

The Success or Failure of Its Semiconductor Strategy Will Determine the Future of the Nation

How can Japan ensure its economic security in relation to semiconductors?

How can the nation gain an advantageous position in the ongoing restructuring of supply chains?

In this issue of *My Vision*, we discuss the semiconductor strategy that Japan should adopt.

About This Issue

Design and Development Capabilities Are the Wellsprings of Semiconductor Competitiveness - Rather Than Relying on Large Corporations, We Must Cultivate Broad-Based Private-Sector Capability

Yasufumi Kanemaru

Chairperson, NIRA/ Chairman and President, Group CEO, Future Corporation

Against the background of conflict between the U.S. and China and concerns over the China-Taiwan situation, Japan's national strategy for semiconductors, a crucial commodity, is coming under discussion.

What direction should Japan's semiconductor strategy take from the perspective of economic security?

How can Japan gain an advantageous position amid the restructuring of supply chains?

In this issue of *My Vision*, leading experts, including policymakers, a business leader, a journalist, and a researcher offer their opinions on these questions.

Keywords...Direction for national strategy, semiconductor design and development capabilities, broad-based private-sector capability

Expert Opinions

The Success or Failure of Its Semiconductor Strategy Will Determine the Future of the Nation

What direction should Japan's semiconductor strategy take from the perspective of economic security?

Against the background of ongoing reorganization of supply chains, how can Japan gain an advantageous position in this area?

Enhance "Strategic Autonomy" and "Strategic Indispensability" in Collaboration with Ally Countries

Keitaro Ohno

Member of the House of Representatives

Keywords...Enhancement of manufacturing capability, friendshoring, game change

Improve Design and Development Capabilities for Semiconductor Chips to Maintain Competitiveness

Kimio Fujii

President and Executive Officer, Nihon Synopsys G.K.

Keywords...Semiconductor design and development capabilities, development and deployment of human resources, profitable business model

Avoiding Fragmentation and Advancing Semiconductor Technology Through International Collaboration

Hitoshi Wakabayashi

Professor, Integrated Green-niX+ Research Unit, Institute of Innovative Research, Tokyo Institute of Technology

Keywords...Key industries with shared global importance, knowledge accumulation, chiplets

Collaborate with Other Countries to Strengthen the Manufacturing Ecosystem, Aiming Toward Next-Generation Domestic Production

Hisashi Kanazashi

Director, IT Industry Division, Commerce and Information Policy Bureau, Ministry of Economy, Trade and Industry

Keywords...Attraction of TSMC to Japan, Rapidus, responsibility for the manufacturing ecosystem

Businesses Play the Leading Role: Take Advantage of the Opportunities Offered by Geopolitical Friction and Periods of Technological Transition

Yasuhiko Ota

Columnist, Nikkei Inc.

Keywords...Security and free trade, corporate initiative, development of intellectual property (IP)

Interview period : August,2023-October,2023

Interviewer: Sosuke Suzuki (Research Coordinator & Researcher, NIRA), Yoshie Udagawa (Research Coordinator & Researcher, NIRA), Yuki Takenaka (Research Coordinator & Researcher, NIRA)

About This Issue

Design and Development Capabilities Are the Wellsprings of Semiconductor Competitiveness

-Rather Than Relying on Large Corporations, We Must Cultivate Broad-Based Private-Sector Capability



Yasufumi Kanemaru
Chairperson, NIRA /
Chairman and President, Group
CEO, Future Corporation

When thinking about national security, it goes without saying that semiconductors, in particular logic semiconductors such as central processing units (CPUs) and graphics processing units (GPUs), will be extremely important for the future world. High-performance semiconductors are essential to the solution of problems in every field, including artificial intelligence (AI), electric vehicles (EV), measures in response to global warming, and the military. While I have high hopes for Japan's semiconductor strategy, I also have concerns. If the direction of the national strategy is misguided, the private-sector projects that follow will not produce results.

