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Ritsumeikan University Research Report

2019–2020

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RADIANT is an adjective that means to “shed light” or “shine brightly.” We used this meaning so that the research results of Ritsumeikan University can be a step towards create a bright future and help to shed light upon the world in the future.

COVER STORIES

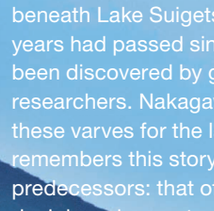
FEATURE #01 Connecting with the World

FEATURE #02 Life

FEATURE #03 Kyoto

Counting 70,000 Layers of Lacustrine Sediment to Obtain a Calibration Curve for Radiocarbon Dating

Have you ever imagined reading a book with seventy thousand pages, counting the pages one by one, transcribing all its contents into your notebook, and analyzing them to figure out what information the author really intended to convey? If you have, you might have been overwhelmed by the thought of how much work would be involved in this process. But this is what a multinational team led by Takeshi Nakagawa accomplished with regards to varved (annually laminated) lake deposits beneath Lake Suigetsu in 2012. Twenty one years had passed since the varves had first been discovered by global paleoclimatology researchers. Nakagawa, who has studied these varves for the last twenty years now, remembers this story shared by him and his predecessors: that of defiant researchers who deciphered a masterpiece written by nature.



Takeshi Nakagawa

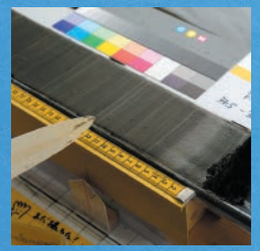
Professor, Research Organization of Science and Technology, Director of Research Centre for Palaeoclimatology

Subject of Research: Climate reconstruction using varved sediments
Research Keywords: Palaeoclimatology, Geochronology

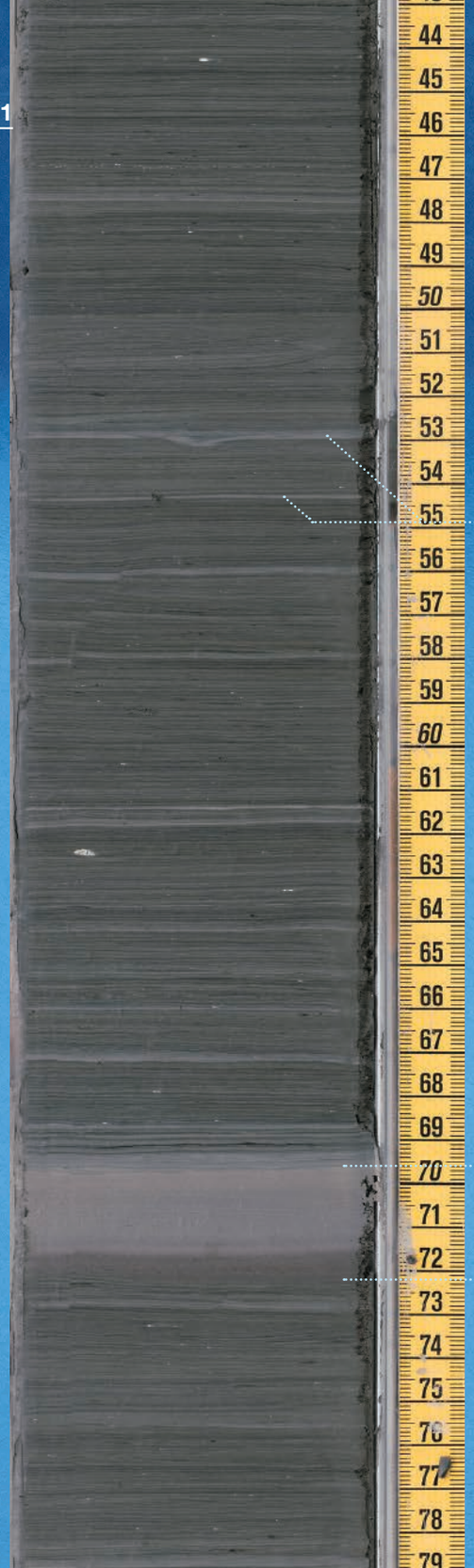
Nakagawa's story reached a climax on October 18, 2012, when the American Association for the Advancement of Science (AAAS) gave a press conference at the Ministry of Education, Culture, Sports, Science and Technology in Tokyo. "It was rare for AAAS to hold such a press conference for a specific research outcome." Nakagawa recalls. "They sent their representatives from Washington D.C., had them set up the conference hall, and give out documents to Japanese journalists."

At the press conference, Nakagawa and his team presented their work, which was about to be published in Science on October 19, 2012, the day after the conference. Till then, precise age could be acquired only for the last 12,450 years using the annual tree rings as references. Nakagawa's team had established reliable chronology for ca. 10,000 to 50,000 years ago by counting varves they excavated from the bottom of Lake Suigetsu. The team had also determined the ages of the varves by combining their new data with the carbon 14 dating of leaf fragments embedded in the mud sediments.

Photographs: Taken by Ayumu Muneno, courtesy of Tokyo Shoseki Co., Ltd. (Page 4-5, page 6-7 spread); Kazuma Yamane (3 photographs in the top left and center on page 7; Mitsuru Mizutani (bottom left on page 6)

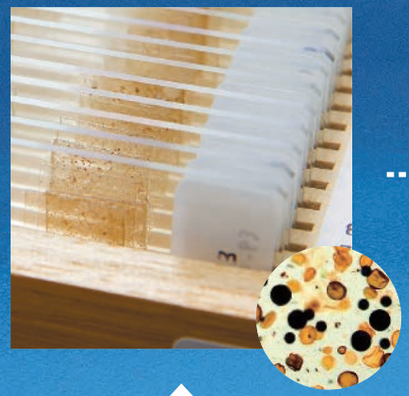


A long drill is lowered from a ship to dig at the bottom of the lake and extract sediment in a column. This is a method that was uniquely developed by Nakagawa. The sediment inside the tube is cut into two to reveal the sections of varves, by a method that was developed by Nakagawa.

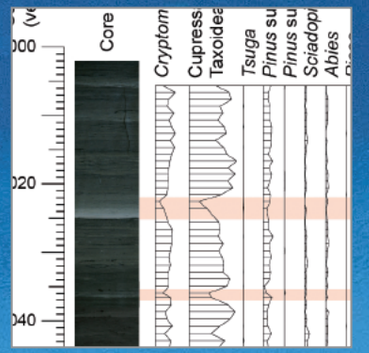


Typhoon

Major earthquake



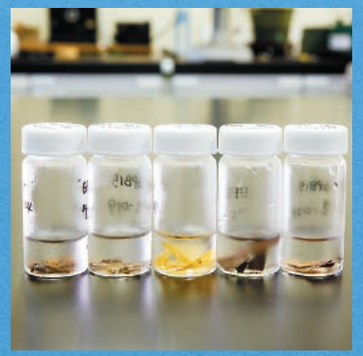
Pollen



A graph (partial) showing the amounts of different types of pollen contained in individual varves. By checking the increase and decrease of the amounts of pollen, researchers can obtain data pertaining to temperature changes.

