

# TRENDS

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## Manufacturing Innovation Based on the IoT Transforming Manufacturing through Data Visualization and Utilization, and the Concept of Symbiosis

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Innovation has started to take hold in the manufacturing industry based on such digital technologies as the Internet of Things, big data analytics, and artificial intelligence. Multiple government-led strategic initiatives have been organized to accompany manufacturing companies along the innovation journey, including the USA's Industrial Internet Consortium, China's Made in China 2025 project, and Germany's Industrie 4.0 strategic initiative, which pre-empted both of these. In the case of Japan, which has raised the idea of Society 5.0 with the aim of realizing a "super-smart society," developments in this area include the "Connected Industries" concept being championed by the Ministry of Economy, Trade and Industry. Seen as representing the future of industry, the Connected Industries concept envisions the Internet of Things as a platform on which people and machines can work together, and aims to achieve this through public-private partnerships. How should companies view and respond to these new initiatives for transforming the nature of manufacturing? To discuss this question, we spoke with Koichi Iwamoto, a Senior Fellow at the Research Institute of Economy, Trade and Industry, who is very familiar with Industrie 4.0 and developments in the corporate use of the Internet of Things, and with Youichi Nonaka, Senior Chief Researcher at Hitachi's Center for Technology Innovation – Production Engineering, who has been involved in research into production technology for many years.

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### **Yoshiki Kakumoto**

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**Kakumoto:** Innovation in manufacturing is accelerating, with digitalization of the industry being driven by the adoption of the Internet of Things (IoT) in countries around the world. With Germany's Industrie 4.0 strategic initiative being at the forefront of these moves, I would like to ask Mr. Iwamoto, who has put out a lot of information on this subject in print and on his website column, to explain the initiative's background and objectives.

**Iwamoto:** Debate about Industrie 4.0 began in Germany around 2011, leading to the publishing of a concept report\* in April 2013. That Germany embarked on Industrie 4.0 as a joint national initiative was the result of three related factors. The first was that, whereas the economy had weakened in the aftermath of east-west reunification in 1989 to the extent that the country was spoken of as the "sick man of Europe," the reform policies of chancellor Gerhard Schröder and others were such a success that the German economy was said to have taken a dominant position. Despite this, the reform process had plateaued and the need for further reforms has grown stronger, for the German economy to stall would put the Euro zone in a terrible situation. For the German economy to stall would put the Euro zone in a terrible situation.

Meanwhile, in the industrial sector, the mechanization and automation of production has progressed well in most areas, putting a lid on productivity improvement. Growing recognition that the IoT could help overcome this hurdle was the second factor. Furthermore, whereas economic growth in Germany had been underpinned by the export of automobiles to China, this export growth was slowing. In this context, the third factor was the expectation that mechanical equipment and systems based on the concepts of Industrie 4.0 would become the mainstay of a new major export market.

**Kakumoto:** Manufacturing is a major industry in

Germany that accounts for about 25% of its GDP. I think it is safe to say that increasing added value will help make its manufacturing industry future-proof. In Japan, the developments in Germany prompted growing interest in Industrie 4.0, and Hitachi was quick to take note of Industrie 4.0 and the IoT, including through involvement in standardization work.

**Nonaka:** Standardization is essential if networks are to be used to link a wide variety of production machinery and systems and operate them in the best possible way. The International Electrotechnical Commission (IEC) launched a project in 2014 in which participants from major nations considered what the next generation of factories should look like and worked on determining their technical requirements. The outcome of this work was the publication in October 2015 of standardization guidelines in the "Factory of the future" whitepaper. This whitepaper adopted the H-ARC security requirements for infrastructure, as well as the symbiotic autonomous decentralized system concept, both proposed by Hitachi.

Symbiotic autonomous decentralization is a further development of the autonomous decentralization concept that has already been deployed in a variety of industries around the world, including railways and steel. The idea is to establish a business ecosystem in which a number of autonomous systems interoperate cooperatively with the overall aim of achieving sustainable growth. This concept gained broad approval because it aims to achieve sustainable societal development by expanding the optimization scope from individual companies and value chains to overall society, making the most of limited resources. "Symbiosis" is one of the main keywords of the whitepaper.

Inspired by the sharing economy, which has its origins in the idea of symbiosis, the whitepaper also adopted crowd manufacturing. This concept refers to a crowd-sourcing platform that enables flexible production by providing companies shared access to production resources on an as-needed basis.

