Science Window

2021 Summer Issue 7▶9

Hunter-gatherer society that was mostly dependent on game hunting (Society 1.0) developed into the agricultural society (Society 2.0) as a result of the spread of agriculture. Then, the industrial society (Society 3.0) was created through the steam engine and other inventions and the information society (Society 4.0) was formed with the progress of ICT. Now, under the vision of Society 5.0, we aim to change society to a better "human-centered society" by highly integrating "cyberspace" created in computers and "physical space" where we live. (See next page.)

JST

SUSTAINABLE DEVELOPMENT GOALS

Features

"White Paper on Science, Technology and Innovation" is a Door to the Future

Science Window

2021 Summer Issue 7▸9

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Features

“White Paper on Science, Technology and Innovation” is a Door to the Future

All article translation in this issue was done by Science Japan (https://sj.jst.go.jp/) .

About the Features of 2021 Summer Issue

The 2021 edition of the White Paper on Science, Technology and Innovation describes a scenario for the realization of Society 5.0, a future society that is safe and secure and that makes the diverse happiness (well-being) of each individual happen. This issue introduces the key to this scenario, “convergence of knowledge” and the science and technology that forms its basis.

About the Cover

This cover was prepared by JST based on the 2021 edition of the White Paper on Science, Technology and Innovation (provided by the Ministry of Education, Culture, Sports, Science and Technology). The illustrations tell lives in the future society (Society 5.0) that we aim for and are filled with hints on how to create a human-centered society.

What is Science Window?

The world is full of science and technology, which enriches our daily lives and gives us the joy of learning about the natural world. We hope that the future will be brighter with the development of science and technology. “Science Window” is an online magazine that provides easy-to-understand and enjoyable information to make science and technology more accessible to as many people as possible.

The latest articles are now available on the Science Portal site (https://scienceportal.jst.go.jp/). (Available only in Japanese)

About the 2021 Annual Theme “SDGs”

The deadline for achieving the Sustainable Development Goals (SDGs), adopted by the United Nations General Assembly, is 2030. We have less than ten years left. The world has been hit by an epidemic of a novel coronavirus infection, which has revealed the vulnerability of society, leading to higher-than-ever expectations for science and technology. What kind of “sustainable society” can we realize, applying the lessons of the disaster? Let’s think together about the way happiness and society should be.

Osamu Sakura, Professor of the Interfaculty Initiative in Information Studies at the University of Tokyo, who is researching topics such as the relationship between science and technology, and society (Provided by Osamu Sakura)

CHAPTER 01

What Kind of Convergence of Knowledge is Required in Today’s Society? —Interview with Osamu Sakura

“The 2021 edition of the White Paper on Science, Technology and Innovation” states that to realize “the overall well-being of each individual,” it is important to utilize convergence of ‘knowledge’ that integrates the ‘knowledge’ of the natural sciences with the ‘knowledge’ of the humanities and social sciences. We asked Osamu Sakura, Professor of the Interfaculty Initiative in Information Studies at the University of Tokyo, who specializes in the relationship between science and technology and society, why convergence of knowledge is needed now and what it means to all of us.

Anxiety about the autonomous evolution of science and technology

Sakura explains the historical background of the idea of convergence of knowledge. “Originally, technology progressed in response to the need to travel further or help us to make things more easily. Today, however, diverse values make it difficult to think of technology as having a single purpose. And an increasing amount of new science and technology has been produced without a specific purpose.”

“Artificial intelligence (AI) and robots are typical examples of this. Science and technology have developed autonomously in a way that they can do ‘such and such’ a thing. When they are introduced to the world, it is unclear what kind of problem they will solve or what result they will bring, which sometimes amplifies anxiety around the technology. In addition to the diversification of values, the need to address these things and think about the use of technology and its value to society — I think this is why we need ‘convergence of knowledge,’” Sakura goes on.

According to Sakura, historically speaking, scientists stopped discussing happiness around the start of the latter half of the 20th century. The twisted link between state policy and science and technology has resulted in numerous sacrifices, including the tragedy of the World War II era. Prioritizing the values of the whole society can lead to individual unhappiness.

“Science has no say in happiness; the realms of morality, philosophy, and religion should be separated from the realm

of science — the trend of not stepping on each other's toes arose. Of course, scientists need to be cautious when discussing happiness and value. Still, scientists should be a little more aware of what they can say about human happiness as scientists in this day and age. On the other hand, philosophy and religion also need to use the results of science actively to add to their own value. I think that will lead to the convergence of knowledge," says Sakura.

"Crossing the Border of Humanities and Sciences" and "Editing Knowledge" is necessary

Creating and utilizing "convergence of knowledge," which is the combination of natural science "knowledge" and humanity and social science "knowledge" — What do you imagine when you hear this? You may imagine researchers in the natural sciences and the humanities and social sciences are discussing and collaborating to solve social issues while building new academic disciplines to create a better society. However, Sakura says that this is not so easy.

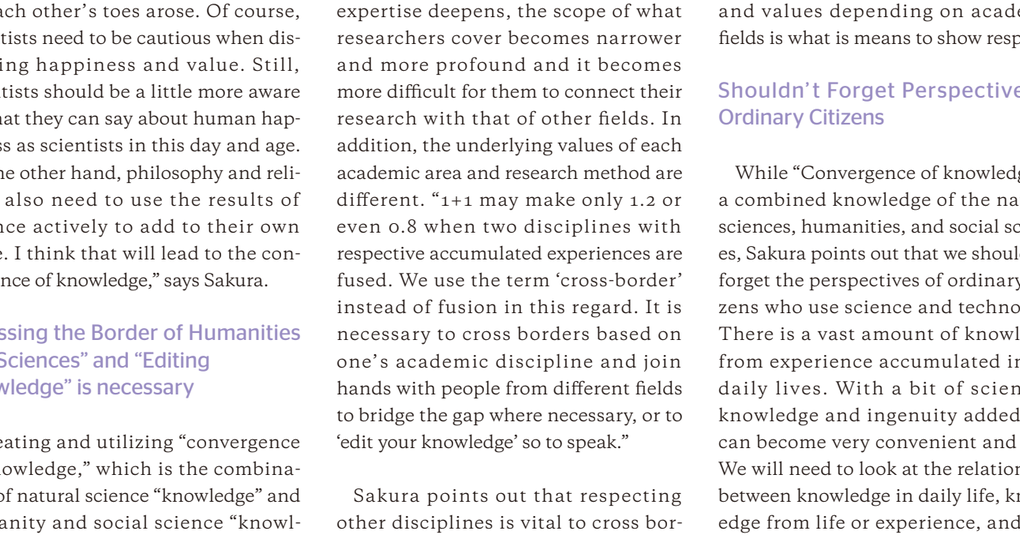
As their research progresses and their expertise deepens, the scope of what researchers cover becomes narrower and more profound and it becomes more difficult for them to connect their research with that of other fields. In addition, the underlying values of each academic area and research method are different. "1+1 may make only 1.2 or even 0.8 when two disciplines with respective accumulated experiences are fused. We use the term 'cross-border' instead of fusion in this regard. It is necessary to cross borders based on one's academic discipline and join hands with people from different fields to bridge the gap where necessary, or to 'edit your knowledge' so to speak."

Sakura points out that respecting other disciplines is vital to cross borders, in addition to the ability to let go of one's field of study a bit and look at it objectively from a higher perspective. "I think this is the same attitude that is required in 'cross-cultural communication.' If you exclude people just because they have different religions or food habits, communication will be difficult. Making an effort to understand different backgrounds of research methods and values depending on academic fields is what is means to show respect."

Shouldn't Forget Perspectives of Ordinary Citizens

While "Convergence of knowledge" is a combined knowledge of the natural sciences, humanities, and social sciences, Sakura points out that we should not forget the perspectives of ordinary citizens who use science and technology. There is a vast amount of knowledge from experience accumulated in our daily lives. With a bit of scientific knowledge and ingenuity added, life can become very convenient and rich. We will need to look at the relationship between knowledge in daily life, knowledge from life or experience, and specialized knowledge, including science and technology. As an example, he introduced a story he heard from a care worker who became a licensed physical therapist.

"In the field of nursing care, there are various procedures to take based on experience, for example, taking a resident to the bathroom after breakfast. The aforementioned care worker said through learning the physiology of human bodies in practice, it was eye opening that all the experiential knowledge accumulated in the field was based on universal principles." In short, "physiology researchers don't know anything about the nursing care field and care workers are working based on knowledge from experience instead of physiology; there is nothing to connect them. The same thing is happening everywhere in our daily lives, not just in the nursing home."



What is necessary to solve social issues by utilizing convergence of knowledge? (Prepared by JST based on the 2021 edition of the White Paper on Science, Technology and Innovation, provided by MEXT, the Ministry of Education, Culture, Sports, Science and Technology)

Sakura says that there is a need to have a process to translate specialized knowledge into living knowledge. And that is where we need to create a place and atmosphere so that ordinary citizens can be more involved.

Pioneering "Tohjisha-Kenkyu" (participant driven research)

So what should ordinary citizens keep in mind?

"Rather than having the idea that you must first learn technology, you think about what technology and knowledge can be useful to enrich and develop your life and values as a central idea. I want people to have the perspective that it is ordinary citizens who are the core users of science and technology," says Sakura.