In the field of computers in particular, Japan's national strategy and projects conducted by large corporations have continued to fail. Japanese companies had a strong global presence at the dawn of the CPU in the 1970s, but lost their place when 16-bit CPUs took center stage. Major Japanese manufacturers followed IBM's lead and concentrated their business resources on mainframe computers, and the government encouraged them to do so. However, the market expanded explosively with the advent of the personal computer. As the market expanded, CPU performance also evolved rapidly, leading to today's smartphones. Both the companies involved and the government misjudged these new technological innovations and market changes, and failed to reap the fruits of their investments.

In the 1980s, a national project for a “fifth-generation computer” was launched under the leadership of the Ministry of International Trade and Industry (now the Ministry of Economy, Trade and Industry), but this too ended in failure. If a semiconductor strategy is pursued without examining and reflecting on why national and corporate strategies have been misguided, the same mistakes will be repeated.

The Position Japan Should Aim Towards in the Semiconductor Arena: More Than Simply Attracting New Factories

The semiconductor field is extremely diverse, ranging from design and development to materials, manufacturing equipment, front-end processing, back-end processing, and further to applications. What areas is Japan targeting and how? The Japanese government and Japanese companies tend to focus on mass production at large factories. Because there is a clear expectation that demand for semiconductors will continue to increase into the future, they perhaps believe that building an advanced plant and making it a strategic production base with the help of the Taiwan

Semiconductor Manufacturing Company (TSMC), which the government has attracted to Kumamoto Prefecture, will lead directly to industrial development and improved national security.

How can we formulate a consistent overarching design for the future of Japan's semiconductor industry that takes into consideration projections of national strategy and changes in the semiconductor market?

Rivalry between the U.S. and China is intensifying in the semiconductor field. With the goal of maintaining military superiority, the U.S. Department of Defense is trying to keep advanced semiconductor manufacturing capabilities at home and in allied countries, and to prevent technologies that might threaten its own security from flowing out of the country. At the same time, from a business perspective, the U.S. and China will remain important trading partners, and the U.S. reluctance to release advanced semiconductor technology may spur China to develop its own technologies. Japan must take these circumstances into consideration in a comprehensive manner and align its national strategy for industry and national security with private-sector strategies. If new investment is focused solely on manufacturing plants, problems in international supply chains will remain, and even if it is possible to realize the manufacture of advanced semiconductors, it will be necessary to compete with TSMC to win customers. The idea that building advanced factories will lead to industrial prosperity and national security seems rather vague as a national strategy.

Keitaro Ohno, a member of the House of Representatives, tells us that Japan should become a maker of products that are indispensable to other countries, allowing it to secure a strategic position.

Hisashi Kanazashi, Director of the IT Industry Division of the Ministry of Economy, Trade and Industry, also stresses the importance of contributing to the world in the fields of memory, materials, and manufacturing equipment, fields in which Japan possesses strengths.

These are valid points, but they are not the only things that need to be focused on. The influential players in the semiconductor field today are companies with strong design and development capabilities, in particular fabless semiconductor manufacturers(*) able to realize competitiveness in their end products depending on the strengths of their semiconductors. AI semiconductors from NVIDIA are indispensable for the development of generative AI models, and the technologies possessed by Arm, a British semiconductor design giant that excels in power efficiency, are reshaping the market structure of the CPU industry. Companies including Google, Amazon and Apple have also commenced in-house development (these companies can be considered fabless semiconductor manufacturers that cater only to internal needs). As Kimio Fujii, president and executive officer of Synopsys Japan, G.K., tells us, Japan cannot remain competitive without semiconductor design and development capabilities.

During a Time of Technological Transition, It Is “New Blood” That Will Move the National Semiconductor Strategy Forward

As Yasuhiko Ota, a columnist of Nikkei Inc., points out, semiconductors have reached a technological turning point. With the emergence of “chiplet” technology, which sees chips being created by combining blocks for different functions, and “RISC-V,” an open-source CPU design, semiconductors are also moving from an era of “concentration” to one of “decentralization.” Professor Hitoshi Wakabayashi of the Tokyo Institute of Technology indicates that collaboration among

numerous companies is required to create a single product.

