



Fujitsu Future Insights

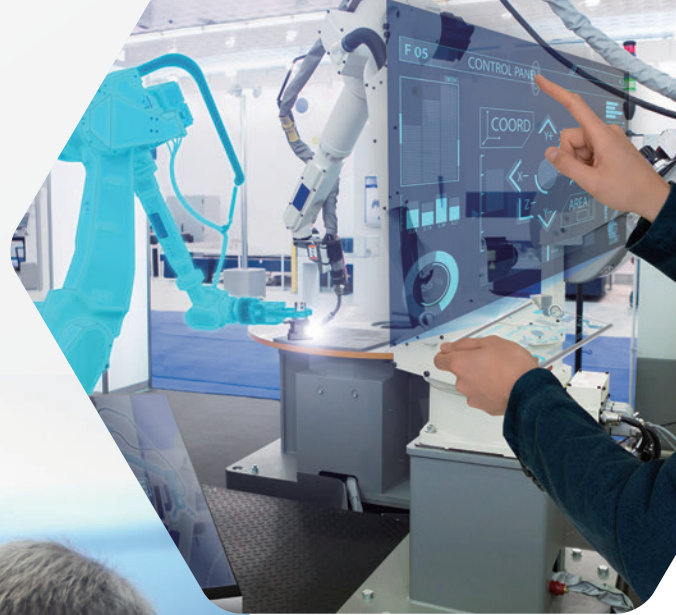
Digital Transformation in Manufacturing



shaping tomorrow with you

Chapter 1

The Future of Manufacturing



Fujitsu Future Insights Digital Transformation in Manufacturing

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Fujitsu Future Insights

Every year, Fujitsu publishes the Fujitsu Technology and Service Vision. This is the company's global vision for the future, looking at how businesses and society will use technologies to drive innovation. Fujitsu Future Insights looks at specific fields in order to provide a deeper analysis of challenges and the impact of technologies. It also offers suggestions for possible future scenarios and strategies related to those fields.

[Website]

Fujitsu Technology and Service Vision
<https://www.fujitsu.com/vision/>

Fujitsu Future Insights
Digital Transformation in Manufacturing
<https://www.fujitsu.com/global/vision/insights/wp5/>

Market changes forcing manufacturers to transform

Until the turn of the century, the manufacturing industry generally focused on developing, mass-producing and unilaterally delivering products that made people's lives more convenient and comfortable. However, the spread of the Internet gave customers access to significantly more information and wider choices. This change led manufacturers, including those engaged in B2B, to incorporate customer feedback more proactively into their product development processes.

As a result of this shift, manufacturers are now transforming their operations to meet new levels of customer expectation, including high degrees of customization, small volume orders and shortened delivery times.

Manufacturers are also working to transform product development and design processes, known as the engineering chain. For example, by introducing front-loading¹ and concurrent development, manufacturers can define specifications more rapidly, using 3-D design data and digital product design tools. Meanwhile, manufacturing supply