\* "Recommendations for Implementing the Strategic Initiative INDUSTRIE 4.0," Final Report of the Industrie 4.0 Working Group (Apr. 2013)



**Koichi Iwamoto** | After graduating from Kyoto University in 1981, he gained a Master's degree in Electronics Engineering from the Graduate School of Kyoto University in 1983 and joined the Ministry of International Trade and Industry. After positions as consul at Consulate-General of Japan in Shanghai, Deputy Director-General of the Tsukuba Center of the National Institute of Advanced Industrial Science and Technology, and Cabinet Counsellor in the Cabinet Secretariat, he took up his current position in November 2015. He is currently engaged in social science research into digital business in the fourth industrial revolution, such as the IoT and AI. He has served as a guest lecturer for the MBA program at the Graduate School of International Corporate Strategy (ICS) of Hitotsubashi University. He was born in Kagawa Prefecture. Major publications: "Industrie 4.0," Nikkan Kogyo Shimbun, Ltd., 2015 (lead author); "Artificial Intelligence for Business People," Toyo Keizai Inc., 2016 (co-author); and "SME's Experience with the IoT," Nikkan Kogyo Shimbun, Ltd., 2017 (co-author), all in Japanese.

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## Encouraging Data Exchange as the Key to Utilizing the IoT

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**Kakumoto:** I believe that one of the factors that prompted Japan to start paying attention to the IoT was the book on Industrie 4.0 written by Mr. Iwamoto. What was the thinking behind your interest in this topic?

**Iwamoto:** To the extent that it was just Germany embarking on something new, it had yet to attract much attention. Just as in Germany, the adoption of manufacturing automation had run its course in Japan and industry was looking around for what to do next. So, you could say that my interest was prompted by a recognition that the IoT represented a breakthrough that had the potential to become a huge market.

**Kakumoto:** Along with pursuing its Society 5.0 initiative, which seeks to create a "super-smart

society," the Japanese government is also promoting digitalization and has devised its Connected Industries concept for the shape of future industry in which the IoT provides a platform for people and machines to work together.

**Iwamoto:** The government has chosen the fourth industrial revolution based on digital technologies such as the IoT, big data analytics, and artificial intelligence (AI) as one of the pillars of its growth strategy. In terms of policy, effort is being put into developing platforms that will underpin this growth and into resolving issues. Progress is also being made on establishing the framework for protecting personal data and facilitating its use in order to encourage the use and exchange of data, something that plays the key role in IoT technology. The government is also taking the initiative in considering things like security measures and standardization activities.

**Kakumoto:** What is Hitachi doing in these areas?



**Youichi Nonaka, Ph.D.** | He joined Hitachi, Ltd. in 1992 and is engaged in research and development of offline teaching techniques and production control technology at the Production Engineering Research Laboratory. After other roles that included visiting researcher at the Massachusetts Institute of Technology, he took up his current position in 2015. He is currently working on interface development for smart manufacturing as well as surveys and proposals relating to international standardization. He holds a Doctorate in Engineering. His topics of specialty are supply chain management, production control, and digital engineering. Other roles include international expert with IEC System Evaluation Group 7 and head of Manufacturing Systems Division at the Japan Society of Mechanical Engineers (JSME).

**Nonaka:** A variety of companies are working to achieve Society 5.0, and Hitachi is directing its efforts toward encouraging the exchange and use of data in cyberspace in particular. We are working with numerous other companies to investigate things like system architectures based on the concept of data ownership. In the case of the Connected Industries concept, because of its similarity to Hitachi's concept of crowd manufacturing, we are participating in the debate surrounding concept formulation.

A collaborative project on the IoT and Industrie 4.0 in manufacturing has been ongoing since an agreement was reached at the Japan-Germany Summit Meeting in 2015 for the two countries to work together in this area. Meetings held once every three months provide a forum where participants from Japan and Germany can hold discussions focused primarily on the two topics of standardization in smart manufacturing and IoT

security. I have been personally involved in the former, and a great deal of efforts have gone into the two nations proposing, not only the standards themselves, but also use cases on how these standards are to be used, and also into presenting case studies encouraging the wider adoption of the IoT.

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### Adoption by Small and Medium-sized Enterprises Affects National Competitiveness

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**Kakumoto:** While interest in the digitalization of manufacturing tends to focus on large manufacturers, the benefits for small and medium-sized enterprises are also likely to be great. Mr. Iwamoto has been holding a study group on using the IoT to develop the competitiveness of small and medium-sized enterprises since April 2016. What was your thinking behind this initiative?

**Iwamoto:** Both Japan and Germany are said to

be nations of small and medium-sized enterprises, with these accounting for 99.7% of all companies. The extent to which such businesses can adopt the IoT will be an issue that goes to the heart of national competitiveness in the future. However, whereas I have presented success cases to people from small and medium-sized enterprises in lectures and elsewhere, I am still frequently told that they do not understand the technology or how it can benefit their own companies. I set up the study group out of my belief in the need to present these success cases in an understandable way in order for progress to be made on the adoption of the IoT by small and medium-sized enterprises.

