vision system**
5. **Intelligent material handling and tracking**

Johnson & Johnson's initiative scales up across the value chain, extending DX beyond production sites by reaching out to the order supply chain (upstream) and their customers (downstream).

In addition, Schneider Electric, a global manufacturer of electrical and industrial equipment, is deploying the following main five use cases at its headquarters manufacturing site in France:

Schneider Electric use cases:

1. **E2E planning and scheduling**
2. **Digital performance management**
3. **Digital/Analytics energy management**
4. **Digital maintenance/scrap reduction**
5. **Automation and operator capacity expansion**

Since launching the lighthouse case study at its headquarters, Schneider Electric has been scaling up through widespread deployment of know-how to its own sites in the U.S., China, Mexico, and Indonesia. By fostering the transformation of its entire site network on a broader scale, this initiative is accelerating DX and successfully expanding Schneider Electric's own lighthouse network. It grew from just five sites in 2017 to more than 80 by 2021.

The cases of Johnson & Johnson Vision Care and Schneider Electric are thought-provoking role models; they are examples of scaling up smart manufacturing from both the value chain and organizational perspective to magnify effectiveness.

Lighthouses are quantitatively assessed using KPIs

WEF lighthouse assessment is not limited to mere technical feasibility, but also quantitatively identifies the impact on corporate management performance and sustainability. As Table 2 shows, the KPIs employed as the WEF assessment axis consist of five major categories and 17 minor categories. While there is variation in the impact confirmed by each lighthouse, the expected results can be verifiably achieved if well implemented. Having obtained such clear data about impact is encouraging for other companies engaging in smart manufacturing.

Table 2 Operational and environmental impacts of the Lighthouse digital journey

KPIs (Major category)	KPIs (Minor category)	Confirmed Impact (Effect)
Sustainability	Greenhouse gas (GHG) emissions reduction	8-97%
	Waste reduction	4-80%
	Water consumption reduction	5-75%
	Energy efficiency	1-100%
Productivity	Factory output increase	2-124%
	Productivity increase	3-400%
	OEE (Overall Equipment Effectiveness) increase	2-84%
	Product cost reduction	4-70%
	Operating cost reduction	1-92%
	Quality cost reduction	2-100%
Agility	Inventory reduction	5-100%
	Lead-time reduction	10-99%
	Change-over shortening	11-100%
	On-time delivery increase	1-30%
Speed to market	Speed-to-market reduction	10-89%
	Design iteration time reduction	2-98%
Customization	Lot size reduction	4-100%

Source: WEF (March 2022). Created by the author based on The Global Lighthouse Network Playbook for Responsible Industry Transformation

It is worth noting that WEF's lighthouse impact verification process is continually improving its KPIs. In particular, the sustainability indicators have been improved. Energy efficiency was adopted as one of the Agility indicators in the initial set of 2018 verification indicators, but by the end of 2019, subcategories such as waste reduction and water consumption reduction had been added. In addition, in March 2021, CO2 emissions reduction was added, and in September 2021, greenhouse gas emissions reduction was also added. In September 2021, three of the 90 lighthouses were designated Sustainability Lighthouses to recognize their impressive eco-efficiency. By March 2022, three more companies were added to the list, bringing the total number of designated Sustainable Lighthouses to six.

As shown above, Lighthouses are bringing about the following four transformations:

1. **Demand chain agility and consumer-centricity**
2. **Supply chain resilience**
3. **Productivity and speed at production sites**
4. **Production efficiency**

In fact, 64% of Lighthouses are bundling use cases to have a positive impact on eco-efficiency. WEF has revealed that by embracing digital technologies, Sustainable Lighthouses demonstrate that sustainability and competitive excellence can be interwoven.

Table 3 lists exemplars of use cases deployed by Sustainable Lighthouses, which may be described as developed forms of DX Lighthouse. All of these use cases are solutions that not only utilize digital technology but also achieve a balance between digitalization and sustainability, thereby serving as aspirational reference examples for other companies.

Table 3 Typical examples of use cases deployed by Sustainable Lighthouses

Examples of use cases	
Sensors and visualization system to improve sustainability in production activities	Optimization of real-time smart energy use with IIoT applications
Use of digital twin to improve sustainability in production activities	Lights out (unattended) automation by optimizing the capacity of the digital twin for sustainability
Achieving manufacturing sustainability through advanced data analysis	IIoT for real-time sensor data collection and analysis for energy, emissions, waste and water management
Advanced data analysis, reduction of cleaning water and optimization of contaminated water cleaning	Reduction of sludge waste by AI process control
E2E CO2 tracking and reporting solutions across the value chain	Energy optimization by predictive analysis

Source: Created by the author based on WEF reports

However, the eco-efficiency outcomes revealed by the 64% of Lighthouses are known to be more the result of pursuing other goals such as production efficiency, rather than the result of working toward a clear goal. In this sense, WEF's Sustainability Lighthouse Assessment Initiatives are a call to companies to look at more sustainable goals.