Sakura cites "Tohjisha-Kenkyu", or participant driven research when translated to English, as a typical example of how ordinary citizens approach science and technology from what science and technology are necessary for them. Tohjisha-Kenkyu began when a person with a mental illness tried various ineffective treatments and began his research in conversation with a social worker confusedly. It uses scientific knowledge as a foothold, and the participants speak in their own words as a way to fill the gap between medical terms, diagnoses and their own senses. This research, which thinks about, and practices how to interpret and deal with the participants situation, is spreading to sites where people suffer from various problems and inconveniences. The academic world has also begun to pay attention to it. The University of Tokyo's Research Center for Advanced Science and Technology has established a research laboratory for the field of Tohjisha-Kenkyu.

"There are many different aspects to Tohjisha-Kenkyu, but I think it is a significant pioneering movement when we think about the relationship between science and technology and everyday life in the future." Sakura thinks we are currently lacking in the seeds that lead to the discovery of science and technology and research themes in everyday life. Still, the seeds that drive science and technology should emerge from our daily lives.

He wants to tell the younger generation that their lives and their interests can be the seeds of science. "It doesn't matter if it's a game, music, or anything else. There will always be a seed of science or technology there. If you take a step forward into the world where you can act on your curiosity, you will find a hook that leads to science. The accumulation of small discoveries brought by encounters with knowledge of science and technology will lead to a fulfilling life and well-being."

Shinichiro Kumagaya is an associate professor at the University of Tokyo's Research Center for Advanced Science and Technology and heads the Center's "Tohjisha-Kenkyu" field. He is also a pediatrician. He has cerebral palsy and lives in a wheelchair. (Provided by Shinichiro Kumagaya)

PROFILE

SAKURA Osamu

Professor, Interfaculty Initiative in Information Studies, The University of Tokyo; Team Leader, RIKEN Center for Advanced Intelligence Project (AIP)

He earned a Ph.D. in 1990 from the Graduate School of Science, Kyoto University. After working as a postdoctral fellow at Mitsubishi Kasei Institute of Life Sciences, an associate professor at the Faculty of Business Administration, Yokohama National University, a visiting researcher at the Institute of Computer Science and Social Studies, Albert-Ludwigs-Universität Freiburg, Germany, and an associate professor at the Interfaculty Initiative in Information Studies, the University of Tokyo, he assumed his current position in 2007. His main research theme is the study of science, technology and society.

Prepared by JST based on the 2021 edition of the White Paper on Science, Technology and Innovation (Provided by MEXT, the Ministry of Education, Culture, Sports, Science and Technology)

MEXT's 2021 White Paper is a Door to the Future:

Achieving "Diverse Happiness for Everyone" through "Convergence of Knowledge"

CHAPTER 02

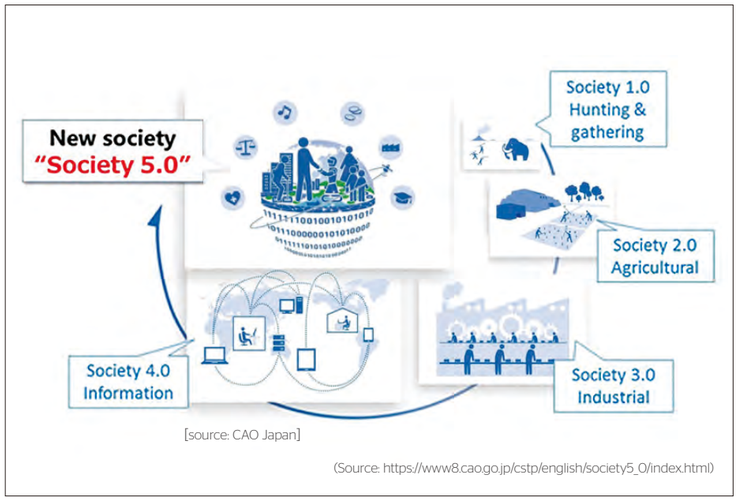
On June 8, the Cabinet approved the 2021 edition of the White Paper on Science, Technology and Innovation. The 2021 edition includes the realization of Society 5.0, specifically aiming to ensure safety and security and achieve each individual's overall well-being by utilizing "convergence of knowledge" that integrates knowledge from the natural sciences, humanities, and social sciences. The detailed illustrations depict life in the future society that we aim for in Society 5.0 and have plenty of hints on creating a human-centered community. The White Paper is truly a door to the future. Let's take a look at the 2021 edition of the White Paper with Tsuyoshi Shiota, Director of the Planning and Evaluation Division, Science and Technology Policy Bureau, MEXT, who was involved in its production.

Merging the virtual and the real through simulations

The White Paper features "Society 5.0," the future society we should be aiming for. The "White Paper on Science, Technology and Innovation" is not just an annual report. How will the world change in the future, and in what direction should we go? It is also a guide to the future, introducing science and technology to realize an ideal society.

In the history of development, we humans have passed through the hunting society (Society 1.0), where we hunted and gathered nuts, then the agricultural society (Society 2.0), where we settled down cultivating the fields and growing crops such as rice and wheat. Then eventually realized the industrial society (Society 3.0), where machines and equipment developed, and products were mass-produced. And the society we live in today is viewed as the "Information Society (Society 4.0)," with the spread of the Internet, computers, smartphones, and other devices that allow us to connect to information both domestically and internationally instantly and to diversify our communication.

"With the steam engine came the transition to an industrial society, and with the advancement of ICT (Information and Communication Technology) came the information society. Society 5.0 is a new society as follows: A human-centered society aiming to achieve economic development and solve social problems through a system that integrates virtual (cyber) space and real (physical) space, which is a concept that originated in Japan," Shiota said.



[source: CAO Japan]

(Source: https://www8.cao.go.jp/cstp/english/society5_0/index.html)

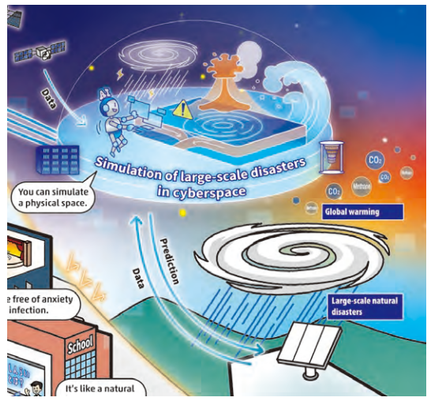
What does "merging virtual space and real space" mean?

A simple example of this is the simulation by the supercomputer "Fugaku" of the preventive effect of masks against the new coronavirus infection (COVID-19). The movie, which reproduced the droplet dispersion caused by coughing with and without masks, was a big hit and became the basis for recommending masks in real life. Also, a video production that simulates what would happen to a city recreated on a computer in a massive earthquake or tsunami is in progress. Efforts are also underway to use these simulations for evacuation planning and disaster-resilient urban development.

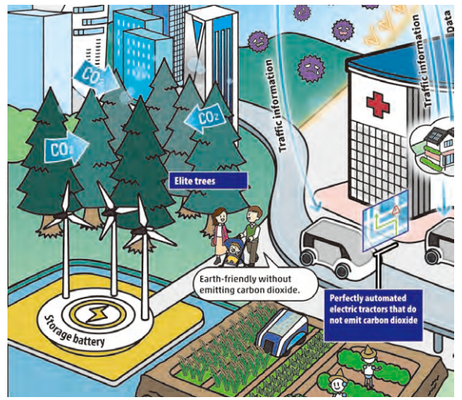
Society 5.0 has "an image of transformation towards a better, more human-centered society: Artificial intelligence (AI) analyzes a variety of information about the real world accumulated in a virtual space as big data and feeds back high value-added information to the real world." Shiota explains. The white paper introduces research and development of advanced technologies such as supercomputers and AI technologies for collecting various data in virtual space for data processing and analysis.

To realize a society where "no one is left behind"

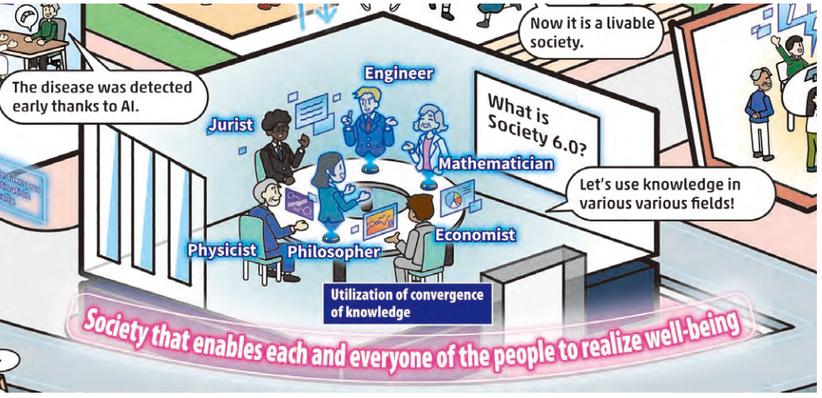
Until last year, the "White Paper on Science, Technology and Innovation" was published with the name "White Paper on Science and Technology. What is the background to including 'Innovation' in the name this year?