The approach of the study group has been to build up a collection of case studies of model companies. This involves observing and discussing the process of IoT adoption at a model company over the course of a year, and ultimately measuring the benefits of the IoT investment. By publishing accounts of this trial and error process on websites and in books, I hope to get the leaders of small and medium-sized enterprises to recognize the adoption of the IoT as the challenges for their own companies.

**Kakumoto:** Given the difficulty of deciding how to invest in something you know nothing about, I can certainly see how the collection of case studies could be of value. While most of Hitachi's customers are large companies, we still have concepts and solutions that are relevant to small and medium-sized enterprises.

**Nonaka:** Crowd manufacturing based on the symbiotic autonomous decentralized concept represents an approach to manufacturing in which everyone contributes resources, including small and medium-sized enterprises as well as large companies. Although we began talking about the concept two years ago, we have not received much contact about it from small and medium-sized enterprises. We are participating in joint projects with local government, in which many Japanese small and medium-sized enterprises are involved, and working together to see if progress can be

made on using the IoT to strengthen coordination across all small and medium-sized enterprises within a region, including the concept of crowd manufacturing.

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### Creating Manufacturing Workplaces where Everyone Finds it Easy to Work

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**Kakumoto:** The strength of Japanese manufacturing is said to lie in its workplaces. How do you see the IoT and other forms of digitalization transforming manufacturing in Japan?

**Iwamoto:** I was told recently by a large manufacturer about an initiative it has that is aimed at using the IoT to improve productivity by 30%. By linking together a large number of factories located around the world it will be able to centrally monitor and manage the production line operations at all these plants from a "mother factory" in Japan. This will make it possible to accelerate the pace of improvement, provide high-level maintenance, make fine-tuned improvements, and manage risks. It will also allow the successful improvements or knowledge that one factory identifies to be shared with others around the world so that improvements around the world progress in step. Reforms like this will likely expand into other areas.

The core concept behind the adoption of the IoT by this manufacturer is that it is led by people. The IoT is just a tool for providing information about the workplace; humans are the ones who can utilize the data to make decisions and improvements. This approach, in which the overall system is put in place with the expertise of experienced workers, is seen as the core and basis for adoption of the IoT by today's manufacturers. However, given that the number of experienced workers is expected to fall in the future, the use of AI is also likely to become necessary for things such as learning from past data to assist human decision-making. This future is something that it is important to keep in mind when considering the configuration and requirements of current IoT systems.

**Nonaka:** While the centralized management of production lines at different sites is something that already happens in sectors such as the semiconductor industry, what sets today's digitalization apart from these past practices, I believe, is the way in which it involves people, as you described. With the aim of having people work alongside and in harmony with machines on a higher level than before, Hitachi has proposed a concept it calls "super barrier free" as part of its work on initiatives such as Industrie 4.0 and Connected Industries. As the birth rate falls and the population becomes much older, there will be more and more demand for safe and secure workplaces that are well-suited to even elderly or inexperienced workers. Creating factories and societies in which it is easy for everyone to work forms part of our vision for utilizing the IoT.

The exchange and use of data spoken about by Mr. Iwamoto is an important part of this. A key consideration in manufacturing reform is to deepen the relationship between people and machines both horizontally and vertically, where 'horizontally' refers to utilizing knowledge and other forms of know-how in such a way that it can be put to effective use, not only at one specific factory, but also at other sites, and 'vertically' refers to handing on skills to the next generation and beyond. One of Hitachi's solutions for the manufacturing industry that uses its Lumada IoT platform involves working with customers to hand on expertise through the digital encapsulation of work skills and know-how. By using the transformation of skills into numerical form as a way to achieve rapid skills acquisition, standardize work, and raise standards, we hope to contribute to improving quality and productivity as well as to strengthening human resource development throughout the world.

**Kakumoto:** When the IoT is used to give access to data on things like people, goods, equipment, workplaces, production, and inventory, it does not just facilitate innovation in manufacturing. The analysis of this data by AI and other techniques



Yoshiki Kakumoto

also enables business improvement and faster management decision-making.

**Nonaka:** The linking of workplace data to management strategy is another area where there are high hopes for the use of digital technologies. While there has been interest in the use of the IoT to predict equipment faults, operational errors by people are actually a more frequent cause of problems in the manufacturing workplace. I have heard that incidents that border on major accidents caused by careless mistakes are on the rise both in Japan and Germany. I feel that we also need to be addressing these practical manufacturing workplace issues.

**Iwamoto:** Were the IoT able to deal with human error, this alone would bring a major improvement in productivity. Manufacturers often say that they can achieve significant productivity improvements simply by being able to run their production lines non-stop. I look forward to Hitachi developing IoT solutions that meet the practical needs of such plants.

**Kakumoto:** Using the IoT and other digital technologies to link people, things, and systems together contributes to manufacturing innovation on a variety of fronts. Thank you for your time today.