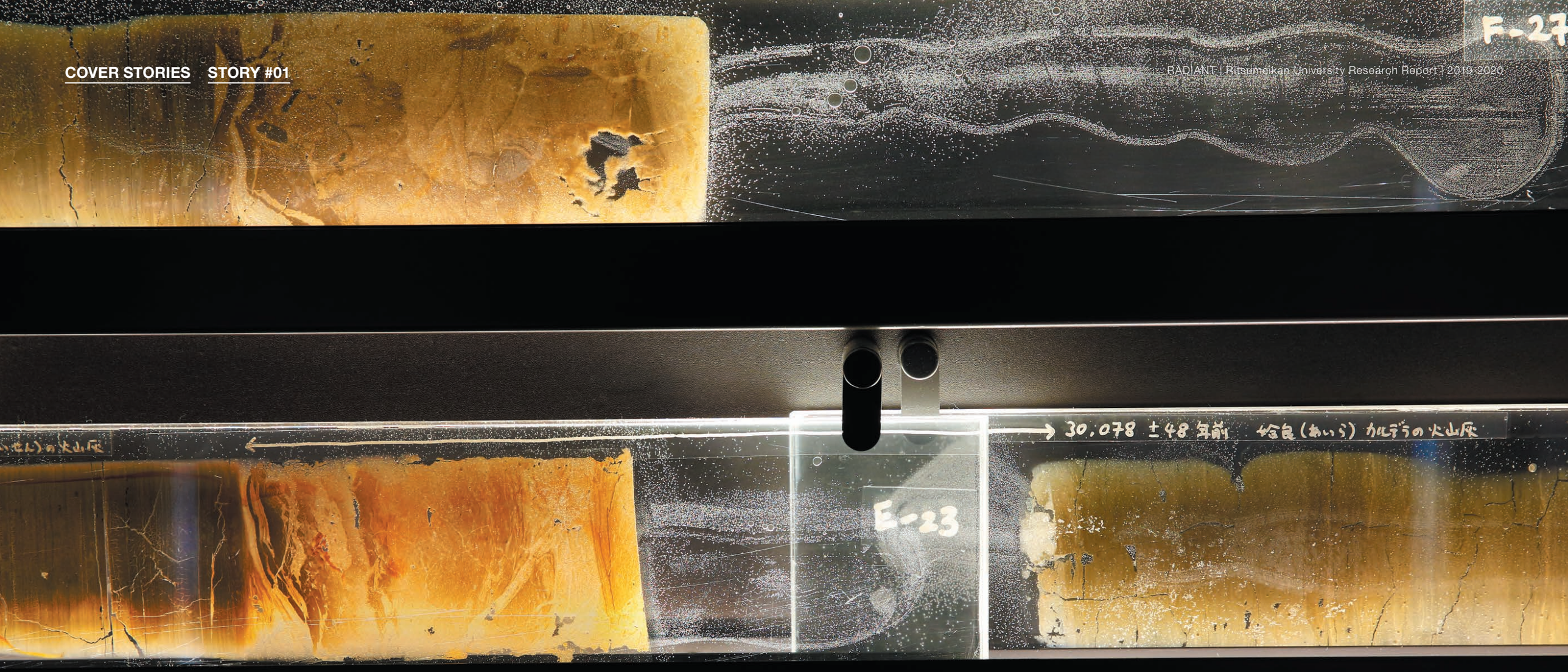
Varve

A layer that corresponds to one calendar year is formed as a set of whitish and blackish seasonal layers. The thickness of one annual layer is 0.6 or 0.7mm. Irregular stripes represent natural disasters such as earthquakes, eruptions or flooding. By studying the radioactive carbon, pollen and many other microscopic objects included in the layer of each year in detail, researchers can obtain a wide range of information, such as ancient climate and temperature fluctuations.



Radioactive elements

Plants take in a radioactive isotope of carbon (^{14}C) contained in the atmospheric carbon dioxide, and when they die, the amount of ^{14}C contained in plant's body starts decreasing. By measuring the amount of remaining ^{14}C, the age of plant fossils can be determined.



Determining the age of ancient objects is not an easy task. Generally, objects excavated from lower layers are older than those found in upper layers of sediment if no earthquakes or other crustal deformation events have disturbed the order of layers. Although this principle is simple, how many years ago the sedimentation took place always remains to be measured.

As long as objects contain organic material and are younger than approximately fifty thousand years, there is a chance of their ages being determined via carbon 14 dating. Carbon 14 is an isotope of carbon that is unstable and weakly radioactive. Carbon in organic material has stable isotopes: carbon 12 and carbon 13, which are slightly lighter than carbon 14. Since carbon 14 is a radioactive isotope, it slowly decays and is reduced by half in 5730 years; it becomes almost undetectable in about fifty thousand years. Organic lifeforms, including plants and animals, contain carbon 14 in the form of carbon dioxide; plants accumulate carbon 14 through photosynthesis and animals, by eating plants. Both, however, stop taking it in as soon as they die. In other words, if researchers could measure how much carbon 14 is left undecayed in a sample, they could calculate how many years ago the lifeform contained in the sample died.

"The carbon 14 dating method is widely prevalent in archaeology today," Nakagawa explains. "However, since its early stage of development in the 1960s, researchers have recognized that a number of conditions had to be fulfilled to prove that the determined ages were really accurate." The issue was that the proportion of carbon 14 in the atmosphere might not have been constant over the past fifty thousand years. "That was why researchers worldwide scrambled to find an older organic material whose age has been determined with other methods, to the extent possible, and measure its radioactive carbon content. For the varve in Lake Suigetsu, our team could obtain hundreds of terrestrial leaf fossils and several reliable methods to determine their ages without resorting to carbon dating," Nakagawa continues.

The survey of the varves in Lake Suigetsu was started in 1991 by Dr. Yoshinori Yasuda, who later became Nakagawa's supervisor and is currently Professor Emeritus of the International Research Center for Japanese Studies. Dr. Yoshinori Yasuda first conducted a drilling of Lake Mikata, a lake adjacent to Lake Suigetsu, and collected layers of mud which had light and dark striped patterns. He then conducted an experimental survey of Lake Suigetsu later in the same year, hoping to retrieve better varves since Lake Suigetsu has no river flowing into it and the lake bed remained unaffected by water flow. He was rewarded by 15 m of serial varves. Two years later, he conducted a full drilling and successfully obtained another serial varve more than 45 m thick.