The WEF report, published in March 2022, raises the concept of responsible transformation (RX), and adds the environmental, social and governance (ESG) elements of workforce engagement and governance to the concept of sustainability, with eco-efficiency at its core. WEF describes this as reflecting the growing commitment to combating climate change and the unprecedented importance of ESG due to the cataclysmic changes in the global business environment wrought by the pandemic and other factors. This seems to be in line with the thinking of Germany and the EU.

Part 3

4 Ways CxOs Can Overcome Manufacturing Challenges

In part 3, we summarize the findings of this study mentioned in Part 1 and Part 2.

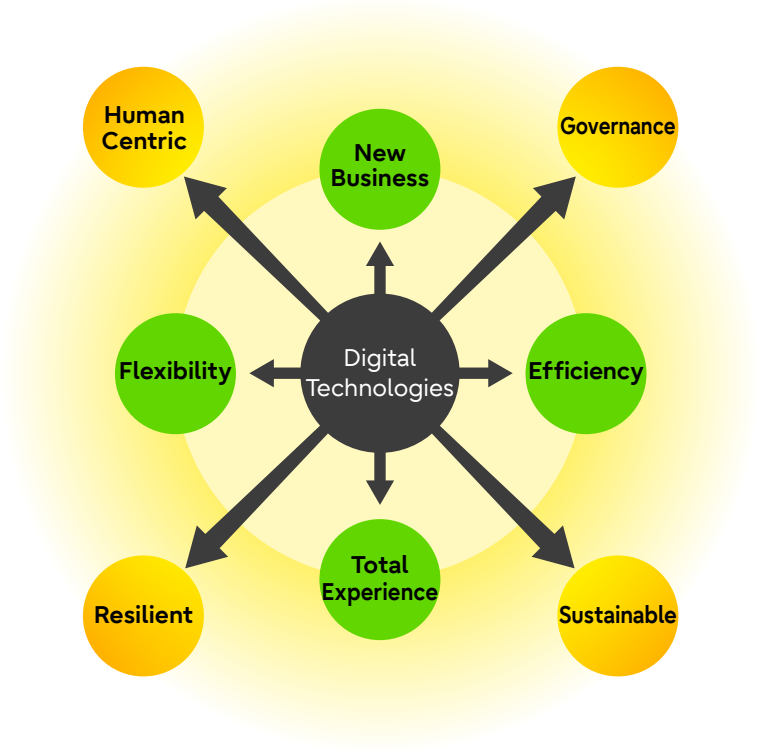
While the progress of Industry 4.0 or smart manufacturing over the past decade has not been as strong as expected, in the two-plus years since the pandemic began, expectations of manufacturing DX have expanded beyond productivity gains and customer value creation to improvements in resilience and sustainability as well as solutions to societal challenges. Of course, digital technology cannot solve all economic, environmental, and societal problems, but we must recognize the need to leverage it to help solve societal problems.

In Part 3, we present four recommendations that CEOs should address immediately, based on the challenges posed by smart manufacturing and the initiatives implemented by leading companies to date.

Growing expectations of digital manufacturing

Figure 3 illustrates the growing expectations placed on manufacturing DX. The push for smart manufacturing was initially expected to improve efficiency and total experience, and create flexibility and new business, as shown by the dotted circular line in the figure. Currently, as the diagram's outer circle shows, the area denoting expectations has expanded to include implementation of sustainability, supply chain resilience, human centricity/workforce engagement, and corporate governance.

Figure 3 The breadth of functions required for manufacturing DX



Source: Created by the author

As described above, the functions to be delivered through manufacturing DX and the demands (needs) made by the economy and society are changing, but digital technologies will remain as core enablers for Industry 5.0. It will therefore be important to determine how to fulfil new economic and social needs and values. The fundamental debate here does not revolve around naming conventions such as Industry 4.0, Industry 5.0, SX (Sustainability Transformation), or RX (Responsible Transformation), but rather, that the use of digital technologies for building new solutions requires a solid approach.

Composable architecture as a common platform for manufacturing DX

As already mentioned, in an era that calls for resilient and agile management, composable thinking is a key requirement for manufacturing DX. IT systems and OT systems (mechanical products and manufacturing processes) must both therefore have composable architectures. This will not only accelerate the pace of integration of IT and OT, but also promote low-cost smart manufacturing, as well as meet the societal demand for human-centricity.

As mentioned above, the concept of modular architecture originally existed in the IT field for both hardware and software products. In recent years, especially since the start of the pandemic, composable thinking has developed and applications have shifted in a composable direction. Manufacturing DX is not simply a matter of focusing on digital technologies. It is important to implement composable architectures for everything involved in smart manufacturing, including the design and manufacture of physical production systems and production technologies that apply digital technologies, as well as the corporate organization. The challenge here is how to componentize physical products and production equipment on the production floor, something that has been considered difficult until now. In essence, it is critical to use such a composable approach to develop common infrastructure for all IT and OT in smart manufacturing.

Taking advantage of economies of scale and network effects

In applying digital technology, it is essential to consider economies of scale and network effects. 'Economies of scale' means that by gathering many similar items together, a greater result can be achieved than with a single item. In business and management, it can be expected to improve management efficiency, reduce costs, and expand production volume. The 'network effect' is linked to Metcalfe's Law, in that the expected effect can be maximized by forming an E2E ecosystem along the value chain.