Under these circumstances, how can we foster and strengthen fabless semiconductor manufacturers with strong design and development capabilities?

Most important of all is human resources, but education in the field of semiconductors has already disappeared from Japanese universities, and companies lack the requisite expertise. The Japanese government is spending a huge amount of money to attract semiconductor factories to Japan, but it should be expending the same amount of money and resources on acquiring human resources. Recruiting talented engineers from overseas by offering attractive compensation packages is an efficient and reliable strategy, and spinning out teams with semiconductor design capabilities from large companies to form start-ups is also an option. It will be important to increase the amount of new blood in the field, not only in the area of cutting-edge semiconductor design and development, but also in companies that use these semiconductors in their products and services.

Above all, the government should develop a national strategy that organically links the disparate efforts of government agencies, universities, and the private sector. This includes training engineers to prevent the decline of legacy semiconductor manufacturing capability and promoting the consolidation of companies. It will also be essential to provide budgetary support for new entrants to the market, who are always the main drivers of innovation, rather than simply relying exclusively on existing large companies. The success of Japan's semiconductor strategy depends on whether it will be able to create a broad base of private-sector capacity.

(*) This refers to manufacturers which specialize in functions such as product design and marketing, but which do not have their own factories or production facilities, outsourcing all production to external manufacturing companies.

Mr. Kanemaru is the Chairperson of the Nippon Institute for Research Advancement (NIRA) and the Chairman and President, Group CEO of Future Corporation. He has served in a number of public positions, including as a member of the Council for Regulatory Reform, the Growth Strategy Council - Investing for the Future, and the Growth Strategy Council.

Expert Opinions

Enhance “Strategic Autonomy” and “Strategic Indispensability” in Collaboration with Ally Countries



Keitaro Ohno

Member of the House of
Representatives

The pandemic and the war in Ukraine were chief among a number of factors that caused a worldwide shortage in semiconductor supply. In Japan, there were backlogs in numerous areas such as the automotive and home appliance industries. Larger trends include the global movement towards carbon neutrality and the fully-fledged spread of AI. Investment in the field of semiconductors is vigorous in light of these trends. Particularly noteworthy is the deterioration of the international order against the backdrop of conflict between the U.S. and China. The international supply chain for semiconductors has emerged as a major economic security issue. Japan is, naturally, working to enhance the manufacturing capabilities of its own companies, but is also “friendshoring,” the restructuring of the supply chain through cooperation among ally countries, in order to stabilize the international order, all the

while bearing in mind the possibility of contingencies in relation to Taiwan, among other factors. It has also begun to make efforts to attract manufacturing bases to the country.

In the development and production of cutting-edge semiconductors, it will be important to deepen cooperation with ally countries and ensure “strategic autonomy” to avoid excessive dependence on specific countries, in addition to realizing “strategic indispensability,” i.e., making Japan an indispensable presence for other countries.

For the time being, the basis of Japan’s efforts will be to provide the necessary support to domestic industry utilizing the existing framework. The provision of support for R&D and investment in manufacturing facilities is of course a given, and the creation of institutional measures to prevent the outflow of Japan’s cutting-edge technology to other countries has already been instituted. In addition, due to the complexity of technological trends and industrial structure, the government has begun to create an “economic intelligence” infrastructure that can accurately analyze Japan’s strengths and weaknesses.

With regard to next-generation architecture, it would be desirable for Japan to focus on creating “game-changing” technologies while maintaining an accurate grasp of changing needs. Japan should also work actively to resolve its “valley of death” problem” (i.e., its inability to reach the stage of commercialization and implementation despite world-class research and development), which has been a consistent weakness for the nation. It will also be important to create mechanisms to encourage strategic efforts toward international standardization. One example is NTT’s “IOWN Concept,” which seeks to reduce power consumption through photoelectric fusion. With the world’s demand for electric power rapidly increasing, this project has great potential. In order to respond to uncertainties in the future, it will be necessary to prepare and implement multiple options in parallel.