Simulation in a virtual space based on actual weather data, etc., to be used for prediction and forecasting of natural disasters (Prepared by JST based on the image provided by MEXT)



A variety of other initiatives have launched to solve issues common to all humankind. (Prepared by JST based on the image provided by MEXT)



Solving social problems by utilizing "convergence of knowledge" that transcends the boundaries of the natural sciences, humanities, and social sciences (Prepared by JST based on the image provided by MEXT)

The Basic Law on Science and Technology, enacted in 1995, is the backbone of the government's measures to promote science and technology. Based on this law, the government formulates the Science and Technology Basics every five years, a five-year plan which outlines it's basic policy. The Basic Act was amended in June 2020 and renamed the "Basic Act on Science, Technology and Innovation." In line with this, both the Basic Plan and the White Paper were renamed. To better society, we need to utilize research and development results, such as discoveries, inventions, new products, etc., and disseminate them throughout the community. It is important to solve social issues through innovation. The name change reflects the belief that it is the creation of science and technology and innovation that will bring about the development of our country and humanity.

We face many social issues — for example, issues that Japan faces now, such as the declining birthrate, an aging population, and declining population, and problems common to all humankind, such as food, energy, and global warming. Society 5.0 is a society that addresses these social issues, is sustainable and resilient, ensures the safety and security of its citizens, and brings about their well-being.

Shiota explains, "This idea is in line with the SDGs adopted at the UN Summit 2015, which call for a sustainable, diverse, and inclusive society where no one is left behind."

"Convergence of knowledge" necessary for insight into humans and society

In solving social issues, it is often impossible to solve them with knowledge of natural science alone. Taking the new coronavirus infection as an example, we need to think carefully about how measures to control the epidemic will affect the economic system and people's behavior. Not only the development of vaccines and treatments, but a wide range of knowledge is required, including sociology, economics, and psychology. The same applies to individuals. A wide range of knowledge and thinking is becoming necessary to understand and solve the problems we face.

Against this background, the humanities and social sciences are featured prominently as part of science and technology in the latest White Paper. To respond to increasingly complex social issues, we need deep insight into the nature of human beings and society. "The humanities and social sciences are precisely the disciplines that study how human beings and society should be. From now on, we need to make greater use of 'convergence of knowledge' that combines the humanities and social sciences knowledge with that of the natural sciences," Shiota says.

Shiota says that at the same time that knowledge from the humanities and social sciences is becoming more critical in solving social issues, there are more and more examples of the use of natural science methods in research in the humanities and social sciences. For example, there is the question of what human beings and society should do to address the widening inequality and poverty. The white paper introduces models of how researchers in psychology, economics, legal philosophy, and ethics have teamed up with researchers in brain science and other fields to study the brain' s functioning to reveal that humans have a common interest in those less fortunate.

Strengthening basic research capabilities for the future

While emphasizing innovation, the white paper also mentions the importance of basic research and introduces issues and initiatives to enhance basic research capabilities.

While 18 Japanese have won Nobel laureates in natural sciences this century, the international standing in regards to the number of published papers continues to decline: from second in the world in the average number of papers in 1996-98 to fourth in 2016-18, and from fourth to ninth in the number of high-profile publications.

Also, each country's index of R&D expenditure in the university sector, with 2000 as 1, was 2.5 in the United States, 2.2 in Germany, 1.8 in France, 2.3 in the United Kingdom, 19.0 in China, and 4.5 in South Korea in 2018, with Japan' s index instead decreasing to 0.9.

To solve these problems and to think about and support the future of Japan, initiatives to strengthen research capabilities, such as providing financial support to doctoral students and supporting the diverse challenges of young researchers, are about to start.

What has been the impact of the new coronavirus infection?

The new coronavirus infection that shook the world also affected the direction of scientific and technological development. The technologies forecast by 2040, described in the 2020 edition of the White Paper, were predicted before the outbreak of the new coronavirus infection.

Due to the coronavirus epidemic, some of these predictions have been realized earlier than expected, and others have been delayed. For example, the development of technologies to promote work-style reform, such as technologies to improve the work efficiency of office workers and telework, and technologies for health crisis management, such as infectious disease detection and epidemic prediction, are expected to be realized earlier than initially predicted. In the "with corona" and "after corona" societies, we need to ensure safety and security and seek a community where we can achieve well-being.

I hope people get a sense of the future society we're aiming for

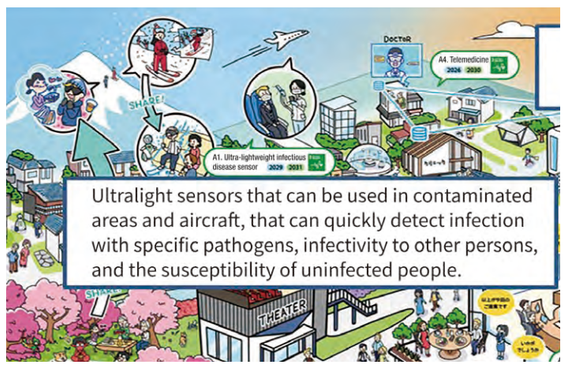
The white paper is published as a booklet and is also available on the MEXT website. Shiota says, "The white paper introduces Japan' s most advanced efforts in an easy-to-understand manner using illustrations and photos, and also introduces related research examples and topics in columns throughout the book. For those who want to know more, you can use QR codes to connect to associated websites. I hope you will pick up the white paper and get an idea of what kind of society will be created by science, technology, and innovation and the future society we are intending to build.

The humanities and social sciences fields are now essential elements for creating science, technology, and innovation. The potential for young people to play an active role in the future society has increased even further. At the beginning of the white paper, there is an illustration of what kind of society 'Society 5.0' will be. If use the image as a reference while reading the article, you will understand more. Even if you think that science is not your thing or that science, technology, and innovation have nothing to do with you, please pick up this white paper. It will give you a glimpse of how we can live with science and technology in the future society we hope to create.

Cover of the 2021 edition of the White Paper on Science, Technology and Innovation (Japanese edition) (Provided by MEXT)

"White Paper on Science, Technology and Innovation" (English edition) on the MEXT website
https://www.mext.go.jp/b_menu/hakusho/html/kagaku_e.htm

MEXT YouTube Channel "Understanding Society 5.0, featured in the 2021 edition of the White Paper on Science, Technology and Innovation" (Japanese)
https://www.youtube.com/watch?v=NpKO8gtYihw



Examples of technologies supposed-to-be realized soon (Prepared by JST based on the image provided by MEXT)

PROFILE

SHIOTA Tsuyoshi

Director, Planning and Evaluation Division, Science, Technology and Science Policy Bureau, MEXT

Graduated from the University of Tokyo, Faculty of Law, in 1996 and joined the Ministry of Education in the same year. After serving as Director of the Office for Professional Graduate School, Division of Technical Education, Higher Education Bureau, MEXT, Director of the Office for Financial Support in Upper Secondary Education, Finance Affairs Division, Elementary and Secondary Education Bureau, MEXT, and Director, Council for Science, Technology and Innovation Policy, Cabinet Office, he assumed his current position in October 2020.

Yuko Hara, Associate Professor at Tokyo Institute of Technology, School of Engineering, has succeeded in developing an ultra-compact, power-saving CPU.

CHAPTER 03

What is the Internet of Things (IoT) that Supports the Realization of Society 5.0? —Interview with Yuko Hara

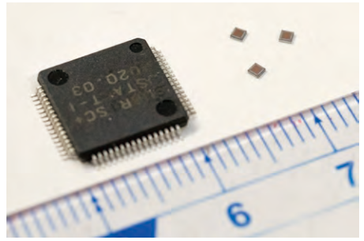
"Society 5.0" is the society we should aim for, as stated in the 2021 edition of the White Paper on Science, Technology and Innovation. What kind of society will it be, and what type of science and technology will be required to realize it? We asked Yuko Hara, Associate Professor at the Tokyo Institute of Technology's School of Engineering, who is drawing worldwide attention for her success in developing an ultra-compact, power-saving CPU (central processing unit, or the brain of a computer), about what the Society 5.0 will be like, and how it relates to her research.

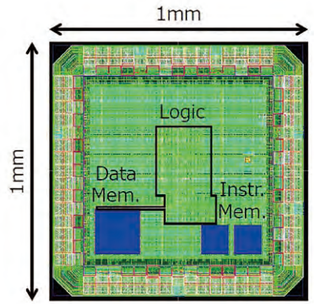
Ultra-compact at just 1 mm and power-saving CPU

The society envisioned in Society 5.0 is "a human-centered society that achieves both economic development and the resolution of social issues through a system that highly integrates cyberspace (virtual space) and physical space (real space)." In other words, it is a society where all people can equally receive services realized by science and technology like computers and the internet, where people can live safer lives, and where everyone can realize happiness in different ways for different people.

Hara conducts her research seeing fairness, equality, and unbiased information and services as essential concepts. In terms of science and technology, she believes that Society 5.0 will overlap with IoT (a society where everything connects to the internet). Let's take a look at what this means, along with her research contents.

The use of terminals such as computers and tablets varies from person to person, as some edit videos, while others only browse the internet. The ability to support such a wide range of uses is called "general-purpose." In contrast, Hara's research focuses on what is known as "embedded (systems)," where the purpose of using the device is determined at the time of design. Both hardware and software are designed for specific purposes, which reduces waste, size, and power consumption.





The ultra-compact, power-saving CPU developed by Hara (the three small square objects on the right side of the photo) and the package with the wiring for external access to the left: The layout diagram on the right shows that only around half of the total area is used. (Provided by Tokyo Institute of Technology)

The research bore fruit in the form of an ultra-compact, power-saving CPU, which went public in February of 2021. It is only one millimeter in length and width but contains about 9,000 logic gates (ultra-small unit parts of electronic circuits) and about 6 kilobytes of memory. Moreover, the CPU can continue to function for about 100 days on a single button battery. It is excellent in terms of power-saving as well.