"Because Japan has a temperate humid climate, the changes in season lead to definite differences in sediment types," describes Nakagawa. "In spring, single-cell algae called diatoms flourish in water. Their lifespan is very short. They die in late spring and their corpses go down and settle on the lake bottom. After spring, we have the rainy season which sometimes causes soil erosion and creates a slightly coarser layer on the diatom layer. In summer, huskless phytoplankton grow and die in the water to leave a layer of black organic substance. Another kind of diatom appears in autumn, followed by iron carbonate precipitation under cold winter water with enhanced carbonate and ferrous ions. This recurring seasonal layering increases sediment thickness by 0.6-0.7 mm per year, resulting in more than 45 meters of lakebed deposit in Lake Suigetsu."

But how could Lake Suigetsu even hold sediment of this thickness? Nakagawa emphasizes two characteristics that make Lake Suigetsu truly special: "The first one is water depth. Lake Suigetsu is about 34 meters deep, which causes anoxia in the deep water and lake bed. Thus, deep water fish and benthic animals that might disturb the sediment layer cannot live in Lake Suigetsu. The second is a geologic fault located about two kilometers away from the center of Lake Suigetsu. Due to this fault, the lake bed of Lake Suigetsu is depressing. The speed of this subsidence is slightly higher than that of underwater sedimentation, which prevents Lake Suigetsu from being reclaimed."

The world's first museum of varves opened in Wakasa-cho, Fukui Prefecture. The varves in Lake Suigetsu are a global standard measure for age determination. Sediments with varves piled up continuously in the lake bed for 70,000 years unravel mysteries of ancient history.

In 1993, soon after the drilling core was retrieved by Dr. Yasuda, a young researcher began to count the number of layers in it to determine how many years ago the layer had been created. This researcher was Dr. Hiroyuki Kitagawa, then Dr. Yasuda's assistant and Nakagawa's senior at the International Research Center for Japanese Studies. Back then, tree rings were used to calibrate radiocarbon dates to calendar years, and the dataset used in the calibration covered about eleven thousand years in the past. Therefore, Dr. Kitagawa had to prepare a dataset beginning eleven thousand years ago and going back to fifty thousand years ago; that is, he had to count almost forty thousand layers and measure the amount of carbon 14 in all the fragments of leaves, which had become fragile over thousands of years.

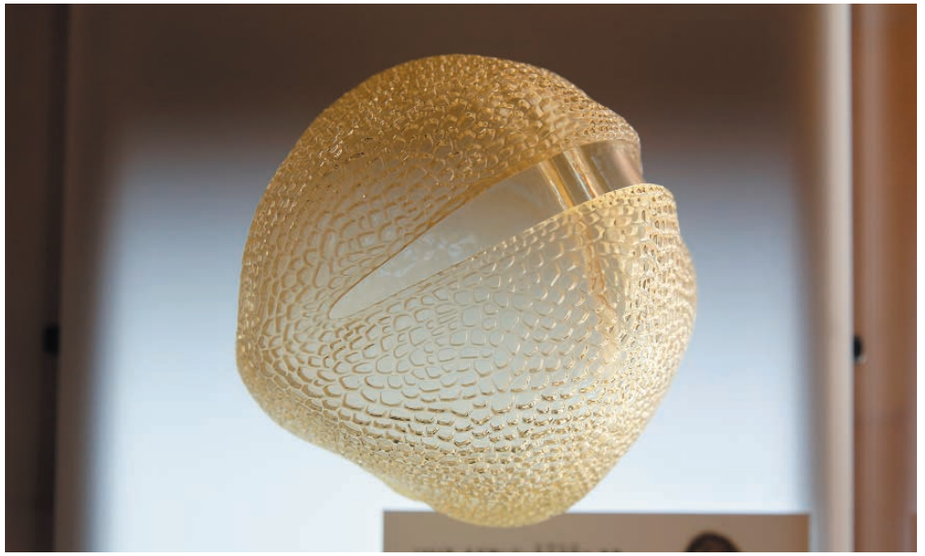
"Dr. Kitagawa completed this grand project almost all by himself," Nakagawa says, admiring Dr. Kitagawa's accomplishment. "His paper was published in Science in 1998 and welcomed with applause. In the US, another researcher, Dr. Konrad Hughen conducted a similar project on marine sediment retrieved from the anoxic Cariaco Basin located off the north central coast of Venezuela. Dr. Hughen's paper was published in Nature at a similar time. A group of scientists based in different parts of the world were independently working towards the same goal: creating a more accurate global standard age scale dataset for obtaining a better carbon 14 calibration curve (IntCal).

Although Dr. Kitagawa's counting and carbon isotope measurement were both correct, the drill cores he obtained from Lake Suigetsu lacked a few centimeters of sediment every meter. "Due to technical limitations, it is difficult even now to efficiently retrieve a core longer than a meter. We have to repeat drilling every meter to reach the bedrock underneath the sediment layers, and we lose layers from both edges of each core every time we drill through another meter. When I decided to re-drill the lake bed, I had to drill four cores, with the starting depths slightly offset from one another in order not to lose the same layer in the different cores," remembers Nakagawa.

After careful re-drilling and six years of international research, Nakagawa and his team successfully retrieved seventy thousand layers, analyzed them, and finally finished constructing a new dataset based on the lacustrine sediment of Lake Suigetsu in 2012. Their rubrical work ultimately bore fruit in the same year when the IntCal group accepted their dataset for inclusion in the IntCal13 as a principal component. The Lake Suigetsu varve has become a world standard as indicator for carbon 14 dating.

Following his success with the Lake Suigetsu varves and leaf fragments, Nakagawa is now analyzing ancient pollen collected from the sediments. "As a paleoclimatologist, I am interested in characterizing ancient environments from the type and number of pollen grains. Since we now have an accurate age scale, it might be possible to link historical events to changes in paleoclimates," Nakagawa explains.

There is no doubt that more than one story still lies hidden in the seventy thousand pages of Lake Suigetsu's chronicle, waiting to be revealed by Nakagawa and his team.



Varves give us clues not only of identifying the specific age of excavated articles, but of finding out what the ancient natural environment was like such as general climate, the appearance of forests in ancient time, etc. Examining the species and amount of pollen from the plants around the lake that are confined in the varves makes it possible to simulate what the appearance of the forest and general view around the lake were like in ancient time.