Japan has earned a high degree of trust from other countries as a country that adheres to and defends free trade and international rules. It is important for Japan to help maintain and strengthen the international order while leveraging that legacy, and to play a role in shaping international rules for the new era with the agreement of the international community.

Dr. Ohno is a member of Japan’s House of Representatives. Following a career with Fujitsu Limited and Fujitsu Laboratories, he was first elected to the House of Representatives at the 46th election in 2012. As of the time of writing, he is serving his fourth term. Dr. Ohno has served in posts including Parliamentary Vice-Minister of Defense and State Minister of the Cabinet Office. He also serves as Chief Secretary of the Liberal Democratic Party’s Headquarters for the Promotion of Economic Security. In addition to his involvement in the LDP’s “Overall Vision for Japan’s Future Economic Security,” he has been an active voice in the field of economic security, formulating a series of proposals that contribute to economic security, including the promotion of system design for security clearance and cyber security, active involvement in the formation of international rules such as trade control regimes, and the establishment of analytical methods for understanding supply chains. Dr. Ohno holds a Ph.D. in Information Science and Technology from The University of Tokyo.

Expert Opinions

Collaborate with Other Countries to Strengthen the Manufacturing Ecosystem, Aiming Toward Next-Generation Domestic Production



Hisashi Kanazashi

Director, IT Industry Division,
Commerce and Information
Policy Bureau, Ministry of
Economy, Trade and Industry

The semiconductor supply chain suffered considerable damage as a result of the Covid-19 pandemic and the war in Ukraine. Two years ago, amid the increasing geopolitical instability of the U.S.-China confrontation, action began to be taken in the area of semiconductor policy due to the need for economic security. Since then, steady progress has been made in moving forward with the policies which needed to be adopted, seeing the government work to attract Taiwan's TSMC to situate a plant in Kumamoto Prefecture in order to enhance domestic semiconductor supply, and the establishment of Rapidus as a production base that will boost Japan's future competitiveness. With geopolitical tensions increasing, it will be necessary for Japan and Taiwan to complement each other without Japan becoming too reliant on Taiwanese semiconductors, and for Japan to bear in mind potential contingencies.

No single country can take on the burden of the entire semiconductor manufacturing process. The key to economic security is to have a smoothly functioning manufacturing ecosystem, including the supply of human resources, realized in cooperation with other countries. Japan should contribute to the world in the areas of memory, materials, and manufacturing equipment, where it is strong, and rely on other countries in areas in which it is less capable, in this way fulfilling its absolute responsibility in the formation of the supply chain. For example, other countries require a stable supply of wafers and substrates, and this is an area in which Japan boasts a large market share. In order to ensure the technological evolution of these products, it will be essential for the government to continue to provide the necessary support to small-scale businesses that have difficulty in raising funds.

Japan's current semiconductor production capability is in the 40 nanometer range (a nanometer is one billionth of a meter). When the TSMC Kumamoto plant is operational, it will be possible to manufacture semiconductors in the range of 12 to 28 nanometers in Japan; these are in high demand in industries including the automotive and electronic products industries. In addition, TSMC's second plant is expected to mass-produce higher-performance 6-nanometer semiconductors. TSMC's expansion into Japan is a joint venture with Sony and Denso, an approach that TSMC itself is in favor of. The company is building a plant in Germany using a similar joint venture approach. Further, while cutting-edge 2- and 3-nanometer semiconductors have not been in demand in Japanese industry up to the present, they will be essential in the 2030s. It is hoped that Rapidus will set its sights on this market and promote the domestic development of cutting-edge semiconductors.