Indispensable for autonomous and distributed edge terminals

Why are such ultra-compact and power-saving CPUs needed?

At present, data collected from terminals connected to the network around us (edge terminals) mainly go to the cloud (a group of computers in a remote location), where analysis and simulation are centrally performed to return the processing results (cloud computing). The information is centralized in the cloud and not processed at the edge terminals.

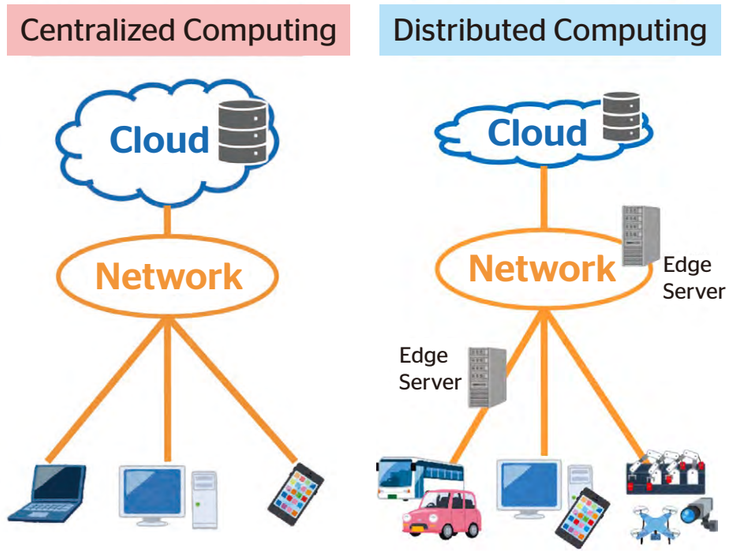
However, if the IoT progresses further and many more things get connected to the internet, the volume of data will be huge. It will then take more time and cost for the edge terminals to receive the processing results. As a result, edge computing, which performs autonomous distributed information processing at or near edge terminals, will become indispensable.

"This is just an example; In the event of a tsunami, it will be necessary to have a supercomputer in the cloud to simulate how far the wave will travel inland. However, when an earthquake occurs and a tsunami actually hits, everyone panics, the network gets congested, and real-time decisions are needed, so you cannot rely on the cloud. Even in such a situation, a system and technology that can guide us safely is necessary, and that will be processed on the edge side," Hara explains the roles of the cloud and the edge taking disaster prevention as an example.

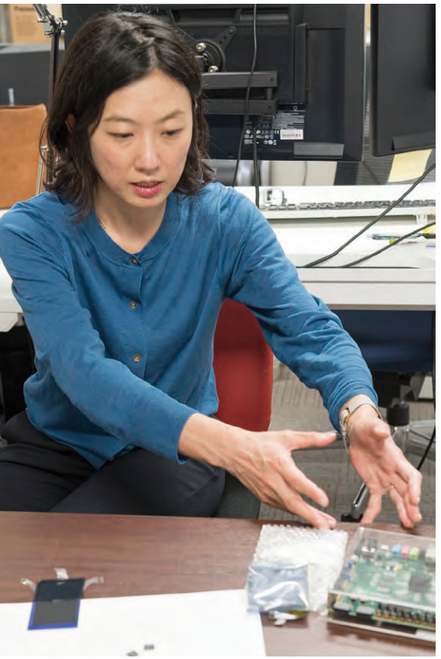
The global market for edge computing is expected to grow at a rapid rate. CPUs for edge terminals to date have been providing higher performance at the cost of consuming more power. Hara believes that CPUs that, depending on their application, can efficiently achieve data processing with low-power consumption and are lightweight will be needed in the future. Ultra-compact and power-saving CPUs such as the one developed in this research are essential for the IoT of small edge terminals.

Healthcare will become a crucial service linked by IoT

Hara envisions healthcare (health management) as the primary purpose of the newly developed CPU. It will be combined with sensors for heart rate, blood pressure, brain waves, electromyography, and so on, and incorporated into wearable terminals. If you wear such a device all the time, you can notice physical abnormalities early on. The information can then be passed on to your family members or home doctor via smartphone.



Images of cloud computing (left) and edge computing (Source: Ministry of Internal Affairs and Communications "Research Study on Informatization in Heisei Era" (March 2019), translated by JST editorial department)



Hara explaining the CPU she has developed

"Even if Society 5.0 is realized, I think everyone will be concerned about their own health and that of their families. I want people to be free from the anxiety and stress of being unaware of a serious illness or being uninformed of the disease name or its cause due to lack of access to a specialist depending on where they live. I myself had a hard time not knowing what my family member's illness was for a long time. I believe that healthcare will be a key service of IoT," says Hara.

However, there are quite a few problems to be solved; one is a security issue. For example, if someone reads biometric data indicating signs of illness through the leaking of electromagnetic waves from a terminal, it could lead to discrimination and prejudice. Therefore, Hara also plans to develop security technology to support the IoT's advancement.

Moving toward a prosperous society, but there are other concerns in the meantime

As a researcher in information and communication technology, what does Hara envision for a society in which cyberspace and physical space are highly integrated?

Hara says that while she is concerned about job loss due to the shift to artificial intelligence (AI), she also sees significant benefits. "Machines will replace work that can be done manually. We can also suppose that AI can supplement human labor in search and rescue at dangerous disaster and distress sites, as well as at accident-prone construction sites. In that case, I think there will be significant benefits in terms of the economy and safety." She predicts that this will lead to a more affluent society, where people can focus on jobs that cannot be done manually and create new things.

On the other hand, the concern about the increasing self-responsibility of people is huge. "As the IoT progresses, we will see more and more systems getting customized for individuals and specific applications. Users will then have to understand the advantages and disadvantages. You would hate to hear things like, 'It's your fault for not looking into it carefully,' with no questions asked. So, we need to create a system where the disadvantages do not become the individual's responsibility." This problem cannot be solved by science and technology alone. As well as the security issue mentioned earlier, Hara believes that we will need to rethink our society, including legislation development, using knowledge of the humanities and social sciences.

I want people to be interested in various things

We asked Hara to give a message to young people. She said, "Society 5.0 is a society where various things are involved in a complex way. Therefore, it would be good to get interested in multiple things, not like engineering students only interested in engineering matters. If your interests are too broad to narrow down, I think you should decide on a focus while trying not to lose your sense of curiosity."

Hara pursues her research and development with a clear vision in mind, aiming to create a society where everyone can realize the happiness they seek and where technology stays by their side. We can't wait to see what kind of research results she will present next.

PROFILE

HARA Yuko

Associate Professor, Department of Information and Communications Engineering, School of Engineering, Tokyo Institute of Technology

Received a Ph.D. in information science from Nagoya University in 2010. She was a Japan Society for the Promotion of Science (JSPS) Postdoctoral Research Fellow from 2010 to 2012. In 2012, she joined Nara Institute of Science and Technology as an Assistant Professor. Since 2014, she has been with Tokyo Institute of Technology, where she is currently an Associate Professor.

Her research interests include hardware/software co-design and designing automation technologies for embedded/IoT systems.

COLUMN

What will the society of the future, Society 5.0, be like?

What kind of society will the highly integrated cyber (virtual) space and physical (real) space envisioned in Society 5.0 be? Let's take a look at disaster prevention, medical care, and transportation as examples. The illustrations below are only a tiny part of the whole picture. We hope you will join us in thinking about how we can solve the social issues at hand and create a society where every person feels happy.

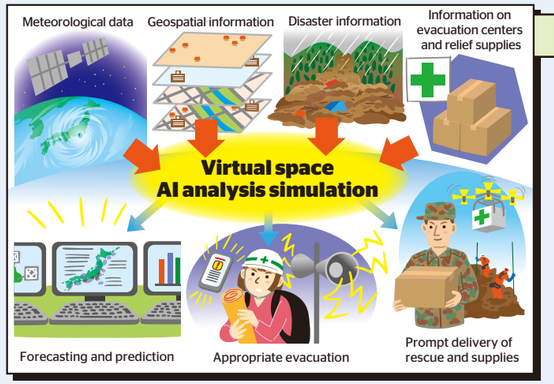
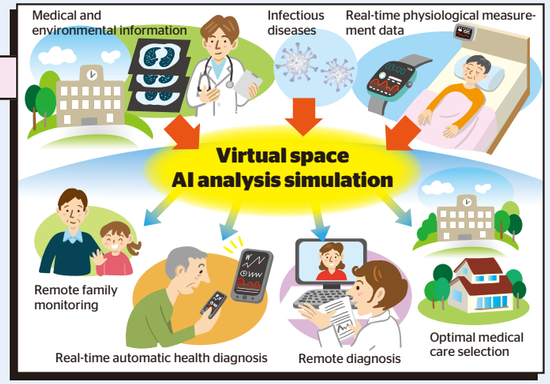


Image of disaster prevention to be realized in Society 5.0 (Created by JST editorial department)

Disaster prevention

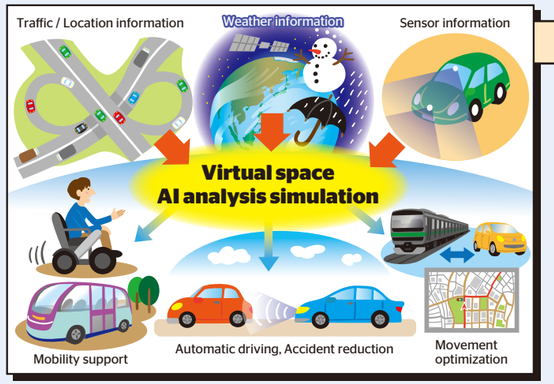
Data such as meteorological information, topography, maps, and past disasters will be analyzed by supercomputers on the cloud, and damage will be predicted through simulations. Supercomputers will also play an active role in predicting climate change and clarifying the causes. On the other hand, when a disaster occurs, terminals owned by individuals and systems installed in the city will autonomously analyze information of a relatively small area and indicate the optimal time of evacuation, evacuation routes, and evacuation sites. In addition, safe and rapid disaster relief and smooth delivery of relief supplies will be possible through the linkage of terminals around us and the cloud.