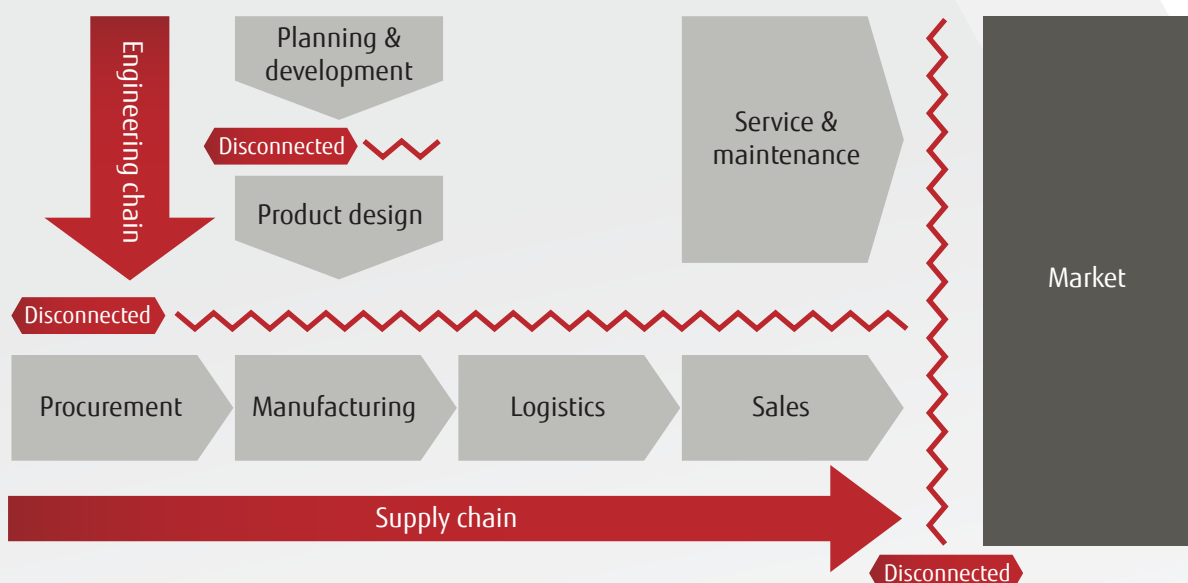
processes, known as the supply chain, are being transformed by the ability to track and analyze operational performance data in real time. This enables more efficient physical production processes.

However, the end-to-end systems to fully exploit these developments are generally still in their infancy, as the data connections between the engineering and supply chain functions typically remain fragmented and disconnected. We believe manufacturers will need to seriously consider building such end-to-end digitalized operations, both to provide rapid response to changing customer demands and also to enable new ways of delivering value, such as subscription and pay-as-you-go.

Moreover, the COVID-19 pandemic has threatened both health and economies throughout the world. It has also exposed weaknesses in physical manufacturing operations. The suspension of production across numerous geographies has fragmented global supply chains, making it impossible to continue normal business operations.

Digitalization is now key to creating resilient manufacturing systems that can respond to an uncertain future.

¹ Using resources in the early phase of a product development process.



Fujitsu's vision for the future of manufacturing

It is becoming increasingly difficult for manufacturers to transform their manufacturing business systems by acting alone. No single organization will be able to deliver all the value that customers want. The required value will be created only when suppliers, channel partners and other customer touch points become connected ecosystems.

It is not enough to digitalize internal processes and link them with data. Today, organizations also need to connect and exchange data with external ecosystem partners. Indeed, COVID-19 has highlighted the need to rebuild more distributed supply chains with closer proximity to the market, in order

to provide resilience against similar crises in the future. This requires connecting the engineering chains and the supply chains through data. Such connections enable resilient ecosystems, where functions may be physically separated but are digitally connected, so that they work as a single, integrated manufacturing system.

The keys to design integrated ecosystems, comprising internal and external processes, focus on driving the required customer value. These customer-value-driven ecosystems can flexibly combine necessary processes to deliver tailored value that meets the customer needs. This creates end-to-end manufacturing systems, linking internal and external processes with data.



