

# Taking Up the Challenge of the Fourth Industrial Revolution

Rapid technological innovation centering on IoT, Big Data and AI, which is being labeled the “Fourth Industrial Revolution,” has the potential to significantly change our lifestyles and our societies. As giant US IT platform companies extend their global dominance, what growth strategies will Japan need to implement in order to boost its presence on the world stage in the coming era?

In this issue of My Vision, our interviewees consider the issues that the Fourth Industrial Revolution presents Japan, and strategies to overcome these issues and achieve growth, from the five perspectives of platform creation, the social implementation of technologies, intellectual property systems, the promotion of innovation, and the cultivation of human resources.

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Representative Executive Officer & Chief Executive Officer, NIRA / Chairman and President, Group CEO, Future Corporation

Keywords...Cyber-economy, innovation creation sandboxes, role of universities, government budget allocation, utilization of data, opportunities originating with the individual

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Keywords...Big Data, industrial revolution based on data use, data science

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## **The Fourth Industrial Revolution: Drawing Out the Power of the Individual – An Era of Opportunity in which Everyone has the Chance to Flourish**



### **Yasufumi Kanemaru**

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The technological revolution represented by the Internet of Things (IoT), Big Data and Artificial Intelligence (AI), which is being referred to as the “Fourth Industrial Revolution,” is producing significant changes in the global map of economic power. A range of arguments and proposals have been presented in relation to what Japan should do in order to ensure a stable position in the future world and the ability to make a contribution to that world.

Before discussing these, it will be necessary to briefly consider the general background to the issues.

The explosive development of the commercial use of the Internet which commenced in the latter half of the 1990s generated only speculative interest in Japanese society. As a result, Japan overlooked the essential nature of the innovation that was occurring, and became one of the “losers” in the race. Today, US IT platform companies dominate the world. For example, the total market value of the companies known collectively as FAANG (Facebook, Apple, Amazon, Netflix, and Google) has now reached approximately 300 trillion yen. The importance of the “cyber-economy,” an economy of data, ideas, and other intangible and invisible things, is increasing as an adjunct to the “real economy,” the economy of tangible, visible things. However, we have to face the fact that Japan’s presence in the cyber-economy is minimal.

### **Creating Environments that stay out of the Way of Entrepreneurs**

What is the essential nature of the innovation taking place?

Google’s search engine had its origin in research conducted by graduate students. The search engine was developed as its creators grappled with the technological means to realize an idea that anyone could come up with: The creation of an enormous index of information. Similarly, Facebook’s founder Mark Zuckerberg created an SNS to connect fellow students through a process of trial and error. As this indicates, innovation is generated by people who come up with a modest idea, and work to implement that idea whether they succeed or fail. The origin of innovation is entrepreneurial individuals. Today, the phenomenon is not restricted to IT; in the worlds of biotechnology and materials development also, if one or two entrepreneurial individuals come up with an idea, they are able to procure venture capital from around the world.

Professor Tatsuyuki Negoro of Waseda University, one of our interviewees in this issue of My Vision, sees Japan’s problems as originating in excessive regulation and a culture that emphasizes the resolution of problems in advance. Hideyuki Tokuda of the National Institute of Information and Communications Technology, urges the provision of a demonstration experiment environment on the scale of the society as a whole.

Both of these scholars emphasize that what is necessary in Japan is the provision of an

environment that stays out of the way of entrepreneurial individuals and allows them to freely take up challenges. One example of this is provided by the “innovation creation sandboxes” that the Growth Strategy Council of the Cabinet Office has proposed systematizing. This is a mechanism allowing the flexible easing of regulations around near-future technologies in a variety of areas, facilitating the smooth implementation of proving trials. After appraising the risks involved, users would become part of the project team, participating as central players.

Izumi Hayashi of Sakurazaka Law Offices discusses the utilization of data as a new form of information goods. Suspicion regarding data use is deep-rooted in Japanese society, at least in part as a result of the clumsiness of the efforts of the government and related agencies in this area. However, it is very likely that excessive protection would impede activities in the cyber-economy. It will be necessary to provide an environment that allows the development of advanced services using data, while also realizing a balance with consumer protection.