Possessing the ability to supply next-generation semiconductors will also be important from the perspective of Japan's security. We are also now witnessing a change in the structure of semiconductors, which continue to miniaturize (see note), giving Japan an opportunity to enter the market. Additionally, it will be important to be able to design and manufacture with end-users in mind, as U.S. companies do. The status of supply and demand in the area of semiconductors is changing rapidly, making it difficult to judge whether current policies are adequate to the situation. Nevertheless, Japan must also enhance its initiatives in the areas of analog and power semiconductors.

(Note) Transistor structure is undergoing an innovation from FinFET to GAAFET in order to realize the further miniaturization of semiconductors.

After joining the Ministry of International Trade and Industry (now the Ministry of Economy, Trade and Industry), Mr. Kanazashi worked in the Industrial Revitalization Division and the Cabinet Secretariat's Japan Economic Revitalization Bureau, before being stationed at the JETRO Los Angeles office for three years from 2016. From 2019, he served as Director of the Industry Creation Policy Division, promoting the implementation of the Open Innovation Taxation System in the field. He has held his current position since July 2022. Mr. Kanazashi is responsible for coordinating the Ministry of Economy, Trade and Industry's "Semiconductor and Digital Industry Strategy," and leading the efforts to attract TSMC to construct a plant in Japan and establish Rapidus Corporation, which aims to become a Japanese semiconductor foundry, and LSTC, which will support the development of the country's semiconductor technology.

Expert Opinions

Improve Design and Development Capabilities for Semiconductor Chips to Maintain Competitiveness



Kimio Fujii
President and Executive
Officer, Nihon Synopsys G.K.

As geopolitical and supply chain risks increase, the Japanese government has moved to attract TSMC to Kumamoto Prefecture and support the establishment of Rapidus, a Japanese company targeting fabrication of cutting-edge semiconductor chips. However, the semiconductor industry is built on a global ecosystem. Some increase in fabrication capability in Japan does not necessarily mean elimination of geopolitical risks. This could be one form of revitalization, but not sufficient from the perspective of economic security. Japan is strong in the areas of semiconductor materials and manufacturing equipment, but these are only part of the semiconductor supply chain.

The real strategy that should be adopted to boost Japan's industrial competitiveness is to increase semiconductor chip design and development capabilities. Otherwise, Japan's semiconductor industry will not be able to thrive. Furthermore, it will lose out in competition with the rest of the world in all electronics-related industries. A clear example is the automotive industry, which is one of Japan's strengths. Up to the present, the key to competitiveness has been the performance of the engine, but as electrification and autonomous driving progress, the only thing that will make the difference between winning and losing in the market is the performance of the semiconductor chips, besides the storage batteries. If we continue to develop only software that utilizes general-purpose chips rather than designing customized chips, as we are doing at present, we will not be able to take the lead in the global market. Tesla is already designing its own semiconductor chips. This is not only the story in the automotive field. GAFAM companies have also started designing their own customized chips to survive in the market. They have realized it is essential for them to design the semiconductor chips that form the foundation of their systems and software products, to differentiate them from competitors. Without the ability to design and develop semiconductor chips, Japan will lose its competitiveness. This is true for industries in general.

Japan's past failures in the semiconductor business have led to a decline in investment and a downward spiral over more than 30 years. The government has been shortsighted, and management has only considered immediate profitability without working toward the realization of a long-term vision. As a result, the number of human resources involved in the semiconductor industry has declined sharply, and there is an overwhelming shortage of semiconductor chip designers. We must create opportunities for the provision of chip design education, but this alone will not be enough. Unless a business model is created in which educated human resources continue to generate profits within companies, the bitter past will come back again. The key to the success or failure of Rapidus, which fabricates cutting-edge semiconductor chips, will be also whether or not it is able to establish its own business model. One idea is that the government takes measures to link Rapidus with the automotive and other industries that apply semiconductor chips. Rapidus would foster new customers, and the automotive industry would be encouraged to develop its own customized chips using Rapidus fabrication. The government should actively encourage the semiconductor industry and the industries that apply semiconductors to revitalize themselves through synergistic effects.