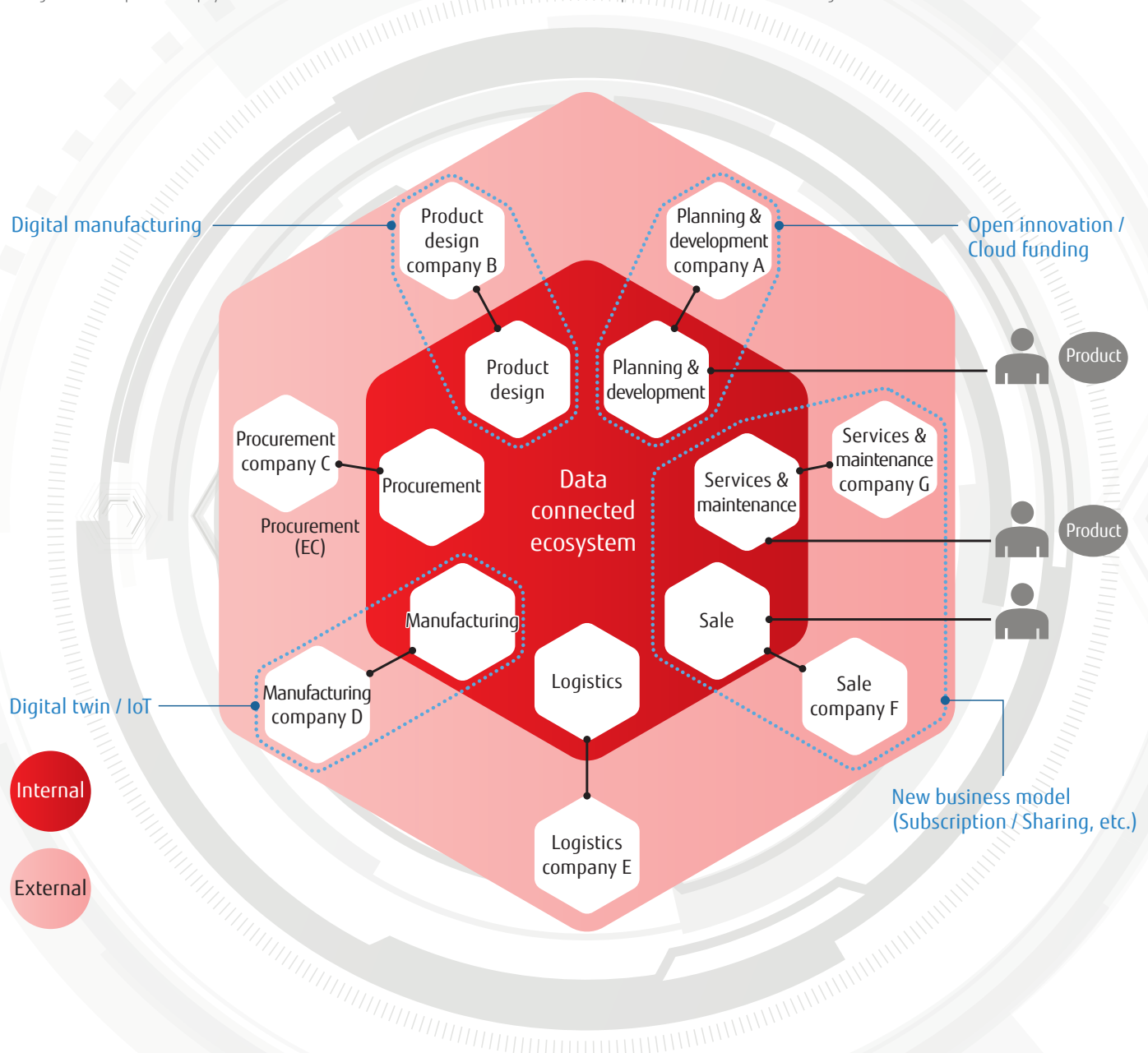
In the product development process, it is important for manufacturers to leverage customer behavior data, as well as open innovation with external partners and customers. In the design process, concurrent digital manufacturing among the ecosystem partners will be enabled by sharing 3-D data across both internal design and development functions and across external partners for design and quality assurance.

Digital twins² can help organizations to understand and optimize their manufacturing processes. This requires connecting the design process and the manufacturing process with data. In addition, suppliers and in-house manufacturing

processes need to be connected. Their sales, service and maintenance functions will also benefit from connecting with customers and sharing data to adapt to new business models, such as subscription and sharing, and offer new products and services.