Developing Soft Robot End Effectors to Grasp Multiple Items

Sadao Kawamura

Professor, College of Science and Engineering

Subjects of research: Robot development for underwater operations, the design and development of soft robots, and the development of next-generation industrial robots
Research keywords: Intelligent mechanics and machine systems

Convenience stores provide a variety of bento meals (i.e., rice and accompanying dishes packed together in take-out packages) every day. Side dishes depend on the season or the trends, and one can enjoy hot and healthy meals from very early in the morning to very late at night. However, who is preparing these meals? Are there automated bento factories? Are there robots packing every dish? The answer is no. These meals are packaged by people with their own hands. But why do convenience store companies not automate this time-consuming task?

"Robotic handling of materials is not completely practical, especially when it comes to handling soft material like food," reveals roboticist Sadao Kawamura, professor at the Department of Robotics, College of Science and Engineering, Ritsumeikan University. According to Kawamura, the hands of pres-

ent-day robots cannot yet adjust their grasp according to various object shapes and/or for soft materials, as human hands do. This is one of the reasons behind Kawamura's claim that "the mass media usually makes a fuss about robots and artificial intelligence replacing humans in the work place, but I believe it won't apply to material handling, at least for the time being; in fact, they are always short-handed and have to rely on imported labor."

The bottlenecks of technology include recognition, mechanism and control, and implementation. Regarding recognition, audio-visual sensors are way ahead of other sensing technologies. The Big Four (Google, Amazon, Facebook, and Apple—also referred to as GAFA) have dominated the current IT industry with their audio-visual sensing technologies, including facial recognition and voice dictation. Cyber eyes and ears are now either equivalent to or in the process of transcending our physical ones, and information detected by them is easily shared on the Internet. However, the same ubiquity of information has not yet been applied to tactile or force sensors.

"Robots have fingers or hand-like devices connected to their arms to touch or grasp materials; the devices are called end effectors. It is a difficult task for end effectors, even with touching, weight, and force sensors, to take delicate actions such as quickly picking up a paper cup; however, most of the commercialized end effectors are neither equipped with those sensors, nor are they connected to the Internet, and we are struggling to accumulate and send physical information on our servers or the cloud," Kawamura explains.

It might sound queer, but commercialized material-handling robots do not have the "physical touchsensing" to handle objects. As mechanism design theory and control theory have not yet fully matured, it is still challenging for developers to make robots firmly grasp or assemble soft materials and/or multiply shaped objects. "I want to break through the wall," Kawamura says emphatically, adding "my plan is to create a soft end effector, equipped with lots of sensors. I don't stick to the shape of the human hand; academia thinks highly of it, but it is not necessarily the most efficient when it comes to industrial application."

Making the end effector soft is one of his key considerations. He highlights the benefits of this softness, saying "Controlled with edge computing, soft end effectors can safely grasp and handle soft materials." Use of polymetric material and 3D printing technology are also unique features of his approach. "Polymers have rarely been used in industrial robots, but I believe they would open up the path to light, flexible, and foldable robots. If robots were made completely out of plastic, we wouldn't have to worry about the adverse effects of the electromagnetic field on them. In recent years, 3D printing—or additive manufacturing—has made remarkable progress and can be applied to not only plastics but also metal, and gel. With this technique, prototyping and modeling is becoming much faster and easier."

Kawamura recalls when he first gained interest in robotics, a symbol of modern science. “Like many other children, I too watched the famous TV program ‘Astro Boy’ and was thoroughly entertained by the story. However, I knew that Mighty Atom was not the robot I wanted to create.” With age he realized he was curious also about the movements of animals and started to wonder whether he could apply animals’ abilities to robots. Kawamura started studying biomechanics and later switched his major to mechanical engineering to learn more about robotics.

“I am not mimicking the human hand, even though I have learned the principle of the human hand movement,” emphasizes Kawamura. “Mimicking hands, while familiar and acceptable, is not the optimal solution, nor is it a goal in life evolution. It is true that it is effective, but we must admit that sometimes it is ineffective as well.” Kawamura mentions the so-called Cambrian explosion, an event that took place approximately 540 million years ago, which refers to the sudden and explosive appearance of complex animals in the fossil record, to illustrate the importance of diversification. “Some robots can be hard; some can resemble human hands. But they still cannot cover the different needs of different industries.” Kawamura also reminds us that robot–human cooperation might be an illusion. “Sanitation is the most important aspect of food handling,” says Kawamura, adding “and humans carry bacteria in their bodies. Getting rid of humans results in cleaner food factories. Food will last longer in the fridge than at room temperature, and there are some food items and drinks whose taste deteriorates when exposed to light. If there were no humans around, robots could work in the environment that is best suited for the particular food item.”

Kawamura is now working with around 15 laboratories inside and outside Ritsumeikan University. Kawamura’s lab is responsible for developing a control algorithm and analyzing the dynamics of finger-like end effectors actuated with air pressure. The other labs are in charge of key technologies such as new material development, etc. Kawamura manages this development project in its entirety.

“First, we had to be aware of each industry’s needs,” Kawamura explains. “We also had to learn what the 15 labs were good at, in order to combine our technologies and expertise. We have also asked many private companies to cooperate with us.” As a part of the industry–academia collaboration, one of the graduate students established Chitose Robotics Inc. in Kawamura’s lab in 2018, with Kawamura as one of its directors. Chitose Robotics Inc., a system integrator company in Japan, developed and merchandised a new, automated dishwasher system. The company is working on verifying the robotization of the dish-washing process. “We set up a mock kitchen and sink in our lab, installed some industrial robots, and started testing them. Dishwashing is a time-consuming task and physically tasking too, as the dishes are heavy and one always has to bend while washing them. We provided our new motion-control methods to demonstrate picking up, carrying, and stacking dishes.”

Kawamura emphasizes that as they are aiming to develop their findings for practical use, their robots should have a minimalistic design and be relieved of too many parts and equipment that need to be especially purchased or maintained. “I said that the end effectors would have lots of sensors, but I would equip them only if they were necessary,” says Kawamura. “We have to keep studying which sensors and equipment the industry really needs.”

Kawamura’s project (the Cabinet Office (CAO), Cross-ministerial Strategic Innovation Promotion Program (SIP)) is “[A]n intelligent knowledge processing infrastructure, integrating physical and virtual domains” started in 2018 and is expected to be completed in 2022. Its major goals are developing end effectors, clarifying their mechanism, and solving their problems. As its immediate goal, Kawamura is now planning to increase the industry–academia joint projects, following the dish-washing project, before 2020. Using these startup projects as a foothold, Kawamura and his lab will cultivate future collaborations before the completion of the project in 2022.