### **Transforming the universities to promote innovation**

Both fundamental research and applied research are essential to generating innovation. We often hear the opinion that we should be prioritizing fundamental research at universities. However, the governance of Japan’s universities is so conclusively inadequate that we could not expect any benefit to be generated by simply increasing the budget for fundamental research. The majority of Japan’s universities do not emphasize their individuality with unique features, and the composition of their faculties and curricula and the disposition of teaching staff and students remain unchanged from the past. This situation is not even conducive to short-term returns, to say nothing of the long-term outlook. Because university presidents and deans are chosen to represent the interests of the teaching staff affiliated with the institutions, fundamental reform is difficult to achieve. To enable Japan’s universities to turn their attention to the rapidly changing external environment, it would be desirable for them to adopt a system similar to the use of external directors in the corporate world, encouraging decision-making that is not simply directed by institutional interests. By this means, they would become able to respond to changes in society and technology. In addition, universities can have an important role to play in bringing entrepreneurs looking to found start-ups together with research personnel.

There are also significant problems with regard to the allocation of government budget resources. Compared to nations like the US, the budget directed towards the stimulation of innovation in Japan is extremely small, and in addition, because ministries and agencies scramble for their own share of these meager budget resources, they are not ultimately directed towards strategically meaningful investments. As Professor Hiroshi Shimizu of Hitotsubashi University points out in his interview, we need mechanisms that will enable us to foster general-purpose technologies. The cultivation of human resources suited to the needs of the era will also be essential to the promotion of innovation. As discussed by Akimichi Takemura, Shiga University has established a Faculty of Data Science and is working to foster human resources for data utilization. The establishment of concrete unique features of this type among universities will be vital to their ability to attract the most promising students.

### **An Era of Opportunity, in which the Individual will be the Point of Origin of Innovation**

Today’s Japan displays weaknesses characteristic of an aging society, including ossified laws and

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regulations and a resistance to new technologies. But if we turn our attention towards Japan's younger generations, we find an abundance of excellent human resources in every field. As demonstrated by achievements including Japanese junior high school students finishing close to the top in world programming contests and Japanese sportspeople performing with the best internationally, superior human resources are not to be found only in Silicon Valley or in India. And as I have previously indicated, today it is the individual who is the point of origin.

The intense vigor of technological innovation means that the playing field is subject to rapid change. Perhaps another Google will not arise, but there are any number of opportunities for success in different competitive domains. A long time coming, this is an era of tremendous opportunity for individuals throughout the world who have an inspiring idea.

To what extent will older people share their experience and funds with younger people, and act as their supporters? Japan's ability to catch the wave of the Fourth Industrial Revolution depends on the answer to this question.

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# Platform Businesses that make Use of Japan's Strengths



**Tatsuyuki Negoro**

Professor,  
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Japan is lagging behind in the field of platform businesses. Google, the representative company in the field, has realized overwhelming competitive power by providing a consumer-oriented information hub able to be accessed via the Internet for a wide range of purposes. Looking ahead over the next five to ten years, it is unlikely that Japan will be able to achieve global competitive advantage in this field, given both linguistic difficulties and the superiority of the US development system. The achievement of competitive advantage in China, a nation with an overwhelming domestic market scale, would also be difficult.

However, there are diverse platform types. The game units in which Japan is a world leader are platforms, as are general-purpose components employed in a wide range of products.

What are the specific strengths possessed by Japanese companies? Potential very likely exists in the area of platforms tailored to specific fields. For example, in the field of construction equipment, Komatsu is offering outstanding services under the banner of “Smart Construction.” The field of autonomous driving necessitates onboard systems that support communications and systems that incorporate control systems for the engine and other parts. Japan is strong in this latter field, but could not expect to be the outright winner. However, the nation would have scope to exercise its specific abilities. IT companies alone are unable to develop and manufacture autonomous vehicles, in which safety is of paramount importance. In addition, Japanese manufacturers have traditionally not merely supplied bare functions, but have also excelled in offering the refinement of a human touch, a detailed consideration of the user. Exploiting this point offers Japan the potential to take the lead in the field of applied robots specialized in specific tasks, for example care or rescue.

If we slightly expand the interpretation of “platform” in this way to encompass the definition “shared foundation for products and services,” we will find that there are still fields in which Japanese companies can display their strengths. However, in order to win out in the global market, it will be essential for Japanese companies to develop and make products available before the rest of the world, and to allow themselves to be honed and become stronger in the market itself. Regarding these last points, in today’s Japan excessively stringent regulations and a culture that places an excessive emphasis on resolving problems before the fact represent impediments to the development of platform businesses. The key here will be the establishment of a system of “regulatory sandboxes” (temporary suspension of existing regulations) to allow active testing of new businesses.