The individual WEF-designated Lighthouses mentioned above have deployed around 15 to 30 use cases, and some Lighthouse companies have already realized economies of scale and network effects through widespread deployment to additional manufacturing sites. Their approaches and use cases are likely to serve as a useful reference.

Combining smart manufacturing IT infrastructure with use case-enabled applications

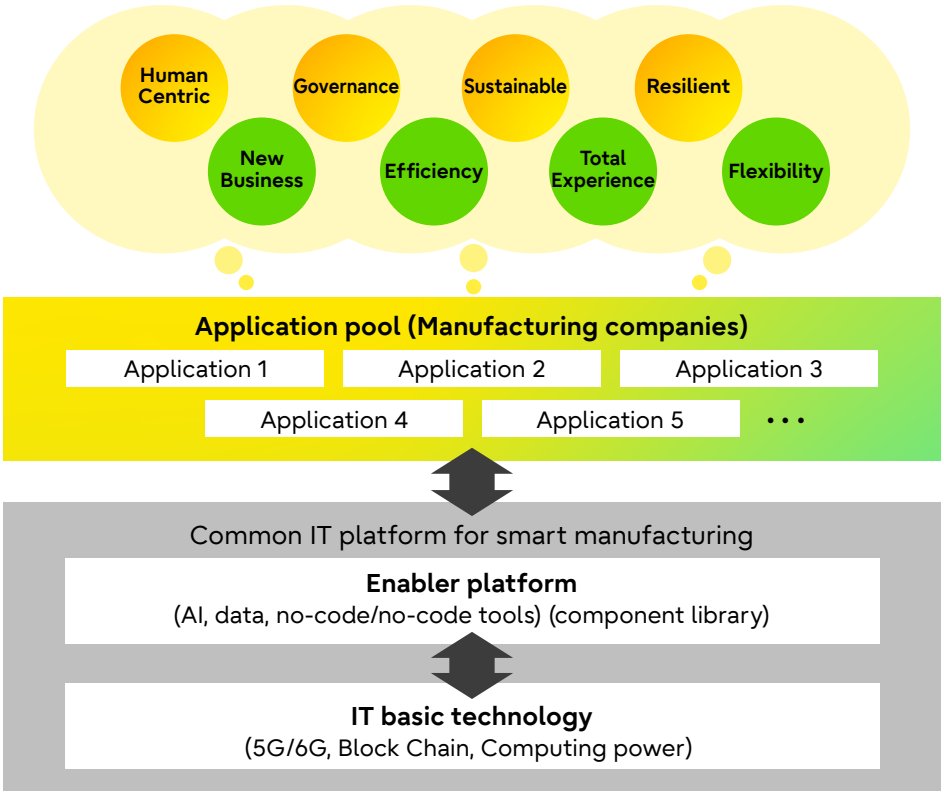
As discussed, manufacturing DX must provide new value the more the global environment changes, so with each change comes a new name, such as SX, RX, Industry 5.0, and so on. Meanwhile, as made clear by the abovementioned six technology areas supporting Industry 5.0 in the EU, digital technologies continue to occupy a central role as enablers. In the push for smart manufacturing, the IT infrastructure underlying smart manufacturing is indispensable to any transformation.

Put another way, the IT infrastructure for smart manufacturing is IIoT platform, but in some respects, individual manufacturing companies have difficulty building a smart manufacturing IT platform on their own due to ROI issues. For this reason, it is anticipated that industry-wide smart manufacturing IT infrastructure will be established. Service vendors for smart manufacturing IT infrastructure would then play a significant role.

Meanwhile, solutions to support new needs could be addressed by individual use cases (applications). In Fujitsu's approach described earlier, common functions and modules are provided as services on a platform. A framework for enabling reuse of components is also required.

Figure 4 illustrates the combination of IT infrastructure for smart manufacturing and use case-enabled applications. It is divided into two layers: the common IT infrastructure that supports smart manufacturing and the application part for each manufacturer. For the development of the application pool in the upper layer in Figure 4, it will be important to utilize the ecosystem to attract outstanding startup companies that specialize in various fields. Alternatively, manufacturing companies themselves could develop and implement their own solutions (applications) in the future. Vendors providing IIoT platforms will be required to further leverage the ecosystem by adding enablers on top of the platform and co-creating with partners.

Figure 4 Image of IIoT supporting smart manufacturing



Source: Created by the author

Using a solid approach with a clear vision

The expectations placed on digital innovation to solve societal challenges are currently rising and expanding. Meanwhile, the promotion of smart manufacturing has not progressed as expected and we are therefore facing a variety of challenges. Digital innovation as an enabler is also lagging behind expectations, giving rise to many problems when the real world and digital systems do not mesh. In particular, because human-centricity and governance are wrapped up in value judgments when solving societal challenges, social consensus-building and institutional design are in some ways more important than digital technology.

The industrial world and CEOs engaged in manufacturing DX therefore need to raise their outlook, formulate a vision, and develop medium-to-long-term business strategies. Further acceleration of both digital and real innovation is also necessary, and this requires a solid approach.

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