Creation of Ultra-High Strength and High-Ductility Materials by Nano-Meso Harmonic Structure Control

Kei Ameyama

Professor, College of Science and Engineering

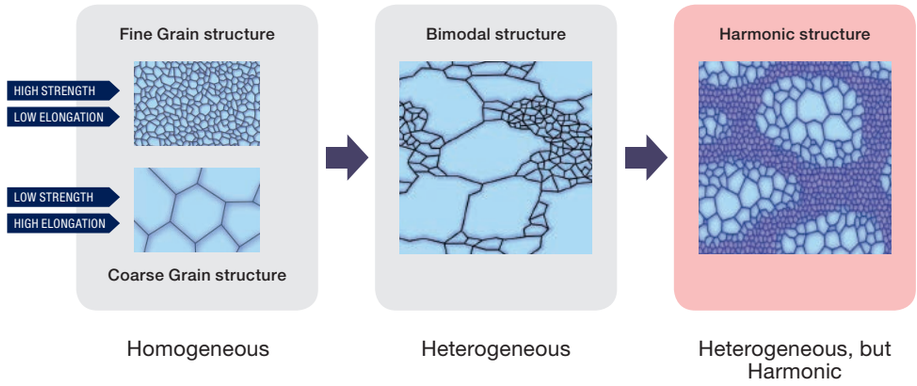
Subject of Research: Material control and structural analysis of metal and ceramic materials, and the development of ultra-high strength and high ductility materials
Research Keywords: Materials Science and Engineering, Structual and Functional Materials, Metallurgy and Material Processing

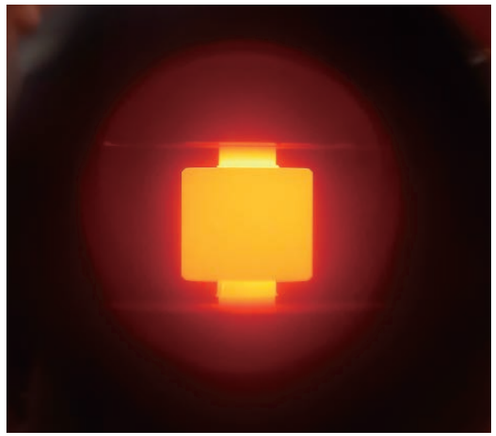
It is common knowledge, found even in basic textbooks, that materials cannot be both tough and hard. Diamond, which is solid crystal carbon, is known as the hardest material in nature; however, it is vulnerable to shock and can be easily broken if hit with a hammer at a certain angle. Meanwhile, nature provides us with some materials that compatibly have high hardness and toughness. For example, seashells, bones, and honeycombs are relatively strong and hard. How is this possible?

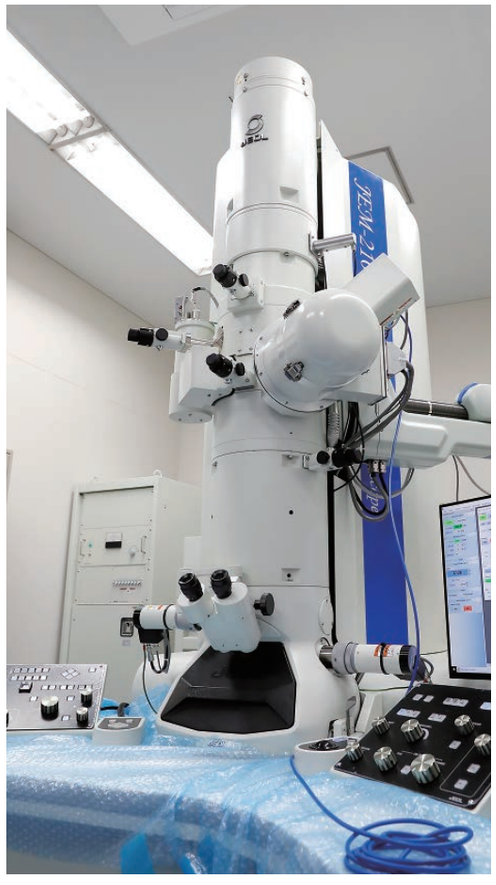
"Heterogeneity holds the key to this seemingly inconsistent coexistence of hardness and toughness," explains Kei Ameyama from the Department of Mechanical Engineering, College of Science and Engineering, Ritsumeikan University, where he is currently studying heterogeneous metallic materials produced by a method called powder metallurgy.

According to Ameyama, although Japan has had prowess in traditional high technologies such as the manufacturing of the Japanese sword (Katana) since the 10th century, the development of modern Japanese materials dates only to the early 20th century, when metallurgist and inventor Dr. Kotaro Honda invented a magnetic-resistant KS steel. Initially, engineers struggled to develop high-strength materials such as hard steel; around 1980, interest in "ultra-fine-grained materials" increased to become one of the central players in material development.

Materials are accumulations of crystals. It is well known that the smaller each crystal, the harder the material. Japanese material development has pursued the creation of very small crystals as its ultimate goal. However, as mentioned, homogeneous materials cannot be







Developing the new materials by using the advanced equipments. Seeking for material's sophisticated mechanism by high-resolution electron microscope.

hard and tough simultaneously. An increase in hardness leads to a decrease in ductility and toughness. However, this is not the case for heterogeneous materials.

Ameyama and his laboratory team purchased packs of metal powder with diameters of several tens of micrometers (half the width of a human hair). They put the powder in a mixing device with small milling balls and argon gas, and rotated this device at high speed to deform the surface of the powder to have nanocrystals on the surface.

"We refine the powder surface halfway to keep the core of the powder unaffected," Ameyama explains. "The internal structure of the processed powder looks just like that of a boiled egg; the core is surrounded by a layer of nanocrystals, as the yolk is surrounded by the white. We call this boiled-egg-like structure a 'nano-meso harmonic structure'." The team then processed the powder into 3D materials using a method called powder metallurgy. First, they collected powders with harmonic structures. Then, they sintered the powder at elevated temperatures with a mold in vacuum. With this process, they could fabricate materials with both high hardness and toughness, in any desirable 3D shape.

The idea of powder metallurgy is actually not new; it is widely used in present-day industries from oil-impregnated bearings and automobiles to smaller products such as watch casings. It is expected to be more sustainable than casting, as it can reduce metal waste, which causes yield loss and cost increase.

Ameyama defines his specialty as basic science, even though he is part of the Department of Mechanical Engineering, which focuses on applied science. Ameyama recalls, "I entered university just before the oil crisis in 1974. Two years prior, senator Kakuei Tanaka, who later became the Prime Minister of Japan, proposed 'Nihon Retto Kaizoron (Building New Japan)', and most Japanese started to realize that we should address our material and energy shortage. Civil, petroleum, and atomic engineering majors became explosively popular, and, like many other classmates, I chose my major in materials science."