Professor Negoro is a leading figure in the Japanese study of business administration, driving the field forward with research in areas including IT and business strategy, business models, and Internet businesses. He graduated from the Division of Philosophy of Kyoto University’s Faculty of Letters, and completed the MBA Program of Keio University’s Graduate School of Business Administration. He took his present position in 2001, following experience including employment with an iron and steel manufacturer, and periods as a Visiting Researcher at the University of Hull and as a professor in Bunkyo University’s Faculty of Information and Communications. Professor Negoro was formerly the Dean of the Waseda Business School, and is Director of Waseda University’s Research Institute of Information Technology and Management. He has held positions including President of the Japan Society for Management Information, Vice-President of the International Academy of CIO Japan, Director of the Academic Association for Organizational Science, and Advisor to the CRM Association, Japan. Professor Negoro is a three-time recipient of the Outstanding Paper Award presented by the Japan Society for Management Information.

## Towards the Realization of a Society of Intellectual Co-creation through Technological and Institutional Innovation



**Hideyuki Tokuda**

President, National Institute of Information and Communications Technology

Following the Fourth Industrial Revolution, the fusion of cyberspace and real space will accelerate, making our society a society of intellectual co-creation between human and machine. The evolution of technology and the generation of innovation will be the cornerstones for the realization of this future society. The concern in some quarters over the existence of unbridgeable gulfs or conflict between humans and machines can be attributed not just to the lack of social acceptance of the technologies, but also to factors including the lack of maturity of the technologies themselves and their mismatch with social systems. Taking autonomous driving technologies as an example, revision of traffic laws, insurance systems, and other systems will be essential to increasing the social acceptance of these technologies, and it will also be necessary to

ensure the safety and security of the software itself.

In order to facilitate the acceptance of new technologies by human societies, we must actively promote “technology shaping,” adapting the form of the technology to transform it into one that fits the society.

Nevertheless, while the speed of technological change is rapid, it takes time for peoples’ lifestyles and worldviews to change. Because of this, the pursuit of technological and institutional innovation as parallel streams is essential to enabling us to delineate the features of a flourishing future society. The establishment of a demonstration environment allowing proving trials to be conducted at the level of the entire society is a pressing issue in terms of advancing innovation in systems and laws that will enable the acceptance of new technologies.

At the same time, it will be essential for every individual to understand the fundamental changes that will ensue, i.e. the effect that new technologies will have on peoples’ awareness, sense of values, and lifestyles. Marshall McLuhan, well known for his writings on media, posited four perspectives for understanding technological artifacts (media). These can be paraphrased as follows: “What does the artifact enhance?”, “What does the artifact render obsolete?”, “What does the artifact retrieve?”, and “What does the artifact reverse into (i.e. how does its character change when pushed to its limits)?” In approaching such phenomena as the various services made possible by the IoT, Big Data and AI technologies, this fundamental understanding will be important as a new form of social literacy.

A new digital divide will open up between countries that embrace this understanding of information literacy and pursue technological and institutional innovation, and which additionally establish demonstration experiment environments, and countries that do not, and this divide will grow into a disparity in international competitiveness.

Professor Tokuda is a leader in research in areas including ubiquitous computing systems, OS, cyber-physical systems, and the IoT, and is the recipient of numerous awards. He received his M.S. from Keio University’s Graduate School of Science and Technology, and his Ph.D. from the School of Computer Science, University of Waterloo (Canada). Prior to taking his present position, Professor Tokuda held the positions of Associate Professor in the School of Computer Science, Carnegie Mellon University, and Professor in the Faculty of Environment and Information Studies, Keio University. During his career at Keio University, he has served as the university’s executive Vice-President, the Dean of the Graduate School of Media and Governance, and the Dean of the Faculty of Environment and Information Studies. Professor Tokuda’s official positions also include member of the Science Council of Japan, Chairman of the Smart IoT Acceleration Forum, and Chairman of the Connected Consumer Device Security Council.