We expect this approach will eventually enable manufacturing processes to work as integrated systems, delivering fully customized value in a timely manner. It is becoming a business priority for manufacturing companies to actively participate in such data-driven ecosystems, in order to exploit the potential of manufacturing in the future.

2 Digitalized companions of physical assets such as machines or facilities that can be used for product simulation or monitoring.



Mega Trends in Manufacturing



Manufacturing based on the value from experience



Leveraging ecosystems for manufacturing



Software-driven manufacturing



Changes in human roles in manufacturing



Contributing to the achievement of SDGs through manufacturing



Manufacturing based on the value from experience

Traditionally, the key role of a manufacturer has been to supply standardized goods efficiently to meet the market demand. To fulfil this role, companies have built vertically integrated supply chains with selected suppliers, to exploit the benefits of mass production.

In these circumstances, an increasing number of organizations are adopting the subscription model, offering unlimited access to products and services at a flat rate, to deliver the required value from experience to customers. Through subscriptions, organizations can develop a better understanding of their customers by connecting with them on an ongoing basis and creating insights from the data.

A key question to continuously ask here is, “what the value from experience do my customers want?” This process enables organizations to develop new products and services that deliver the value from experience customers truly want.

Manufacturers of cars and home appliances are also moving to subscription models. However, just changing the delivery model of products does not enhance the value from experience significantly. Today, it is essential for manufacturing organizations to consider the value from experience first. They must completely shift the emphasis away from efficiently supplying commodity products to the market and towards delivering the value from experience required by customers through their products.

This shift also applies to B2B manufacturers. For example, a major tire manufacturer no longer simply provides tires to business customers, such as bus operators. They also now attach sensors to the tires to collect data on air pressure, temperature and other parameters. The tire company analyzes the collected data to detect abnormalities at an early stage. This service delivers better experience for their business customers, enabling them to prevent accidents, provide more safety and reduce the cost and time of maintenance. Many advanced manufacturing organizations are already embracing this kind of business transformation.

Has your organization started to develop products that deliver the value from experience required by your customers? How well do you understand your customers through your various customer touch points?



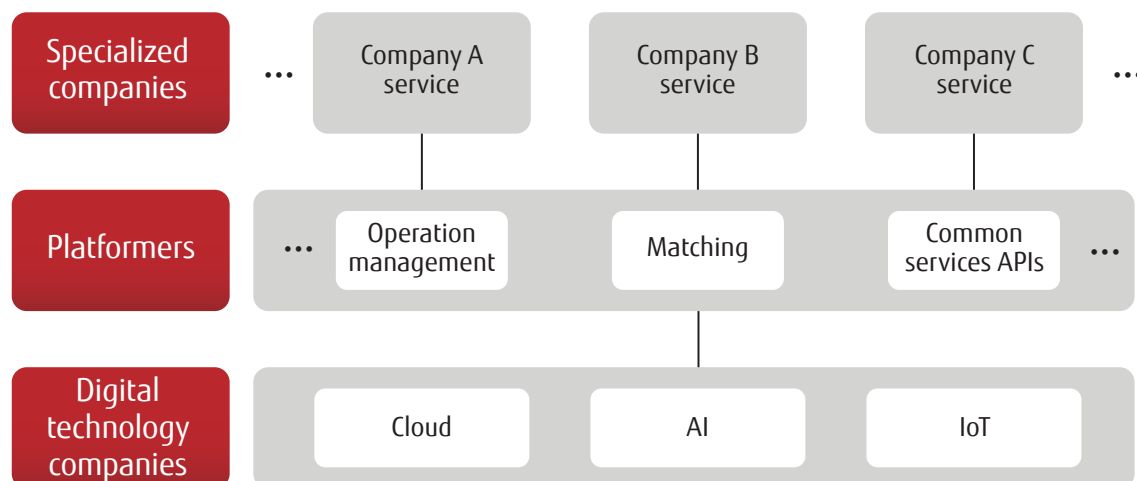
Leveraging ecosystems for manufacturing

As described above, manufacturers need to design products and services that deliver the value from experience their customers truly want. However, it is challenging for a single organization to develop all the end-to-end capabilities required to deliver the desired customer experience. It is difficult for even the largest manufacturing companies to meet customer expectations all by themselves. They need to build wider business ecosystems and collaborate with partners, for example, such as customer-facing companies, digital technology companies and companies who can produce prototypes, in small lots and at rapid pace.