Ameyama emphasizes that he finds metallic materials intriguing because they alter their nature and appearance depending on various conditions, including temperature and pressure. He admits that the number of researchers studying metals is currently declining; more researchers have been shifting their specialty to advanced materials such as functional materials, biomaterials, electronic materials, and so on. However, he is confident and proud of his current specialty. Ameyama enjoys observing the variety of metal behavior. He prefers a tangible research target, rather than searching for methods to observe objects that are small or far away.

"In 2005 or 2006, I happened to fail at producing a homogenous nanocrystal powder in the mixing device," Ameyama remembers, "I was processing uniform nanocrystals, and mistakenly stopped stirring too early, only to obtain a heterogeneous, halfway-crystalized powder which at that moment I regarded as useless. However, I did not want to waste the product, and decided to examine its nature. The result was unexpectedly wonderful — the powder had a nano-meso harmonic structure!" This incident motivated Ameyama to pursue powder metallurgy with a heterogeneous powder possessing a harmonic structure.

Processing powder with a nano-meso harmonic structure is not always that simple. In Ameyama's laboratory, students are currently struggling to find methods to process aluminum and copper surfaces, as they are so soft that they easily stick to each other before their surfaces are crystalized. Temperature

and humidity also affect the success rate of crystallization.

"One interesting aspect of materials engineering is that not everyone can succeed despite everyone working according to the same manual," Ameyama smiles. "If you are assembling a machine, all you have to do is to fit all components in accordance with the blueprint. However, if you are processing a material, this is not the case. You need to have some sort of craftsmanship, which, honestly, I cannot precisely describe; some students conduct experiments much better than others, even if all of them are working in the same way." Isn't this similar to the instincts of a chef in a restaurant?

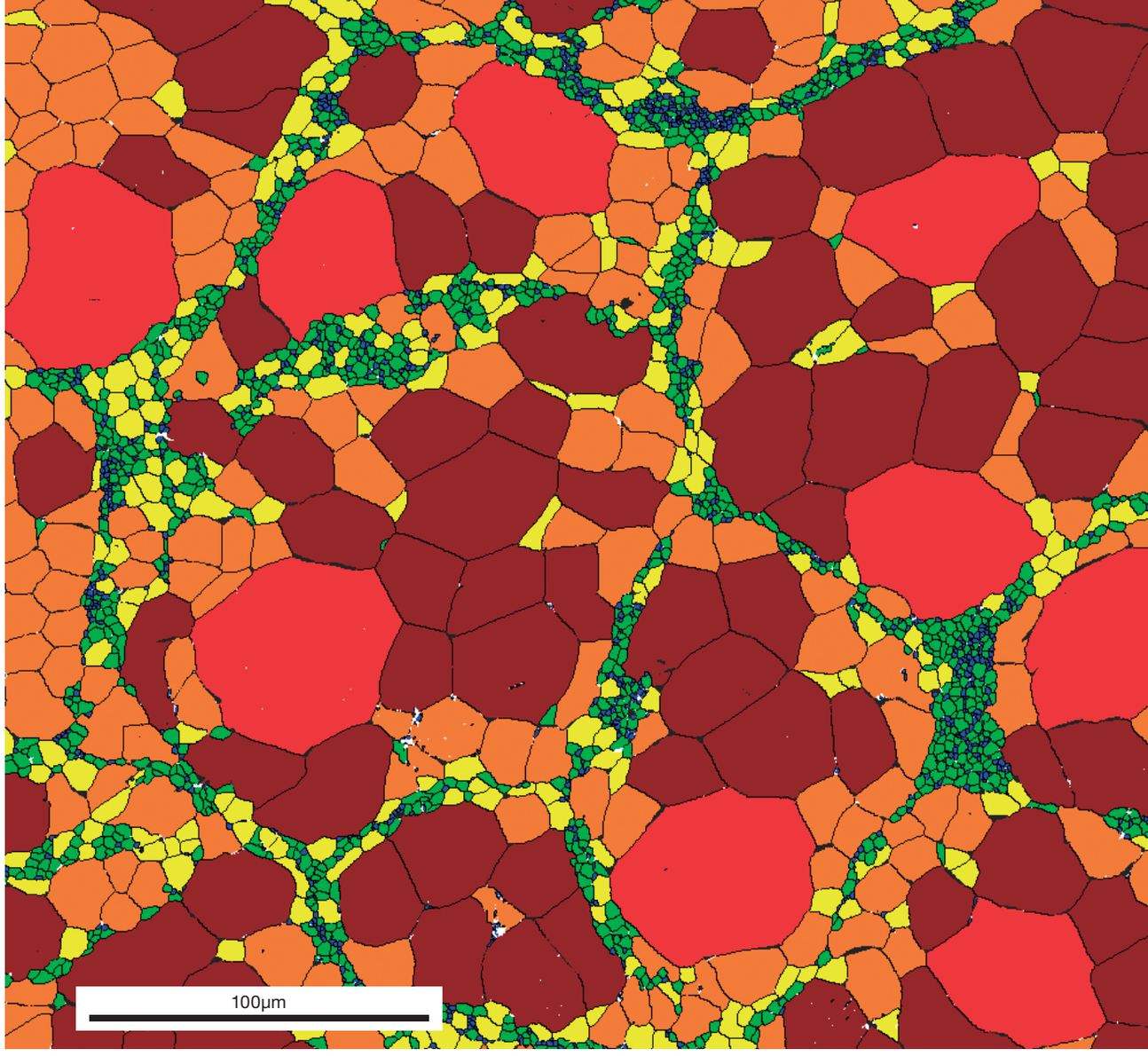
As material development requires a broad knowledge of engineering, Ameyama admits that it is not realistic for him and his team to work on all research and experimentation by themselves. His team's responsibility is to process materials and evaluate their basic characteristics; other teams within and outside Ritsumeikan University are responsible for the fatigue and functional tests, as well as computer simulations of the deformation behaviors. Ameyama emphasizes, "We have so many tests and experiments to do. Teamwork is indispensable in material studies."

Heterogeneous materials can absorb collision energy, and have high torsional strength. This nature is common to all metallic materials, and Ameyama currently works with titanium, which is widely used in the present-day industry.

Ameyama explains, "Tough materials can be molded small, and are sufficiently reliable to be used in the human body; on the other hand, stronger materials can be down-sized and are sufficiently light to be applied in aerospace engineering. Currently, I am mostly working on developing small and robust medical tools, namely scissors and knives for laparoscopic surgeries, as medical devices are less expensive and have a larger demand than aerospace machinery." He recalls that, several years ago, he was asked to investigate a medical accident in which a pair of metal scissors got chipped in the patient's body. The group of surgeons had reported that the scissors were not sufficiently strong and tough and that one of the tips broke during the surgery. Ameyama learned how crucial it is for medical personnel to work with tougher and more robust equipment.