# Creation of Systems for prioritizing the Use of Data as New Information Goods



**Izumi Hayashi**

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For connected industries, which are creating new added value from the connection enabled by digitalization, it will be essential to flexibly adapt the balance between promotion of the use of data as new information goods and protection of data in accord with the state of development of technology and society.

Current law provides for the protection of patent rights and copyright in the case of deep-learning programs and learned models (the combination of programs and parameters). At the same time, the possibility of easing restrictions under copyright law in relation to copyrighted material contained in data for machine learning is under review. Products generated using AI as a tool are subject to copyright and patent right protections, etc. if there is any human creative contribution employed in the process of generation of the product. In addition, information managed as confidential is protected as a trade secret under the Unfair Competition Prevention Act.

At the same time, the treatment of “new information goods” that do not meet the requirements for protection under this existing internationally shared intellectual property system is currently under discussion by the Ministry of Economy, Trade and Industry. Even internationally, there are as yet no examples of the creation of exclusive (monopolistic) intellectual property rights or laws regulating conduct in relation to data in general. There is concern that the creation of specifically Japanese exclusive data rights or data regulations would run counter to predictability and the safety of transactions, and might impede the distribution of data. Given this, in the case of regulations focusing on information goods, it will be reasonable to commence by expanding the existing provisions for the protection of trade secrets; in the case of revisions to laws, from the perspective of measures to respond to data security threats such as targeted attacks, it will be appropriate to treat highly malicious activities (for example, decryption of data) as acts of unfair competition.

What is required at present is the creation of a system to establish top priority for data utilization. In doing so, in order to clarify authority for data utilization by means of flexible negotiations (for example with regard to dividing up data related to trade secrets or personal information), and to establish data distribution environments (for example Personal Data Stores (PDS) and information banks (provision of personal data to a third party with the consent of the relevant individual, as specified in the Act on the Protection of Personal Information)), it will be necessary, among other things, to obtain the agreement of consumers, promote the diffusion of guidelines that attempt to ensure trust, and implement data utilization by the government/private enterprise with the involvement of the individuals concerned.

Ms. Hayashi has an extensive involvement in consultations, contract negotiations and dispute resolution procedures in the areas of domestic and international corporate legal affairs and intellectual property management. She registered as a lawyer in 1987, following experience as a prosecutor for the Public Prosecutor’s Office. Ms. Hayashi is actively involved in a wide range of areas, serving as a member of government committees including the Council for Regulatory Reform, the Regulatory Reform Promotion Council, and the Intellectual Property Strategy Headquarters, while also working as an educator, for example in the Chuo Law School. In addition to these roles, Ms. Hayashi serves as the Secretary General of the Intellectual Property Lawyers Network Japan, and as a member of the Steering Committee of the IoT Acceleration Consortium and the Advisory Board on Artificial Intelligence and Human Society, acts as moderator and offers presentations at symposiums concerning intellectual property and international business, and frequently publishes papers on legal issues.

## Revising the Assessment of Fundamental Research – Fostering General-purpose Technologies



**Hiroshi Shimizu**

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The reason for the tremendous impact of the industrial revolution in 18th-century England was the fact that steam engine technology, which was developed for the specific purpose of pumping water from coal mines, came to be applied in a variety of fields (for example, in the development of the locomotive), undergoing a process of cumulative refinement and successively giving rise to new forms of value.

In the case of the contemporary “Fourth Industrial Revolution,” it is not absolutely clear what the general-purpose technology that will become the mainstay of the economy will be. Whether it is AI or new information and communications technology, in order to generate value worthy of the name “revolution,” it will be necessary to accumulate a foundation of research efforts to bring the technology to a sufficiently high level.

However, current research efforts are concentrated on applied research from an early stage, meaning that there is a tendency to use up the potential seeds of future growth before the general-purpose technology has solidified. In order to foster general-purpose technologies that have the nature of public goods, it will be necessary for the government to revise its approach to the assessment of the outcomes of highly uncertain fundamental research, and to create mechanisms to support fundamental research by national research institutes and universities.

In the US, government agencies including the Department of Defense and the Department of Energy have provided funding for fundamental research, but in Japan no such organizations have played this role. In their place, large corporations have supported fundamental research. However, changes in the business environment have been severe in recent years, and it will not be possible to expect companies to maintain this role in the future. Now is the time for national research institutes, universities, and similar institutions to take up this role, but they are proceeding in a different direction.