There are three main categories of companies within an ecosystem.

The first category is made up of ‘platformers’. These may be companies with major market share within the industry, or new entrants such as companies from other industries and

Three main categories of companies within an ecosystem





startups. For example, a Japanese start-up in the clothing industry has launched a cloud platform that connects individuals and companies who want to produce clothes with a network of small and medium-sized factories, providing a one-stop clothing production service. Whenever they receive specific requests, they can quickly analyze multiple variables, including budget, lead time and order quantity, to select the best factory in the network.

The second category comprises companies that specialize in very specific functions and roles. They can operate at lower cost through leveraging the common services that the platforms provide. The factories within the clothing ecosystem described above are in this category. Each factory has its own unique technologies and skills, such as pattern-making, embroidery and printing, executing production-to-order. They benefit from using the platform's common functions like matching services.

The third category comprises digital technology companies that help connect various players and provide data-driven value-adds to the ecosystems. Fujitsu is one of these organizations, helping manufacturing companies digitalize their internal processes, managing their data securely and

providing services to help them connect with each other.

It is expected that many new ecosystems will be created both within manufacturing and across other industry sectors. There will be both cooperation and competition within these ecosystems, as well as between ecosystems. In order to achieve growth while competing against other ecosystems, it is important for an ecosystem to develop fair, transparent governance and to design effective incentives for the participating companies within it.

How do you leverage your ecosystems to connect with your customers and deliver the value from experience? Are you creating your own industry platforms? Are you considering opportunities to work on other industry platforms?



Software-driven manufacturing

Just as fixed-line telephones have been replaced by mobile phones, and more recently by smartphones, the value for customers has radically shifted from hardware products to software and digital information. We have seen this kind of value shift not only in smartphones but also in many other

products like cars, electrical appliances, power meters and vending machines. Some companies have started innovative software-driven services even around commodities like clothes and tires. They obtain data about a person's health or the condition of tires to create useful insights. The same principle applies to industrial goods. Manufacturers are shifting their business model from the supply of equipment to provision of software-driven services to operate and maintain the equipment. It is also likely that the COVID-19 pandemic will accelerate the drive towards automation using software, reducing human intervention in production processes.

Traditionally, manufacturing companies have differentiated their value through their in-house hardware technologies. They typically take a closed-loop strategy, operating the end-to-end processes by themselves, including design, development, production, sales and service. However, today, manufacturing companies need to strengthen software-development capabilities to exploit new opportunities in a fast-changing market. The traditional in-house approach can

limit their success. Manufacturers have to embrace a more open approach to innovation, collaborating with a variety of companies, startups and research institutions.

To take advantage of open innovation, companies typically need to develop internal functions to determine what external resources to adopt and what internal resources to offer externally. It may be necessary to set up or participate in consortia to engage with potential new business partners. It may also be necessary to create more open technical interfaces, like APIs, to enable open-innovation partners to use information and functions more effectively. In addition, we expect to see greater adoption of industry-specific clouds, enabling a more collaborative approach to software development across industry ecosystems.

How are you preparing for software-driven manufacturing? Are you making use of open innovation or industry-specific cloud? Have you considered the security implications of using software-driven products and services?





Changes in human roles in manufacturing

We have already seen that digital technology and robots are increasingly used to automate manufacturing processes. What will happen to manufacturing operations in the future? Are we moving toward completely autonomous operations that require no human intervention at all? Or will people continue to play a key role? Will robots increasingly collaborate with people in manufacturing?