Images of medical care to be realized in Society 5.0 (Created by JST editorial department)

Medical care

Test data at medical institutions, real-time measurement data from individual terminals, and infectious disease information from all over the world will be analyzed on the cloud. Those data will help in disease detection, accurate diagnosis, optimal treatment, and effective prevention. Online medical practice where specialists see patients in remote areas and surgery from a remote location will also become possible. Information detected by the terminal in real-time will be passed on to family members and medical institutions via the cloud, which will lead to warm and considerate medical care.



Images of transportation to be realized in Society 5.0 (Created by JST editorial department)

Transportation

Cameras and sensors installed on roads or in vehicles will monitor traffic volume and road conditions. The data will be aggregated into a high-performance computer on the cloud. The computer will also take in the weather data and other parameters. Artificial intelligence (AI) will then conduct a comprehensive analysis to provide vehicles and drivers on the road, or those about to move, with traffic information that enables smooth travel. The terminals installed or worn on respective cars or people will autonomously perform automatic driving and collision prevention functions and exchange data with systems on the cloud as needed to realize safer and more comfortable travel.

Akira Isogai, Professor at the Graduate School of Agricultural and Life Sciences, the University of Tokyo, explaining cellulose nanofibers

CHAPTER

04

Bringing about a Decarbonized Society with New Technologies

——Interview with Akira Isogai and Akira Oda

Research and development for a decarbonized society is attracting attention as a necessary solution to the social issues we will face as a society in the future. We asked Akira Isogai, Professor at Graduate School of Agricultural and Life Sciences, the University of Tokyo, and Akira Oda, Assistant Professor at Graduate School of Engineering, Nagoya University, about their research and the prospects for a decarbonized society.

Cellulose nanofibers are comprised of plant fibers

Since the Industrial Revolution, humans have built affluent lives using fossil fuels such as coal and oil. On the other hand, this development has caused various problems, such as accumulated non-degradable garbage, marine microplastic problems, abnormal weather, and global warming. And now, there is a need to build a decarbonized society. A decarbonized society is a society where we reduce the emission of greenhouse gases such as carbon dioxide (CO_2) and recover the emitted CO_2 to nullify greenhouse gas emissions in real terms.

Isogai has developed a technology to produce cellulose nanofiber (CNF), a plant-derived material that can contribute significantly to the decarbonization of society. It is three nanometers thick (a nano is one billionth), only 1/30,000th of a hair. Despite being that thin, cellulose is very strong and can be chemically given various functions, drawing attention as a new industrial material.

Water and ordinary pulp (left): Water and CNF mixture looks transparent (middle), but with an orthogonal polarizer, you can observe CNF dispersing (right).

"Cellulose is made up of linear chains of glucose, which is produced by photosynthesis using CO_2 absorbed from the atmosphere. It accounts for about 40% of the weight of trees and is the most abundant polymer stored on earth. Since it is plant-derived, it can be reproduced, and even if incinerated after use, it does not increase CO_2 in the atmosphere. Cellulose is a material that can contribute to a decarbonized society if it replaces plastics and other materials derived from fossil fuels," says Isogai.

Industry-academia collaboration will expand practical applications

Isogai had been studying the use of cellulose since he was a graduate student, but it was not easy to extract cellulose fibers. A turning point came in 1995. A Dutch research group reported their study results. The group used a substance called TEMPO (organocatalyst) as a catalyst to oxidize starch at standard temperature and pressure without using organic solvents. Isogai thought that the TEMPO catalyst could be applied to cellulose, a polysaccharide like starch, and worked to research his idea. In 2006, he and his graduate students succeeded in developing technology to obtain CNF by treating pulp fiber with TEMPO catalyst without using large amounts of energy or harmful chemicals.

He took the result to the industrial world. Then, in addition to the merits of contributing to global warming countermeasures, the ability to add a variety of functions drew attention, which drove many companies to enter industry-academia collaborative research and development. CNF production methods other than TEMPO catalysts also progressed, with some already being put to practical use.

One example is paper diapers for nursing care with metal ions that have deodorizing functions attached to their CNF. Ballpoint pens that allow us to write without applying pressure are also commercially available — by mixing CNF as a dispersant, the ink becomes homogenized and smooth. It is also used as an admixture in concrete, shampoo, rinse, etc.

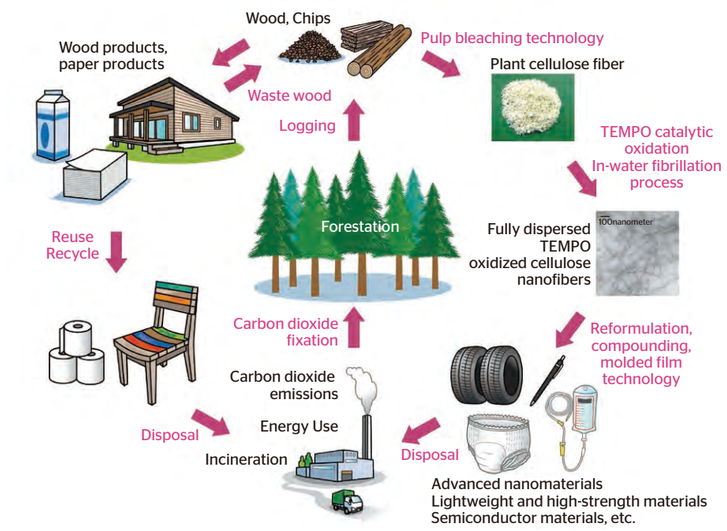
In addition, a film that is impermeable to oxygen has been developed by blending CNF into it. If CNF is applied in packaging materials, deterioration of food and medicine due to oxidation can be reduced. Since we consume a massive amount of packaging materials derived from fossil fuels, even if CNF replaces only some of them, CO_2 emissions will decrease considerably.

Isogai is also looking at the application of CNF to tires. Soot (carbon black) is added to tire rubber to increase stability, but as tires wear away gradually, the carbon black is discharged into the environment. In that regard, CNF will not negatively impact the environment even if it is released as the tire becomes worn. "CNF and rubber go well together and increase strength when they are mixed. Automobile tires using CNF have already been developed and are on the market, becoming a promising alternative candidate for reducing their environmental impact."

Utilizing the advanced technologies of Japan's paper industry

At present, CNF is still expensive due to its low production volume, and its use is limited to applications that bring high functionality with little added volume. In the future, if manufacturing it at low cost and in large quantities becomes possible, the range of applications will surely expand. In this way, we hope to replace petroleum-derived materials with CNF even if it is little by little.

The Japanese paper industry has advanced technology to create high-quality papermaking pulp and electricity. "There is a lot of unused thinned wood in the mountainous areas of Japan. By making use of it, we will be able to revitalize the forest industry in Japan. Although there are some problems, we have raw materials



The carbon stored in woody biomass has long been used in circulation (left side of the figure). In addition to this cycle, CNF will create a circle of new materials (right side of the figure) that can be used as cutting-edge materials. (Original image from "JST news," December 2017, and translated by the editorial department)

■CNF's potential contributions to the SDGs

Goal	CNF 's contribution	Goal	CNF 's contribution
2 ZERO HUNGER	Since CNF film is impermeable to oxygen, it can extend the expiration date of pharmaceuticals and foods. So, we can expect it to be used as a long-time-storage food packaging container.	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Quantitative and qualitative expansion of the use of CNF can contribute to building a recycling-oriented social infrastructure for energy and materials made from renewable plant resources.
6 CLEAN WATER AND SANITATION	By incorporating CNF into equipment for creating freshwater from seawater, the equipment may become solid and stable, facilitating freshwater security.	13 CLIMATE ACTION	An increase in the use of CNF can reduce CO_2 emissions from the combustion of fossil resources and contribute to the prevention of global warming and abnormal weather.
7 AFFORDABLE AND CLEAN ENERGY	Cellulose fibers can be obtained during the CNF production process, and biomass power generation will be possible simultaneously. It is an environmentally compatible process and can reduce electricity derived from fossil resources by expanding the CNF usage.	14 LIFE BELOW WATER	Plant-derived CNF is biodegradable, which will solve the problems of marine microplastics and accumulated plastic waste.
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	CNF produced from cellulose fibers is a new bio-based nanomaterial and furthering its use will lead to new industries and technological progress.	15 LIFE ON LAND	The cycle of afforestation, silviculture, logging, utilization, and reforestation of woody resources that become raw materials for CNF: Proceeding with it will enrich forests, reduce water pollution, facilitate the fixation of CO_2 in the atmosphere, and protect the richness of the land.

(Prepared by the editorial department based on the materials provided by Isogai)

and technologies. If we can create a new biomass-derived sector in Japan, we will contribute to the global issues we face," says Isogai. Because of its wide range of applications, contributions to the various goals of the SDGs are also expected.