In the 1970s, Japan’s universities conducted a higher proportion of fundamental research than US universities. More recently, however, the positions have been reversed. Under the banner of industry-academia cooperation, in Japan, fundamental research has decreased as the result of a demand for visible outcomes such as patents received and products marketed; in the US, by contrast, fundamental research has been increased while promoting cooperation between industry and academia.

The Japanese government must also adopt measures to promote the entry of new companies in a range of areas. In new areas such as autonomous driving and Airbnb-style leasing, rules remain unfixed, and there are significant gray zones. The entry of new companies that are unfettered by old concepts and vested interests will be the key to promoting radical innovation in these new fields.

In studying innovation, Professor Shimizu conducts historical analyses in relation to corporate strategy, organizational structure and industrial organization, with a particular focus on long-term changes in patterns. He received his Ph.D. from the London School of Economics and Political Science. Prior to taking his present position in 2017, Professor Shimizu’s experience includes a term as a Post-Doctoral Fellow at the Eindhoven University of Technology. His book *Innovations in General Purpose Technology* (Yuhikaku, 2016; in Japanese) was awarded the 59th Nikkei Keizai Tosho Bunka Award and the 33rd Academic Association for Organizational Science Takamiya Award. Professor Shimizu also regularly submits papers to international peer-reviewed journals.

# Cultivating the necessary Human Resources for an Industrial Revolution based on Data Use



**Akimichi Takemura**

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The spread of smartphones and the diverse products and services related to them has resulted in a radical change in the environment in which we live our lives and utilize data. The amount of data that we are able to collect and utilize has rapidly grown in scale, and the phrase “Big Data” has become firmly entrenched. Data is now an important management resource, and has even been called “the oil of the 21st century.” Appropriate use of this resource will boost the international competitiveness of companies and, further, of nations. In Japan, which has traditionally been strong in the manufacturing industry, companies have emphasized the incorporation of advanced functions and multiple functions into their products. However, with the

development of information technology, a new perspective has become more important: Identifying customer needs from massive amounts of data, and attracting consumers by increasing the appeal of content and offering optimum products and services on this basis. Japan is lagging behind in the transition to this type of approach. By contrast, the US, which possesses a cultural environment in which data is regarded seriously and also has a well-developed system for education in statistics, has offered fertile ground for the utilization of data analysis in business. As a result, the US has taken the competitive advantage in the field of information.

Japanese manufacturing remains strong. What Japan must do, as the IoT continues to develop against the background of the Fourth Industrial Revolution, is to use that strength in order to promote an industrial revolution using information in every field of endeavor. In order to do so, it will be essential to foster personnel able to utilize data at the business frontline, and to establish environments that enable them to flourish.

In Japan, in both education and society more generally, the wall between the humanities and the sciences has traditionally been difficult to breach, and it is possible that this will represent an impediment to the utilization of data in business. Nevertheless, a knowledge of data science, involving the use of computers, is now an essential skill, irrespective of one’s orientation towards the humanities or towards sciences. Up to the present in Japan, we have lacked dedicated faculties and departments of statistics, and there have been few teachers of the subject. However, in spring 2017, Shiga University established the Faculty of Data Science. This institution has received an excellent evaluation from the government, and has been selected as a base for mathematics and data science education. We are hearing from companies themselves that while they have data available, they have no personnel able to analyze and assess that data, and they are eager to recruit human resources who possess skills of this type. Based on our awareness of the tremendous importance of fostering human resources able to apply these skills on the business frontline, the Faculty of Data Science is implementing a range of initiatives, including inviting lecturers from companies, conducting cooperative education with companies, and expanding internship programs.

Professor Takemura was instrumental in the creation of Shiga University’s Faculty of Data Science, Japan’s first faculty devoted to the study of data science. In addition to his role as a researcher specializing in the field of mathematical statistics (and one-time President of the Japan Statistical Society), Professor Takemura has also been active in the area of education. After taking his Ph.D. from Stanford University’s Statistics Department, he served as an Assistant Visiting Professor in the same department, a Visiting Assistant Professor in the Department of Statistics, Purdue University, a Professor in the Faculty of Economics, The University of Tokyo, and a Professor in the Graduate School of Information Science and Technology, The University of Tokyo, before taking up his present position in 2017. He is the recipient of numerous awards, including the Japan Statistical Society Prize.