In the future, the processes of product planning, development, design, procurement, production, delivery and post-sales service will be increasingly connected by data. This could lead to minimizing the scope of people's work in the entire process. To enable this, however, it is necessary to standardize various types of data, such as 3-D design data, flowing between product design and production as well as

between suppliers and manufacturers. Sharing standardized data will enable manufacturers to concurrently operate multiple processes more automatically, instead of operating each process sequentially.

In addition, it is expected that the introduction of local 5G networks will enable machines in different manufacturing processes to communicate data with each other in real time and autonomously optimize their operations. In such a data-driven smart factory, human workers will be responsible for finding out issues, making improvement plans and implementing them, leveraging the data across the entire value chain, including product planning, development, design, manufacturing, sales and services. Human workers will also be expected to create valuable insights from data and make strategic decisions such as what to develop and manufacture in the future. In this way, people will continue to play an important role in optimizing the end-to-end manufacturing process.



The communication between people and computers in manufacturing is now advancing rapidly, making it easier for them to collaborate closely. One example of this is 'Generative Design', a methodology of creating designs through human-computer collaboration. Within given specific design constraints, such as material type, weight and cost, computers can quickly generate a variety of design ideas. Using this approach, people can produce innovative design ideas that are not limited by their previous experiences, traditions and customs.

The way people work is also changing. The COVID-19 pandemic has created huge challenges for people operating in the manufacturing sector. This is expected to accelerate the use of digital technology, such as 5G and VR, enabling more remote operation of manufacturing facilities and processes.

Recently, many manufacturing companies have been holding workshops to shape their future visions of

manufacturing. The respective roles of machines and people continue to be relevant and controversial topics in these discussions.

We believe the core strength of a manufacturing company will lie in how it can use the creative power of people. The unique capabilities that only people possess, such as creativity, imagination and empathy, will be in high demand in the future business environment, where people and computers will collaborate more extensively. Accordingly, the profiles of the talent required may change. Companies will look for people who are able to understand fast-changing market needs, people who can design products from original ideas and people who can influence the market. In setting their future strategy, manufacturers must think about what key roles they expect their people to play, and develop plans for developing necessary skills to fulfill them.





Contributing to the achievement of SDGs through manufacturing

At the United Nations Summit in 2015, the Sustainable Development Goals (SDGs) were adopted to address global societal challenges and realize a more sustainable world. Organizations around the world now recognize that business must play an important role in solving these challenges. This is also linked with increased investment in environmental, social and governance activities.

SDGs are becoming a powerful way to engage with employees and customers. Both millennials and subsequent generations are strongly motivated by their desire to solve social issues. Of course, these generations will become the core population of corporate employees and customers in the future.

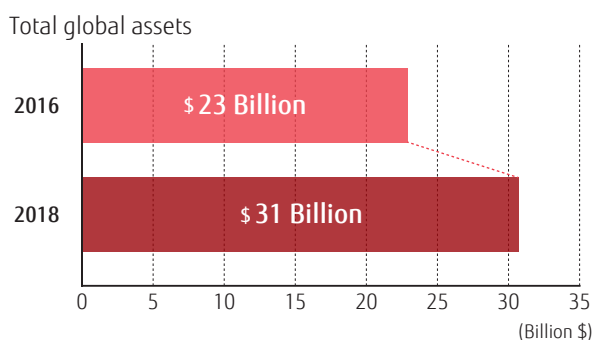
Manufacturers need to respond to the growing demands of their various stakeholders towards sustainable products and services that take social and environmental aspects into account. They are required to continuously consider more sustainable approaches, including the sourcing of raw materials

and the operating processes in place across their supplier ecosystems. Organizations that do not meet this requirement are unlikely to succeed.