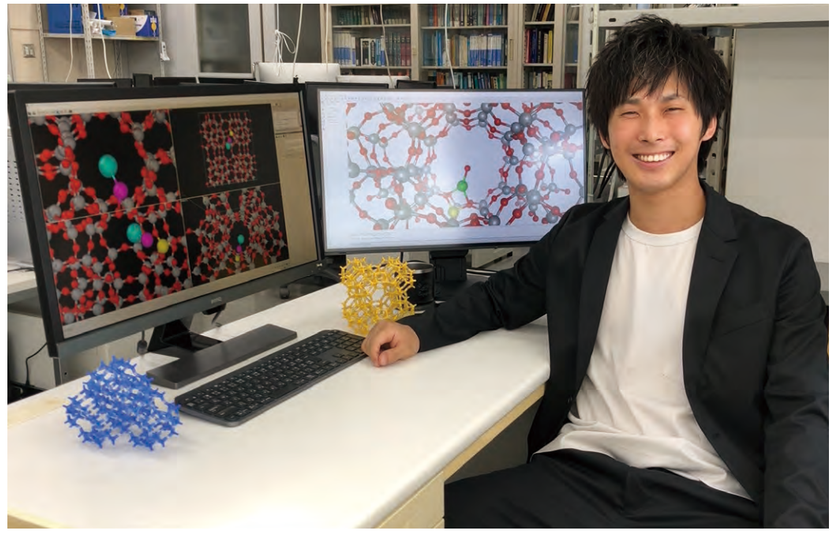
Aiming for decarbonization by realizing "Fairytale Reaction"

Meanwhile, Oda is conducting research that will help contribute to energy issues.

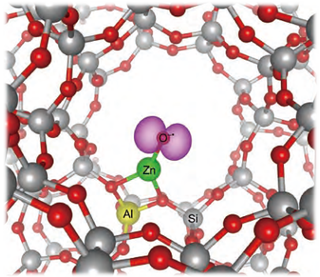
The amount of available natural gas reserves, which are currently used as gas in homes, is increasing due to advances in mining technology. Methane, the main component, produces less CO_2 when burned than oil or coal and is getting a lot of attention as a clean fuel. However, because methane is a gas at ordinary temperature and pressure, transportation and storage costs are high. So, converting it to methanol, a liquid at ordinary temperature and pressure, has been a requirement.

On the other hand, the reaction to convert methane into methanol has long been called a "fairytale reaction" among chemists. Oda explains the reason for this. "The only difference between methane (CH_4) and methanol (CH_3OH) is the presence or absence of one oxygen atom. To convert it to methanol, just one oxygen atom addition to methane is necessary, i.e., partial oxidation. However, methane is a very stable substance with strong bonds between atoms, and it takes a lot of energy to break the bonds between hydrogen and carbon. Despite this, when energy is applied, methane is completely oxidized to CO_2 and water."

Oda and his research group have discovered "oxyl," active oxygen which can partially oxidize methane at low temperatures to prevent the reaction from going too far. Oxyl is in a state where it can receive electrons easily and is therefore easily incorporated into the CH bonds of methane. Oda and his colleagues succeeded in producing oxyl using a porous zeolite catalyst. And they used it to synthesize methanol from methane at room temperature.



Simulating oxyl inside zeolite pores on the computer (Provided by Akira Oda)



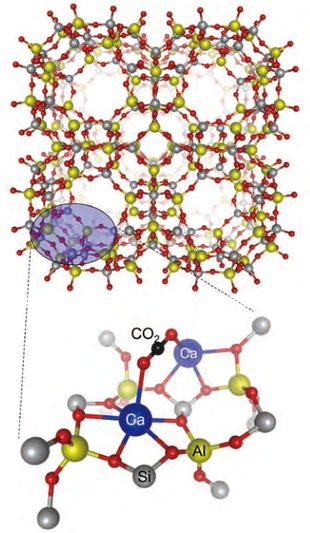
Successfully created oxyl (pink in the center) using zeolite (Provided by Oda)

The wide practical application of this technology would enable efficient transportation and storage. Oda points out additional advantages to directly converting methane to methanol, which has a greenhouse effect 25 times greater than CO_2. "Methanol is easy to handle as a chemical feedstock and can be used as a raw material for various substances. Methane has been used almost exclusively as a fuel because it is very stable as a substance and difficult to handle. But if it can be converted to methanol, it will have a much wider range of uses as a fuel and as a chemical raw material, just like ethane and propane."

Developing technology for low concentration CO_2 capture

Oda and his colleagues have also developed a CO_2 adsorbent by placing calcium ions on zeolite. They have confirmed that it can selectively adsorb CO_2 even from gases containing CO_2 at concentrations as low as 400 to 5000 ppm (ppm is a concentration unit indicating parts per million).

"It is difficult to stop all CO_2 emissions, and in the future, technology to remove CO_2 directly from the atmosphere will be required. It is not easy to collect CO_2 that has diffused into the atmosphere, but if we can establish a technology to concentrate the diffused CO_2, it will collect CO_2 and be used in a wide range of ways. I believe that the development of CO_2 adsorbents will lead to technology that can directly remove CO_2 from the atmosphere," Oda expects further advances.



CO_2 adsorption on Ca ions arranged inside the pores of zeolite (Provided by Oda)

Oda had discovered the phenomenon that led to the creation of oxyl when he was an undergraduate student. However, he was told that the phenomenon was interesting but unbelievable. He was frustrated that he couldn't explain it well. "I wanted to convey the message more clearly, and to do so, I had to understand it better, so I did my best to research it. But before I knew it, I had completed my doctoral program (laughs). After that, as I combined experiments and calculations in my research life, I solved the mystery like unraveling a string, which led to this discovery."

Some experts from early on highly evaluated Oda's research. In 2013, when he was a graduate student, he was awarded the Nishina Prize, which recognizes outstanding graduates (or soon to-be) of science and engineering graduate schools in Okayama Prefecture. He was selected as a PRESTO (Precursory Research for Embryonic Science and Technology) researcher by JST. When he heard about the partial oxidation of methane, Oda was shocked to learn that the "Fairytale reaction exists!" This discovery is the fruit of his desire as a student to be able to create chemical reactions that a high school student could write but cannot realize. With this as a first step, he hopes to further contribute to constructing a decarbonized society.

PROFILE

ISOGAI Akira

Professor, Graduate School of Agricultural and Life Sciences, the University of Tokyo

Received Ph.D. in 1985 from the Graduate School of Agriculture, the University of Tokyo. After working as a postdoctoral fellow in the Department of Chemistry at the Institute of Paper Chemistry, USA, and as a professor at the University of Tokyo, he was appointed as the current position in 2020. Honorary Academic Doctor of Aalto University, Finland.

ODA Akira

Assistant Professor, Graduate School of Engineering, Nagoya University

Completed a doctoral course at the Graduate School of Natural Science and Technology, Okayama University, in 2015. After working as a visiting researcher (JST Sakigake researcher) at the Graduate School of Natural Science and Technology, Okayama University, he assumed his current position in 2019.

CHAPTER 05

Autonomy is the Key to Seizing Opportunities

——Interview with Kei Hashimoto

Chikako Otori, Freelance Writer

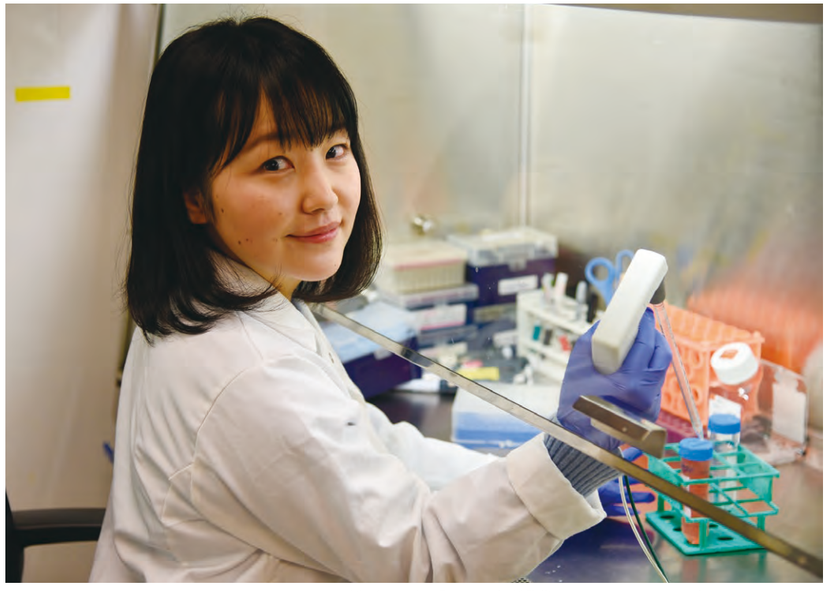
2021 White Paper on Science, Technology and Innovation emphasizes the importance of strengthening basic research and fostering human resources for the future. So, what kind of initiatives can effectively support you when trying to carve out your research path? We asked Kei Hashimoto, Project Assistant Professor of Ochanomizu University Academic Production, who is about to finish her three-year postdoctoral fellowship abroad, about her studies to date online.