Mr. Fujii is the President and Regional Vice President of Sales of Nihon Synopsys G.K., the Japanese subsidiary of California's Synopsys Inc. Among its offerings, Nihon Synopsys G.K. provides tools to support semiconductor design automation (EDA) and pre-designed semiconductor circuits (IP). In 1981, Mr. Fujii saw the potential of semiconductors, a new field at the time, and joined the semiconductor development company Texas Instruments Japan, Ltd. He supported the rapidly developing semiconductor industry, including involvement in the evolution of logic semiconductor design methods. Mr. Fujii was appointed to his current position in 2000, following terms as President and Representative Director of the semiconductor design and development companies Cirrus Logic Japan Inc. and Cygnus Solutions Japan.

Expert Opinions

Businesses Play the Leading Role: Take Advantage of the Opportunities Offered by Geopolitical Friction and Periods of Technological Transition



Yasuhiko Ota
Columnist, Nikkei Inc.

The semiconductor industry is often thought of as being caught in a conflict between national security and free trade, but the two cannot be viewed as opposites. While trade in advanced technology is a matter of national security, and as such is increasingly controlled by the state, general-purpose semiconductors are key products in numerous industries and trade in them should be maintained on a free-trade basis. Looking at the actions of the government alone, the U.S. appears to be monolithic, but inside Washington, the government and businesses are engaged in a fierce daily struggle. The interests of the government, which seeks to expand regulations, and the interests of companies, which want to secure a place in the Chinese market, sometimes tend in opposite directions. The question is how companies can operate strategically within these boundaries. Tectonic shifts

in geopolitics can be seen as an opportunity for companies to create a place for themselves.

Businesses play the leading role in the economy. Rather than being swept away by the main currents of the time and withering away, they must create their own vision for survival in an international community marked by friction. This will depend on the degree to which companies can secure their independence. They will also need to possess sufficient tenacity to enable them to deal shrewdly with China. If they maintain their own proprietary technologies, companies will have the power to negotiate not only with China, but also with the United States. Corporate consultants who emphasize economic security are guiding companies to “protect” themselves by conforming to U.S. export regulations. However, this type of merely subservient protection will not help a company grow.

In order for Japan's semiconductor industry to regain its competitiveness, it must establish engineering unique to Japanese companies that cannot be imitated by companies from other countries. Looking at examples of companies that are doing precisely this, the U.K.-based Arm, which provides basic technologies for semiconductor logic design, and the U.S.-based Synopsys, which provides platforms for semiconductor design, are key players in the current semiconductor value chain. Japanese companies should also aim to develop intellectual property (IP) rights that will be essential to next-generation semiconductor manufacturing. Irrespective of its superiority in manufacturing, Japan's semiconductor industry will not be revived on this basis alone. In order to produce innovators who will change the way of thinking regarding added value in this area, it will be necessary for Japanese companies to provide a broad range of opportunities for human resources from nations in Southeast Asia and other emerging nations.

Fortunately, semiconductor technology is now at a major turning point. This is a phase that necessitates new technological systems capable of attaining the pinnacle of miniaturization and energy conservation. “Chiplets,” which realize advanced functions by layering and combining chips, represent an area in which Japan can demonstrate its strength. If Japan was able to adopt an offensive strategy, taking the lead in standardizing this technology and licensing it out, it would be a significant element in the nation's revival. The conditions for this will be that companies become hungry for the accumulation of knowledge and expertise on their manufacturing frontlines and that the government formulates an industrial policy that outlines a major national strategy.

Mr. Ota has reported on international affairs including diplomacy, trade, and innovation for the Nihon Keizai Shimbun for many years. His book 2030 handoutai no chiseigaku (“The Geopolitics of Semiconductors in 2030,”), published in 2021 by Nikkei BP, vividly depicts the conflict between nations over semiconductors, which are increasing in value as strategic assets. After joining Nikkei Inc. in 1985, he studied at the Massachusetts Institute of Technology (MIT) in the U.S., and reported for Nikkei's U.S., Germany, and Singapore offices. He was an editorial writer from 2004 to 2021. Mr. Ota received the 2017 Vaughn-Uyeda Memorial International Journalistic Prize for his coverage of China's “One Belt, One Road” initiative and other issues. He has given presentations and spoken at international conferences, including the Davos Forum.

