Through IoT, Sharing information in real-time will accelerating more than ever before.

Through the use of sensors and other devices, parts flowing through a production line transmit data to manufacturing facilities through means such as RFID tags. These parts exchange information on the same line to form various models of products, which is as if things are talking to each other. The application of the autonomous exchange of information between things through the IoT has started not only as an innovative tool at manufacturing sites but also for the optimization of entire business processes.

"Industry 4.0" and Japanese "Connected Factories"

For example, in Germany, a manufacturing reform project conducted by industry, government and academia started in 2011 with "Industry 4.0 (the fourth industrial revolution)" as a slogan. They are making efforts to establish "Smart Factories" that manage supply chains efficiently and autonomously, by connecting data from within factories with enterprises involved in manufacturing those products in real time (refer to pp. 10-11 for more on industry 4.0). The U.S. is also actively making efforts toward developing the IoT. It has established the IIC (Industrial Internet Consortium), whose members include major electrical and electronics manufacturers, semiconductor firms and telecommunication equipment vendors. With support from the U.S. government, they aim to establish a new manufacturing model, taking advantage of IT, which is their area of expertise.

In response to these situations, Professor Yasuyuki Nishioka proposes, "Japan should also construct connected factories by leveraging Japan’s own strengths. It would also give small and medium-sized companies (SMEs) the opportunity to make rapid progress." "Connected factories" are based on information sharing within a company and across companies based on the links between manufacturing processes and business operation systems. And, an important point is that it is "information sharing in which human beings are also involved." What sort of approaches and ways of thinking are optimal for increasing the added value of Japanese Monodzukuri? What are the benefits of and challenges that come with being connected? Let’s take a look at the innovations that are taking place for answers.

Japanese Factories Connected Together

The “next innovation” in manufacturing (monodzukuri) is coming!
Full interaction between humans and data allows for the possibility of “mixed flow production lines”

“Operational excellence” translates to a superior workforce competence in leading-edge manufacturing plants, where the focus tends to be on automated equipment. But in “Smart Monozukuri” an operational system which also includes competent workmanship is the greatest driving force for advancement.

Think about a production line, for example. At Shimane Fujitsu, an entire process from assembly and testing to packing is done on one production line, like the fully automatic integrated line for printed circuit boards. It is production based around a conveyor belt, yet each product can be customized. “Large-item, small-volume, mixed-flow production” is supported by “data sharing” and “manufacturing based on full interaction between humans and machinery” that uses IoT technology such as RFID tags.

In addition to quality improvements, lead time is cut by 80%! (Above) Humans and machines are working together in the assembly line for PCs. Robots would still do boring work and attaching stickers. Workers customize each PC according to its color, given to each model. As Akihiko Miyazawa, Development Unit Head of unit Miyazawa explains, expressing the company’s goal: “Our company is also developing service businesses, leveraging our workplace competence. We meet the clients’ needs through operational excellence, with such strengths as the customization and shipping of devices from other companies and LCD lifecycle management.”

President Usami says, “‘Made in Japan’ is an obsession with achieving mass customization.” For that purpose, we connect development sites and manufacturing sites with ‘connecting systems’ and also want to expand the link to our suppliers and partners.” (Head of unit Miyazawa)

“In the long run, it should be as ubiquitous as air,” President Usami says. Both emphasize that “efforts by the entire industry are essential” in order for “Smart Monozukuri” to take root.

The simulation of production lines is an important aspect of “opening” to observers from countries such as Germany and China. “It is difficult to understand everything about Monozukuri just by taking a quick look. Operational excellence is the key.”

FUJITSU LIMITED / Shimane Fujitsu Limited

Accomplished with Assembly Line Production.