The "Program for Leading Graduate Schools" also hones the autonomous and active communication with people from different fields and cultures. (Provided by Hashimoto)

"Program for Leading Graduate Schools" was a turning point

The number of patients with dementia, a neurological disease, is projected to increase with the accelerating aging of the Japanese population. Hashimoto is now at the forefront of research to develop a treatment for this disease. The results of her first two years of study at UCSF, where she worked on clarifying the mechanism of onset of the disease, were published in the scientific journal *Nature* in 2020. She then found compounds that can be candidates for therapeutic drugs. In March of this year, she was offered a Project Assistant Professor position at her alma mater and is about to finish up her postdoctoral life.

It was not until she had exposure to the research field in her master's program that she became intensely interested in working in research. Before that, she had hoped to become a biology teacher at a junior high school or high school, a job that would allow her to be involved in the biology field that she loves, just like the like-minded biology teacher she met in high school. "When I was an undergraduate and early master's student., I was doing my research passively, working only on the task at hand," she recalls.



Kei Hashimoto, a researcher on dementia at the University of California, San Francisco (UCSF) (Provided by Kei Hashimoto)

The "Program for Leading Graduate Schools" was a significant turning point in changing that. With support from MEXT, the Ministry of Education, Culture, Sports, Science and Technology, Ochanomizu University started to nurture female leaders in science and engineering under the program "Fostering long-term creativity and innovation with science and technology disciplines based on the Ochanomizu spirit 'Migakazuba'*.'" First, "we had to find an independent research theme instead of being given an assignment as part of the program," says Hashimoto.

I had been interested in nerves and their associated diseases since I was a master's student, and while reading a paper in related fields, I came across a research result that said, "nerve cells do not age." I was surprised to learn "mice have a shorter lifespan than rats, but when mouse neurons are transplanted into rats, the transplanted cells continue to live beyond the lifespan of the mice."

If this is the case, why does dementia occur when nerve cells are lost? What the paper focused on were "glial cells," which led to Hashimoto' s current research. They act as immune cells in the brain, regulating the environment around nerve cells. While nerve cells function only with the help of glial cells, activated glial cells show an aspect of attacking nerve cells. Due to this, glial cells got added to her list of research topics that she chose based on her interests.

Keenly felt a "foreign way" in harsh evaluations

"As the program was cross-disciplinary, it was very stimulating to interact with students from different fields." In the class where I teamed up with two other students, one majoring in mathematics and the other in physics, I was at a loss at first, like "I can't make myself understood." However, when I showed them a picture of a cell, they said to me, "I can show the cell's behavior with mathematical equations," and "I can analyze it with physics." We then exchanged ideas and proceeded to create a mathematical model of the cell. In this way, we steadily developed our own independent attitudes.

On the other hand, the teacher who taught mathematics in English was a French national, and was relentless enough to grade her "C," which she had rarely received before. She had been thinking, "It's outside my field, so I can get credit for it if I work hard to some extent," but she got a harsh evaluation. She got a glimpse of how hard overseas students work. From then on, her consciousness, which had been completed focused within the laboratory until then, turned outwards.

The "Program for Leading Graduate Schools" provides not only an environment that cultivates autonomy as a researcher but also financial support so that students can concentrate on their research without worrying about living expenses. Some of her colleagues chose to enter the doctoral program because of this program. The financial support also helped Hashimoto to continue her research as a postdoctoral fellow.

"Allowance" lowers the hurdle

"Go abroad." As she neared the end of his doctoral course, professors with overseas experience began to recommend that she study abroad. Hashimoto had not planned it because she was not very good at English and thought that research was a global activity no matter where she was. However, with a push from those professors, she decided to research at UCSF, which her advisor introduced.

The research grant provided to Hashimoto, a research fellow of the Japan Society for the Promotion of Science (JSPS) at that time, could be utilized at a destination of overseas study. She was also able to receive Ochanomizu University' s overseas study grants. Being able to bring a "scholarship" also helped lower the hurdle to studying abroad. Laboratories in the U.S. hire postdocs at minimum wage, but it will be easier for those labs to accept outside postdocs who can secure equivalent money themselves.

*Migakazuba: "Just as a jade or a mirror becomes brighter when it is polished, it is important to work hard at your studies every day without neglecting them."

Working on independent assignments with members from different fields of expertise (Provided by Hashimoto)

It took her about six months to get used to life in the U.S., but with many students from Asia in the laboratory, she could proceed with her research smoothly. She said, “There were researchers from many different countries, and I was able to experience research that I could not in Japan.” It was supposed to be a one-year challenge, but she ended up spending a total of three years in California as a JSPS Research Fellow, although she was desperate for Ramen.

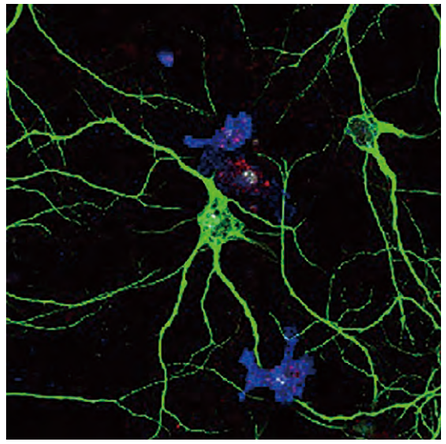
Combining the best of American and Japanese ways

During her postdoctoral life, she has been working on clarifying the pathogenic mechanism of frontotemporal dementia, one of the four major types of dementia. Patients of this type behave impulsively and become socially isolated. It is thought that the glial cells do not work correctly, which disrupts the surrounding environment and damages the neurons.

The candidate compound for the therapeutic drug is about to move onto the next stage, where a U.S. venture company will investigate its effectiveness. Hashimoto herself has decided to return to Japan to improve her career as a researcher. She plans to conduct a “lateral expansion,” in which she will find out therapeutic effects of a different compound for frontotemporal dementia using the model cells she used for her research in the U.S. The drug for multiple sclerosis, which is known to be caused by a similar mechanism, may be effective.

She feels that in Japan, research is conducted in the direction of deeper understanding, for example, the in-depth pursuit of the function of a single protein. In contrast, U.S. research tends to expand horizontally, like to see if a single event occurs in other areas. By combining the best of the U.S. and the Japanese styles, Hashimoto is trying to develop her own unique way of conducting research.

Hashimoto hopes to share her experience as a postdoctoral researcher abroad with those who will aim to do the same in the future. When she started considering her study abroad, she often had to go through the process by herself because there were no senior graduate school students to consult with. But once in the U.S., she got a place to exchange information with other students from Japan and started to get some outlook. She wishes to use her experience as a concrete example of utilizing support tailored to a researcher’s stage.



Glial cells (blue) regulate the surrounding environment near nerve cells (green). (Provided by Hashimoto)

Working on research with international students from various countries in a laboratory at UCSF (Provided by Hashimoto)

Balancing life events and research is the key

In Japan, female researchers tend to be more affected by life events such as marriage, childbirth, and child-rearing than male researchers. Based on what she saw in the U.S., Hashimoto would like to consider what support is necessary for those female researchers who want to continue their research. Having realized that daily accumulation is essential for research, she thinks that a way to reduce “interruptions” might be the key.

She was surprised at the number of women in the doctoral program — perhaps it’s because UCSF has a nursing department. The U.S. may indeed be different from Japan. Men also take paternity leave, the practice of hiring babysitters is widespread, and there is an extensive financial support system for young researchers regardless of gender. Even so, she shows her eagerness to develop some ideas to improve the environment around her.

“Action is also important in research.” Hashimoto, who is moving up one stage in her researcher career, looks back, saying that in addition to autonomy, taking action is also essential for a researcher. You have to think about how to proceed with your research on your own. It is you who builds up a hypothesis and proves it. Time passes if you hesitate, but if the goal you set is too high, you will have cold feet.

Hashimoto says that she was setting three levels of goals as her guideline: “High goals, goals that are reachable if you work a little harder, and goals that are achievable if you take action.” It may be practical advice only she can give based on what she has noticed, for she didn’t plan to be a researcher at first. As one of the “leaders in science and engineering,” there are many things that Hashimoto can pass on to the next generation of researchers.

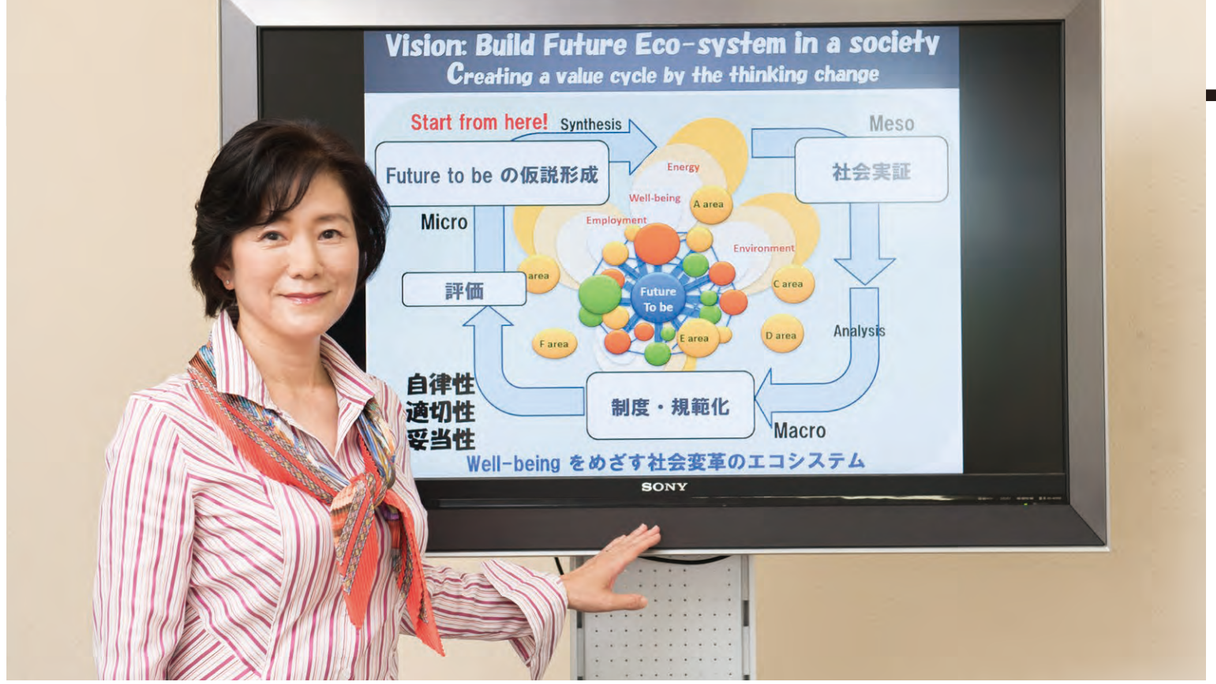
Editor’s note: The application period for the “Program for Leading Graduate Schools” ended in 2013, and “Doctoral Program for World-leading Innovative & Smart Education” (JSPS) is currently in place.