Expert Opinions

Avoiding Fragmentation and Advancing Semiconductor Technology Through International Collaboration



Hitoshi Wakabayashi

Professor, Integrated Green-niX⁺
Research Unit, Institute of
Innovative Research, Tokyo
Institute of Technology

Japan's semiconductor industry has been facing adverse conditions for many years. Now, in the name of “economic security,” the industry has suddenly been thrust into the limelight. I cannot help but feel a sense of unease about this. Semiconductors are used in all areas of our lives, from smartphones onwards, and are essential to people throughout the world in today's ever-advancing information society. Contributing to fields including AI, EVs, and the effective use of energy in power generation, all of which will continue to expand in future, it is clear that semiconductors will make a significant contribution to the resolution of social issues, and will represent a common good to humanity. Even beyond the perspective of economic security, we must recognize that the semiconductor industry is a vital one.

Further, it is undesirable for the semiconductor industry to be compartmentalized on a country-by-country basis for reasons of economic security. The manufacture of semiconductors involves a complex and diverse range of steps, from design, through procurement of raw materials and functional materials, to the set-up of manufacturing equipment and the manufacture of integrated circuits, which can involve more than 1,000 processes. This necessitates “knowledge integration” through collaboration among diverse countries and companies. If only ally countries work together, there is no doubt that the evolution of semiconductor technology will slow down and their utilization will be restricted. As an engineer, I do not want to see the knowledge that has been painstakingly accumulated over the years destroyed by ideology.

The issue of climate change, which is a shared challenge for humanity, is an issue that must be urgently addressed, and these country-by-country divisions make it doubtful whether humanity will be able to achieve ongoing prosperity. Is there really no way to make cooperation with other countries a foundation of semiconductor policy? The world recognizes the importance of Japan in the field of semiconductors, both technologically and as a market. While indicating its own direction, Japan should strategically formulate an outline of the type of presence it seeks to be viewed as by other countries in the supply chain.

At this stage, semiconductor policy is being led by the national government. However, when the government has progressed with projects to a certain extent, it will be desirable for companies to step forward to boost their profits and expand their activities. In this case, open collaboration among companies will also be very important. Five years in the future, the market will see the emergence of “chiplets,” which combine multiple chips (CPUs, memory chips, etc.) into a single package; as a result, “system integrators,” which integrate the products of multiple companies, will become important. If this is the case, collaboration among multiple companies to create a single product will become a matter of course. It will be important for companies to not merely consider their own interests, but to adopt a “sanpo yoshi” (benefit to buyer, seller and society) philosophy or a way of thinking that incorporates a wider range of stakeholders and contexts, and to proceed in collaboration with other companies in the same industry.

As the leader of the Integrated Green-niX⁺ Research Unit of the Tokyo Institute of Technology's Institute of Innovative Research, Professor Wakabayashi is promoting research and the development of human resources in the area of integrated circuit technology in order to realize green semiconductors with low environmental impact. Bringing together leading researchers and promoting joint research with companies, he aims to be a game changer in greening Japan's integrated circuit industry and supply chain. After completing his M.E. degree at the Tokyo Institute of Technology, he worked for NEC Corporation and Sony Corporation before becoming a professor of Electrical and Electronic Engineering in the Tokyo Institute of Technology's School of Engineering. Professor Wakabayashi has held his current position since July 2023, having served as Director of the Research Institute for the Earth Inclusive Sensing, and Member of the Education and Research Council in Tokyo Institute of Technology. He holds a Ph.D. in Engineering, and is now a member of the Board of Directors of the Japan MOT Society.