“High Variety, Low Volume” Production

“Some 80% of our products are for corporations and the required functions and settings for each product vary. In order for customers to be able to use the product when they receive it, we have to optimize manufacturing at the time of shipping. For that purpose, various kinds of advanced technology, ideas, and creativity are involved in the construction and operation of production lines.” (President Usami)

One of them is our own simulation technology. Akihiko Miyazawa, Head of Corporate Product Technology & Monozukuri Development Unit at FUJITSU LIMITED, explains: “We use CAD data for product designs at manufacturing sites. We virtually verify procedures for production with a VPS (Virtual Product Simulator), which is a tool we developed. We also use it for evaluations of prototypes and pilot runs.”

President Usami says, “We save the data on tablets to make it available for on-site operations training. It is very well received as animation makes it easier to understand the training.”

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Keeping advanced technology within our grasp (Tenouchi-ka), refining it with Kaizen

Fujitsu develops tools such as CAD and simulators in-house and actively uses them as development environments. General Manager Miyazawa says the company refers to this as “tenouchi-ka (keeping technology within our grasp).” This allows us to realize the use of tools across the border between developers and design engineers without the constraints of tool licenses. Consequently, these tools can also be used at production sites under the same environment. “Also, the factory team can deal with changes in modules and system design, if they are minor.”

In addition, Digital Mockups, which can visualize product structures, are very useful for manufacturing based on full interaction between humans and machinery because we can see the required production facilities before constructing the actual production line.

“We optimize manufacturing processes with simulators and refine them with Kaizen (continuous and steady improvement) on site. Robot capabilities are constantly increasing in concert with human know-how through our original FIPS (Fujitsu Production System) based on the TPS (Toyota Production System)” (President Usami)

Development of new markets by taking advantage of know-how

“We will start to provide new ‘Monozukuri Solutions’ incorporating know-how acquired through our internal practices and leveraging the strengths of Fujitsu processes. Information related to both physical and virtual aspects of Monozukuri should be shared. We wish to establish a consistent and single foundation that supports cooperation through all the processes in Monozukuri, from planning to procurement and shipping.”

Head of unit Miyazawa

FUJITSU LIMITED

President

Ryuichi Usami

Shimane Fujitsu Limited

Metropolitan Office

(Monozukuri Development Site)

Head of unit

Akihiko Miyazawa

(Metropolitan Office)

Head of unit

Shimane Fujitsu Limited

(Monozukuri Development Site)

Head of unit

Akihiko Miyazawa

(Metropolitan Office)

How we use IoT technology such as RFID tags.

GP4 is a simulator which reproduces manufacturing sites in a virtual manner. It verifies lines of movement for workers and other factors before machines are actually installed in plants. The inspection booths for production processes can also be optimized with GP4. One person can take charge of several processes with multiple machines such as an image-recognition device, an articulated robot, and a laser cutting device. "Operational excellence is the source of competitiveness by using advanced technology.

Metropolitan Office

Head of unit

Akihiko Miyazawa

(Metropolitan Office)
A technology from Japan that provides a way to solve the problem - “Can’t connect!”

Usually, much time and effort is required for connecting devices each other at factories. For solving this problem, the Open Resource interface for the Network, or ORiN, helps workspaces that are reluctant to embrace information technology (IT). In this article, we will be focusing on a standardized open interface originating from Japan that has received high praise around the world.

Conventionally, usual enterprises efficiently manufactured and sold products and provide support when failures arise. However, today, not only this basic function of Monodzukuri (manufacturing), but also Kotozukuri, or the provision of services, and solutions throughout the product life cycle, including flexible responses to individual needs, financing for product purchases and support for waste disposal are needed. As for such processes, the interactions between customers and the companies responsible for sales, manufacturing, and service continue to increase in variety and diversity. “There is demand for the integration of Monodzukuri and Kotozukuri today. So, we expect to connect these various functions together,” says Mr. Toshikazu Kimura of the Japan Society for the Promotion of Machine Industry. Regarding the current situation of the manufacturing industries, for example, he points out the following. “Although the introduction of IT for individual applications, especially in manufacturing processes, is progressing in most manufacturing industries, there is still room to improve the connection with systems that provide value throughout a product’s life cycle. In addition, it takes many man-hours to develop manufacturing system software when factoring in devices from multi-vendor or different standards of technology in a manufacturing line.”