Ameyama has recently become interested in nonmetal materials as well. He emphasizes that it is the universal nature of heterogeneous materials that piques his curiosity, and points out that there are several heterogeneous, hard, and tough nonmetal materials in our immediate surroundings. "Concrete, for example, composed of coarse and fine aggregate (gravel and sand), and cement," he illustrates.

Material development requires long, sustained research. It is not uncommon these days that researchers have to wait for 30 or 40 years before their work is finally commercialized. "Things never work out as you expect, but the excitement of materials engineering lies just inside of this unpredictability," Ameyama advises young followers. "I had my then-research purpose and was testing my hypothesis when I 'mistakenly' invented powder which had a nano-meso harmonic structure. Strictly speaking, I failed in that experiment. I never expected to create something useful until I tested the material. Do not be afraid of failure. Do not waste any products obtained from your experiments; always test them. Lady Luck favors researchers who are bold and curious."

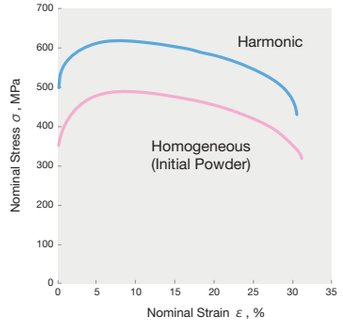


Pure Ti

PREP powder: ~ 120μm,
MM (Planetary Ball Mill): 180ks,
SPS: 800°C , 10min

Grain Size Map (μm)

	Min	Max	Total Fraction
	0.5	2	0.018
	2	5	0.072
	5	10	0.089
	10	20	0.262
	20	40	0.408
	40	60	0.140



Pure Ti	Microstructure	
	Homo-geneous	Harmonic
0.2% Proof Strength (MPa)	371	547
Uniform Elongation (%)	8.6	9.8
Tensile Strength (MPa)	490	619
Total Elongation (%)	31.2	30.4

FEATURE #01

Connecting with the World

We now live in a borderless age where
all things transcend national boundaries.
Researchers search for new insights
around the world to tackle global issues.

The researchers at Ritsumeikan also apply
a world-embracing perspective in their fieldwork and studies,
whether domestic or abroad,
considering the entire planet as their research field.
Through their findings,
they aim to contribute to the betterment of humankind.

Our researchers, along with scientists from
around the world involved in solving advanced,
universal challenges that face humanity today,
will share the appeal of connecting across borders
to engage with diverse cultures while advancing their studies.

The World's first direct Observation of a Hypocenter: Uncovering the Mechanisms of Earthquake Generation

In June 2017, the DSeis Project (shorthand for *Drilling into seismogenic zones of M2.0–5.5 earthquakes in deep South African gold mines*) began drilling 1–3 km underground to get to a location from which earthquakes of magnitudes (M) 2–5.5 were generated. The drilling was completed in June 2018, and the borehole logging survey ended in July.

The proposal for this project was accepted by the Germany-based International Continental Scientific Drilling Program (ICDP) and is led by Japan, with the help of South Africa (SA), Switzerland, the U.S., Germany, India, Australia, and Israel. The individual coordinating this huge international research project is Hiroshi Ogasawara of Ritsumeikan University. Ogasawara has studied the physics of earthquake hypocenters in SA gold mines for more than 24 years. (In Japan, he is currently working together with Tohoku University, Kyoto University, The University of Tokyo, Osaka University, Kochi University, the Fukada Geological Institute, 3D Geoscience, Inc., the National Institute of Advanced Industrial Science and Technology, and the National Research Institute for Earth Science and Disaster Resilience, among others.)

In SA, a large number of deep gold reefs have been excavated over the past 120 years.

As a result of the many cavities, the host rock has become severely unstable, resulting in small earthquakes occurring on a daily basis. Ogasawara explains, “It is believed that natural earthquakes are also generated as a result of stress building up in the host rock, but it is too remote to observe processes of stress build-up and natural earthquake generation in detail from the earth’s surface. In contrast, in gold mines at great depth, hypocenter faults or ruptures can be easily exhumed or instrumentally closely observed. By studying them, we may discover what controls the occurrence and termination of seismic activity.”

Moab Khotsong mine, in particular, provided the means to enable the team to start drilling from a 2.9 km-depth from the earth’s surface. Within 800–900m from the borehole collar, we can gather valuable samples from the faults of a M5.5 earthquake still generating aftershocks. Ogasawara is hopeful, stating, “This is a global first. We are having the closest unobstructed view of hypocenters, something that is unviewable from the earth’s surface. We expect to find clues to address fundamental questions of the mechanisms of earthquakes.”

Between 2010 and 2015, Ogasawara’s research team was able to successfully instrumentally monitor earthquake activity in detail at gold mines at 1–3.4 km depths under the auspices of Japan Science and Technology Agency (JST) and the Japan International Cooperation Agency (JICA) for the Science and Technology Research Partnership for Sustainable Development (SATREPS). During 2015–2019, the collaborating researchers came from a wide range of academic disciplines, including seismology and rock engineering, as well as geology, structural geology, and geomicrobiology. They have been investigating not only the seismic activity and geological structures around hypocenters but also groundwater and microbiological activities. In 2019, samples will be digitally archived into the ICDP Information System and eventually made available internationally for use in a wider variety of scientific research fields.

They are drilling a total of 1.6 km from 3 km underground to reach seismogenic zones, generating quakes of about the same magnitude as the one that struck northern Osaka in June 2018.

If the direction of drilling into seismogenic zones is not carefully set, drilling severely pulverizes recovered samples. The teams successfully collected a core sample with a total length of about 1.6 km with minimal drilling damage, allowing them to start a comprehensive investigation of fractures from earthquakes, fault substances, stress, geological features, physical properties, microbes, gases, and groundwater.

To observe at the closest proximity to a hypocenter, they must first identify the time and location of an earthquake occurrence and install an ultrasensitive seismometer near the hypocenter. Ogasawara made the drilling plan based on data thus obtained by Japan and its partner organizations in SA, which included a main shock and tens of thousands of aftershocks and ultra-microearthquakes. In June 2017, they finally started drilling two holes from a tunnel 2.9 km underground, to probe around the upper fringe of a seismogenic zone of the M5.5 aftershocks. They attempted to collect cylindrical samples called cores by drilling these holes, 76 mm in diameter and about 820 m and 700 m in length. In February 2018, the second drill hole penetrated the M5.5 aftershock zone. Where the fault fracture zone was intersected, a layer of substances thinner than 2 m with very slippery material was recovered.