PROFILE

HASHIMOTO Kei

Project Assistant Professor at Ochanomizu University Academic Production

Graduated from the Department of Biology, Faculty of Science, Ochanomizu University in 2013 and completed the Graduate School of Humanities and Sciences, Ochanomizu University in 2018. Ph.D. (Science). Currently a visiting researcher (postdoctoral fellow) at UCSF, U.S. She assumed her current position in March 2021.



Miwa Nishinaka, Professor at Graduate School of Management, Kagawa University

CHAPTER 06

What is Value Co-creation for Well-being?

——Interview with Miwa Nishinaka

The 2021 edition of the White Paper states that in Society 5.0, the future society, it is vital to utilize "convergence of knowledge" that integrates knowledge from the natural sciences, humanities, and social sciences to realize everyone's overall well-being (WB). So, what should we do to make WB happen? Miwa Nishinaka, a professor at Graduate School of Management, Kagawa University, says that the process of "value co-creation," in which two or more people work together to create something good, will help.

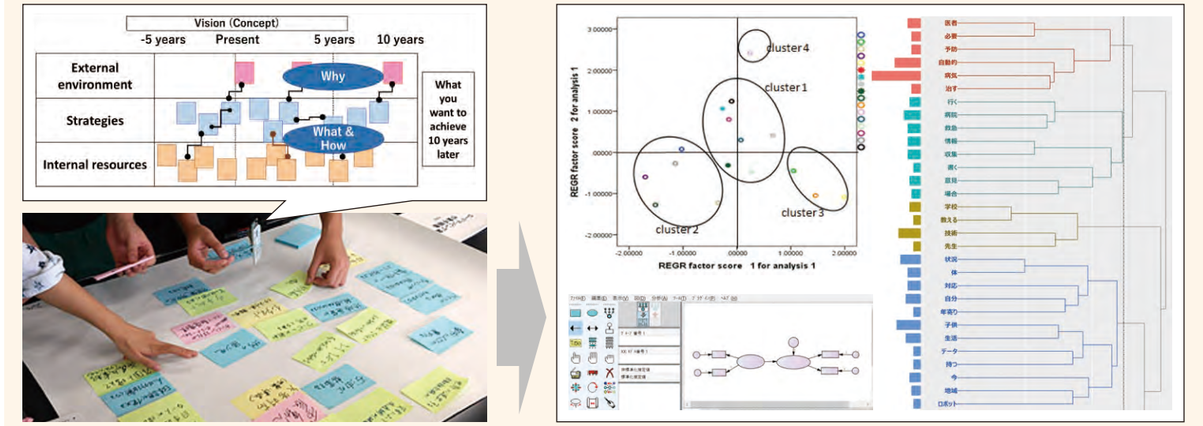
To resolve conflicts between individuals and society

In Japan's mature economic society with a shrinking population and drastic changes in society and environment, people's values are becoming increasingly diverse. And now that we face disasters and new coronavirus infections, we can say that WB is a critical issue. Nishinaka is currently facing it through research that elicits innovative thinking and co-creates values, i.e., subjectively good things.

WB has various definitions, but Nishinaka divides them into two major groups. One is personal WB, which, in a narrow sense, is a state where humans can exercise their potential. The other is social WB, which, in a limited sense, is a social state where you can have opportunities to seize personal happiness, and that state is guaranteed for the future.

Nishinaka says that there are conflicts between these WBs. For example, conflicts of interest exist between different personal WBs. There are conflicts between social WBs and personal WBs, such as a waste incinerator being necessary for society, but not wanting it in your neighborhood. And conflicts between social WBs are things like endangered species that need protection are living in a proposed dam site.

Nishinaka says that we have to think about how to eliminate these conflicts between WBs, or if eliminating them is not possible, balancing them at the very least. "To balance between WBs, it is important to create a place for value co-creation and have everyone participate. And to get people to participate, the place has to have a mechanism from which participants can grow and benefit, and it also needs to be fun," says Nishinaka.



Statistically analyzing workshop participants' statements and awareness (Provided by Miwa Nishinaka)

Sharing tacit knowledge is important

In value co-creation research, several teams of four or five people conduct an experimental workshop of about two hours. The teams are given a task to achieve WB, like "to think about how this region should be in 20 years." They then statistically analyze the statements given in the process of answering the task to find out what kind of interactions produce valuable outputs, develop participants' abilities, and foster new leadership skills.

"During these interactions, knowledge or a solution that has not been thought of before (tacit knowledge) sometimes come up in a flash. Sharing such knowledge is very important for value co-creation, and it is crucial to capture that moment of awareness. I'm working on progressing my research, believing workshops are one of the ways to share tacit knowledge," says Nishinaka.

On top of these workshops, ART SETOUCHI, an art festival, takes place in the Seto Inland Sea every three years on the islands. Nishinaka is investigating how the relationship between visitors, locals, and the intermediaries that connect the two parties realizes value co-creation aiming at the WB of the region. At the festival, viewers experience the island while looking at the artworks exhibited all over the islands. Many people visit the islands and talk about them — repeated visits leads to praise for islanders' identities, which Nishinaka believes is vital for the WB of the region.

The future is something we "create," not something that "happens"

"The subjective happiness of the individual is important, but I believe that if the whole society is not happy, then you are not happy either. Beyond this, if the future generations of your children and grandchildren will not be happy, you cannot be happy now. The future is something we 'create' actively, not something that 'happens.'" Nishinaka is paying attention to a method called "science fiction prototyping" as a tool to prototype a future image collaboratively and look at and think about the present from that future (see later column).

At our request, Nishinaka gave a message to the young generation who will create the future. "It would be good to imagine the future you desire and yourself enjoyably, and then come back from there to think about what you can do now. The important thing is to continue to think as a participant in the creation."

A society where WB can happen will not be created by someone special but by everyone participating and working together. What is WB for you, what is WB for society, and what kind of future do you want to create? Every one of us is required to think consciously.

PROFILE

NISHINAKA Miwa

Professor at Graduate School of Management, Kagawa University

She received her Ph.D. in Knowledge Science from Japan Advanced Institute of Science and Technology (JAIST) in 2015. Prior to joining Kagawa university, she was a researcher at JAIST from 2015 to 2016 and an associate professor at the Graduate University for Advanced Studies from 2016 to 2019.

COLUMN

What is SF Prototyping?

SF in the name “SF Prototyping” refers to science fiction. More than few past science fiction works, written with the future in mind, have guessed correctly about the future world (i.e., the present). SF prototyping is “a method for discussing and sharing future visions with others by creating prototypes of visions that have not been realized, based on science fiction ideas.” This idea is starting to gain attention in the business world (“SF Prototyping: New Strategies for Generating Innovation from Science Fiction,” written & edited by Dohjin Miyamoto, Yuuki Namba, and Hirotaka Osawa, published by Hayakawa Shobo).

We observed the pilot SF prototyping workshop conducted by Miwa Nishinaka, Professor at Graduate School of Management, Kagawa University, with the book’s writer & editor, Hirotaka Osawa, Assistant Professor at the Faculty of Engineering, Information and Systems, University of Tsukuba, and Dohjin Miyamoto, a researcher at the same laboratory and fellow author.

First, they decided on a theme. Then Miyamoto, the moderator of the workshop, solicited keywords from the participants. While talking with the participants, he combined keywords that seemed unrelated to each other to expand everyone’s ideas and create a future story.

A scene from the workshop. From left to right: Osawa, Nishinaka, Miyamoto, Ryu Miyata, Science Communicator at Miraikan, The National Museum of Emerging Science and Innovation, and Sachiko Kiyokawa, Associate Professor at the Graduate School of Education, the University of Tokyo.

“It’s not easy for any company to think about what needs will exist in decades from now. SF prototyping is gaining prominence as a method to weave a future vision in such cases. While freely generating ideas, participants create a future vision as if they were writing a novel. Then, they work backward from the future vision to think about the present and what has to be done right now. Issues that became clear during the discussion and required technical elements are also important. I think this is a method that can be used not only in business but in a wider range of situations,” says Miyamoto.

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