Easy connection among different kinds of devices

As an example, the case of development process of manufacturing system software that displays the status of different vendors’ device is as follows. Generally, it had previously been necessary to develop (1) connection software for each device, (2) software enabling all devices on a network to share information with each other, and also, (3) software which converts types of data into a common format in order to acquire information from each device. Then after making these pieces of software (1) through (3) available, it was also necessary to develop software (4) which displays status information for each device. However, such a process requires time and money, and this had the potential to eventually result in the company’s “missing the bus” in the competition for market share.

The Open Resource interface for the Network (ORiN), a standard for communication interfaces, is to solve this problem and accelerate the networking of manufacturing systems. The greatest benefit of ORiN is its capacity for connecting between not only PC application software, old and new robots from various manufacturers, and Programmable Logic Controllers (PLCs) which are control devices, but also between other standard technologies. ORiN also contributes to the efficient development of manufacturing system software with practical uses for such information.

If one were to say, ORiN acts as a substitute software with practical uses for such information.

Playing an active role in the agricultural sector

A cultivation control system which is based on the balance between supply and demand through IoT, Japanese factories Connected Together

The figure on the left shows a comparison of the man-hours involved in developing and selling monitoring software for a certain machine tool. The monitoring software was developed on an ORiN platform, and thus, individual development for each control device was unnecessary. As a result, the man-hours were reduced by about 40%. In addition, ORiN includes various Providers (connection software) used in factories. A Software that called Provider Wizard enables quick development of a Provider when adding a new device.

Flexible connection will pave the way for the future for a broad spectrum of industries

ORiN does not contribute only to the manufacturing industries. As in the case shown above, it can open a door to the future, for example, in primary industries as well. “We plan to further improve ORiN’s connectivity with different kinds of standard technology and continue to upgrade it,” says Mr. Kimura.

In Japan, there are a number of vendors that can provide production devices and production systems, and these sustain Japan’s strengths in product development and manufacturing. Mr. Kimura says, “Some vendors still tend to keep their products isolated from products from other vendors in order to secure their customer base. On the contrary, we must establish a client-oriented mechanism that enables flexible interconnectivity between these products but not to the degree that it does not damage the existing market of each vendor.”

Mr. Kimura is sure that we have a bright future. “The Japanese people have a fundamental spirit of hospitality and this can enhance our competitiveness through client-oriented Monodzukuri and Kotozukuri. To that end, IT is the key, and therefore ORiN, which can harmonize with Industry 4.0, is a promising technology.”

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Manufacturing industries in Germany are facing issues similar to those in Japan, including a decreasing, aging workforce and difficulties in transferring skills from skilled workers to the next generation. If these problems are not addressed, it is obvious that drain of skills from skilled workers to the next workforce and difficulties in transferring technology. Furthermore, it will be easier for small and medium-sized companies to maintain their competitiveness while staying rooted in Germany for the future. Therefore, Nobilia installed Beckhoff industrial computers and control systems to establish the foundations of automated production from the 1990s. As a result, Nobilia succeeded in achieving a significant improvement in production efficiency. The company employs 2,500 people and manufactures a total of 580,000 kitchens a year, exporting them to 70 countries around the world, with annual sales of JPY 130 billion. These figures alone should be sufficient in demonstrating the extremely high productivity of the company.

The company’s automated production system takes full advantage of advanced IT in every process, ranging from material processing to assembling and distribution, resulting in the establishment of a seamless production system. This allows production to be automated and yet flexible enough to make customized kitchens, a system which is referred to as “mass customization.” Nobilia’s example is a driver for the standardization of IT utilization, leveraging its experience. In the manufacturing industry, superior production systems tend to be regarded as a company’s highly confidential information. This situation, however, limits the potential for industry-wide progress. Germany’s goal is to extend advanced mechanisms for using information beyond the framework of individual companies and industries.