At the World Economic Forum in January 2019, a major consumer goods manufacturer and a recycling company announced a new shopping platform that achieves Zero-Waste-to-Landfill for consumer goods. They are replacing disposable packaging with more sustainable, reusable solutions, including offering free collection from consumers' homes for recycling. They aim to create a recycling-oriented life cycle for consumer goods, providing customers with sustainable options for using products without creating any waste.

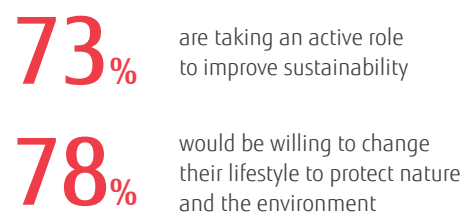
The SDGs represent the shared goals that we should aim to achieve through to 2030. Instead of forecasting a future based on what we are doing now, we need to calibrate backwards from these future goals. It is important for manufacturing companies to define their purpose and align their strategic direction with common social goals. What is your corporate purpose? How can you achieve your purpose by exploiting your manufacturing excellence? Your strategy for supporting the SDGs can be formulated by answering these questions.

Snapshot of global sustainable investing assets, 2016–2018



Source: Global Sustainable Investment Alliance, Global Sustainable Investment Review

Younger generations are more motivated to solve social challenges



Source: World Economic Forum, Global Shapers Survey 2017

Fujitsu and the Future of Manufacturing



The five future trends described above outline the significant transformation underway across the global manufacturing sector. The specific impact of these trends will differ from one manufacturer to another, so each organization must carefully consider how best to respond to these trends and how best to transform themselves.

One important trend is the need for manufacturers to create products and services that deliver the value from experience that customers expect. Digital transformation does not only mean improving business operations with digital technology, but also incorporating the value from experience into manufacturing and delivery processes.

To enable customers to achieve digital transformation, Fujitsu established Ridgelinez in Japan in April 2020.

Ridgelinez has a team of consultants focused on digital transformation in respective industries, as well as a team of

consultants that specialize in customer experience, data-driven AI and operational transformation. These teams collaborate in helping customers with planning, testing and implementing their digital transformation. Fujitsu also brings in design-thinking experts to help solve customers' challenges through co-creation programs, using Fujitsu's unique Human Centric Experience Design methodology.

In the USA and Europe, many manufacturers have already started to use industry platforms and shape ecosystems to deliver the value from experience for their customers. In Japan however, relatively fewer manufacturers are leveraging ecosystems.

Fujitsu and a major Computerized Numerical Control (CNC) equipment manufacturer have jointly started a strategic initiative in Japan to create a cloud-based industry platform

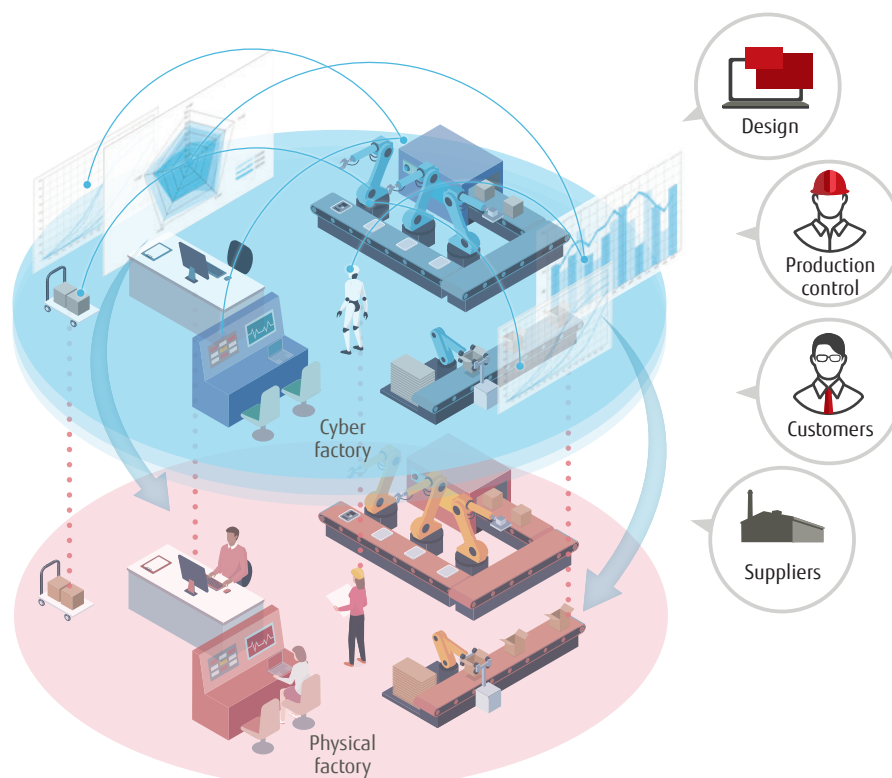
for machine tool makers and their user-manufacturers. This service will incorporate Fujitsu's COLMINA manufacturing platform service, enabling second-tier and small-size companies to easily access manufacturing shared services that are too costly to invest in by themselves. The initiative also aims to help the ecosystem partners to learn from the major CNC equipment manufacturer's best practices of digital transformation. We hope an ecosystem of the machine tool industry will grow through this initiative.

Fujitsu continues to provide COLMINA and other services to help manufacturing companies transform their businesses through connecting currently fragmented processes with data and exploiting manufacturing knowledge, experience and technology.

Fujitsu is also committed to introducing greater use of software across manufacturing processes. For example, we are providing

a software-driven system that enables a manufacturing company to develop products in a virtual space, instead of using actual products or prototypes. In this virtual space, they can easily share and exploit accumulated product development information, experiences and knowledge across various departments. They can also inspect virtual products with 3D virtual reality vision. This allows a manufacturing company to implement front-loading through designing and testing products as well as preparing production plans concurrently at the development stage.

Fujitsu Telecom Networks is implementing smart manufacturing and human-machine collaboration at Fujitsu's Oyama facility. By deploying COLMINA, and using data collected by IoT, the team at Oyama has been able to track and leverage statistical data on the past and current performance of the production line. By visualizing the past, present and future (typically the next 10 minutes) of the



COLMINA realizes digital twin

assembly line, production managers can identify problems on the line, gather relevant information and address potential problems, such as delays in parts supply. By taking corrective measures before a major problem occurs, they are able to avoid the downtime of the lines or reduce it significantly. Indeed, the production line has achieved 10-fold improvements in productivity, measured over six-month periods since the initiative was launched in 2018.

The world has become more interconnected with ever-growing complexity. We are experiencing a fast-changing and uncertain era. Against this backdrop, Fujitsu has set out our corporate purpose: 'to make the world more sustainable by building trust in society through innovation'. To act with this purpose, Fujitsu continues to proactively work to solve many societal challenges using digital technologies, knowledge and experience and helping customers transform their businesses.

In the CDP³ Climate Change Survey 2019, Fujitsu was recognized as a global leader in corporate climate change measures. We were chosen as one of the highest-rated 'Climate Change A List' companies for the third consecutive year. We were also selected in the highest-rated 'Water Security A List' in their water security survey. At Fujitsu, we continue to address climate change and water security challenges. In addition, we will use technologies such as AI, IoT, and supercomputing to help customers and society respond to the challenges of climate change, water resource conservation and water-related disasters. Our approach to realizing the SDGs is to use digital technology to create sustainable shared value through aligning customers' value and societal value.

Together with many other organizations across the manufacturing sector, Fujitsu remains committed to using technology and innovation to address our most significant global societal and environmental challenges.

³ CDP is an international non-profit organization that discloses the survey results of companies about their activities related to climate change, forests, and water security, on behalf of institutional investors that have total investment assets in excess of \$9 trillion.



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