The key to success is “standardization” in data communications, for instance. As standardization progresses, it will also be easier for small and medium-sized enterprises (SMEs) that have been engaged in traditional manufacturing to apply IT technology. Furthermore, it will drive smooth collaboration between various companies, which is expected to open the door to new innovation, independent from industry and regional boundaries. Eventually, there might be the option of adopting a strategy of exporting such superior production systems themselves to the world. Continuing to demonstrate both manufacturing competency with high added value and advanced production systems to the world—Germany industry is aiming to achieve the goals of this “dual strategy” through Industry 4.0. Although Germany is leading the practical use of IT in the manufacturing industry, its challenges have just begun. Japan should also learn from Germany’s efforts as we share a large part of the same challenges.

Nobilia is a high-end kitchen manufacturer. Its advanced production system is highly esteemed, and the company is participating in Industry 4.0 initiative. The company has factories in Germany to manufacture customized kitchens uniquely tailored to individual customers, which safer from raising labor costs in the area. Improvements in production efficiency were crucial for the company to maintain its competitiveness while staying rooted in Germany for the future. Therefore, Nobilia installed Beckhoff industrial computers and control systems to establish the foundations of automated production from the 1990s. As a result, Nobilia succeeded in achieving a significant improvement in production efficiency. The company employs 2,500 people and manufactures a total of 580,000 kitchens a year, exporting them to 70 countries around the world, with annual sales of JPY 130 billion. These
We would like to find our future direction while examining competition and cooperation during a discussion.

Kawamori: Although there are many issues, first of all, Japan needs to establish a framework for cooperation within the same industry or beyond the borders of industries. For example, a new promotion body, the “Robot Revolution Initiative,” is being established for “international standardization.”

Hori: After all, the keys in the future will be “competition” and “cooperation.” It will be important to work together to tackle the issues where cooperation is necessary beyond the borders of individual companies. If we can consider improvement of efficiency and costs as a team, it will be possible to gain an advantage over competitors.

Kawamori: That’s right indeed. Historically, Japanese companies might have been poor at “cooperation” between companies. Concerning this collaboration between Japan and Germany, both national governments will give substantial structural innovation while assessing what cooperation or competition will be necessary from the global perspective.

I think domestic industries and companies should share this attitude.

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The White Paper on Manufacturing Industries (Monodzukuri) is also a global standard in global competition. I think we will need to start face-to-face discussions.

Hori: At the Ministry of Economy, Trade and Industry, of course, we will initiate the discussion of digitalization, not only in cooperation with the manufacturing industry, but also with sectors such as information and communications, logistics, and energy. It is still possible that medium-sized or smaller companies will be squeezed out of the international market if they are late in taking action in response to the new state of Monodzukuri.

---Specifically, how could Japan handle this?

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---Here in Japan, the interest in industry 4.0 is increasing. Could you tell us what is behind the trend?

Kawamori: I think the biggest reasons come from a sense of crisis in the manufacturing industries. One of them is concerning the social issues of the declining birthrate, aging population, deflation, and another is a worry over the “manufacturing revolution” initiated by American IT companies. Over the “manufacturing revolution” and the fear of deindustrialization, and another is wariness concerning the social issues of the declining birth rate, aging population, and the fear of deindustrialization. For example, through the introduction of robots to production sites. Meanwhile, the digitalization of production processes will expand from upstream to downstream and also spread horizontally beyond the borders of industries, heading toward further efficiency. It is going to be possible for Japanese companies, especially for small and medium-sized companies, to respond to such trends as “digitalization in the manufacturing industry” through collaboration between industry, academia, and government to discuss how the international standardization of the manufacturing industry should proceed in the future, for example by addressing the question: “What can we do?”

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