Ogasawara explained their results, saying, “We were able to collect a large number of extremely interesting samples of fresh fractures thought to have been caused by M5.5 earthquakes or subsequent aftershocks, as well as samples of new fissures caused by rock stress enhanced in host rock without previous seismic history.” They have already started measuring rock stress and conducting detailed structural geological analysis with the samples recovered from the hypocenter faults. “It should be noted that a local increase in differential stress was found right at the upper fringe of the aftershock zone. With further seismological analysis of the main rupture and aftershocks of the M5.5 mainshock, we hope to clarify earthquake rupture propagation and the condition that controls rupture propagation.”

At the same time, the geomicrobiology research group from Princeton University in the U.S. is exploring rock-hosted microbes that live in the deep subsurface of the earth. They hypothesize that earthquakes rupture host rock, which generates hydrogen to fuel life deep in the rock. This could unravel the mystery of life during our planet’s early history or extant life on Mars.

Ogasawara explains that from here on out, “We will analyze the core samples, but we also wish to further extend the drilling of the *DSeis Project* and conduct drilling to probe a wider extent of the aftershock zones in greater depth.” Are they close to a new view of the mechanisms of earthquake generation? Their findings are eagerly awaited.

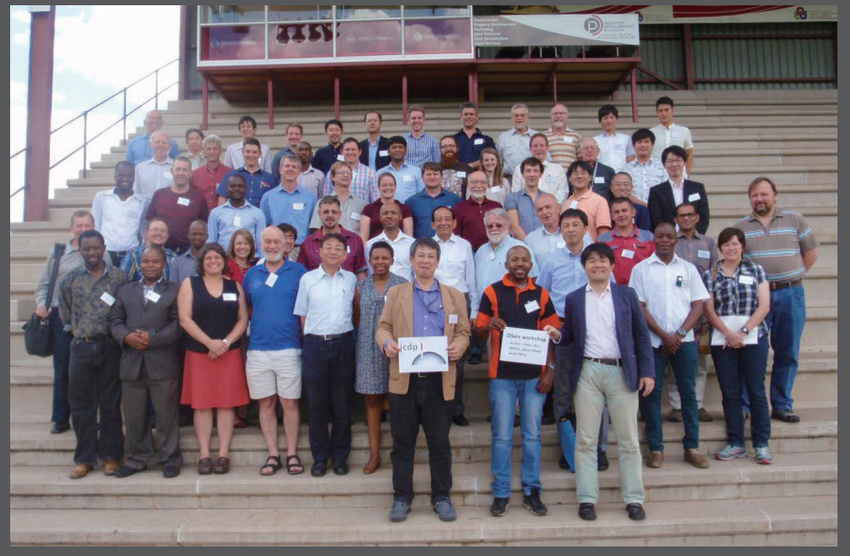
Third from the left, together with his lab students, who also participated in the SA investigation

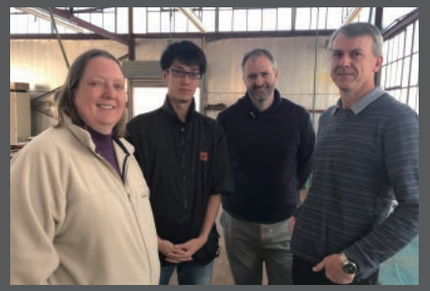
Hiroshi Ogasawara

Professor,
College of Science and Engineering

Subject of Research: Study of the physics of earthquake hypocenters in deep South African gold mines

Research Keywords: Solid earth and planetary physics





Hiroshi Ogasawara has studied the physics of earthquake hypocenters in South African gold mines for more than 24 years. He plays a central role in the South Africa DSeis Project, which brings together Japanese, South African, Swiss, American, German, Indian, Israeli, and Australian researchers from a range of disciplines in the underground tunnels of gold mines.

How to Accommodate Food Taboos

A Key to a Successful Inbound Tourism Business

Over the past few years, with the number of foreign tourists soaring, the inbound tourism business has been booming all over Japan. Aside from China, Europe, and North America, the number of tourists from Southeast Asia has also visibly increased in recent years. Many such visitors list *food* as one of their reasons for visiting Japan. At a time when the restaurant and food industry is attempting to find a way to accommodate these foreign visitors, one especially urgent task is how to deal with food taboos and avoidance.

"At least one third of the world's population observes food taboos and practices avoidance based on beliefs or religion. There are also a significant number of people with allergies, yet Japan cannot be said to be sufficiently accommodating such taboos and avoidances." This is a point made by Mariko Arata, a cultural anthropologist who has conducted fieldwork on food culture in Indonesia and has made many contributions to halal studies.

In the Japanese food service and ready-meal industries, a lack of consideration due to ignorance is not uncommon, and conversely, some choose to exclude everything to the point of neglecting the basics of *providing delicious food*. In response to this current situation, Arata is proposing a method of providing food to people who observe diverse forms of food taboos and avoidance. Arata attaches the greatest importance to *disclo-*

Mariko Arata

Professor, College of Gastronomy Management

Subject of Research: Indonesian food culture studies, halal food studies, food business in multicultural societies and glocalization, food preference, and food choice

Research Keywords: Eating habits, area studies, linguistics, Japanese language education, foreign language education, cultural anthropology

sure. “First, there are two types of disclosure to keep in mind when displaying the menu at a restaurant. There is *menu information* such as ‘Deep-fried chicken’ and ‘Potato salad,’ which lists the main ingredients of a dish and describes its cooking method, and then there is *ingredient information*, which reveals all ingredients used, including those used in small amounts.” Menu information is sufficient for customers who choose their dishes based only on preference, but those who have allergies or religious taboos cannot get by without the ingredient information. If a detailed description is difficult, simply adding labels such as “Pork-free” or “Meat-free” makes it easier for many people to choose their dishes.

Moreover, Arata recommends not only textual information but also labeling, using *foodpicts.*

Foodpicts are pictograms that refer to 14 kinds of food materials provided by FOODPICT Inc. They cover major allergens and religious taboos, and accommodate vegetarians, also. However, “if you use *foodpicts*, you must strictly observe the guidelines. Picking and choosing a part of them as you please is not acceptable,” she warns. “What would happen if there was a hotel buffet that used *foodpicts* for only the seven allergenic ingredients? A vegetarian might never imagine there were no labels for meat or fish and could end up consuming it. This would render the *foodpicts* useless.”

She also says that care is required when labeling for alcohol. This is because two types of needs exist: 1) the need to avoid all food and drinks that use ingredients derived from alcoholic drinks (*khamr*), regardless of the amount, for religious reasons and 2) the need to avoid intoxicating food and drink because of reasons such as pregnancy or having to drive. In the case of the former, because some people avoid food seasoned with *sake*, *mirin*, or alcohol-added *miso* and soy sauce, *foodpicts* accommodate this stricter requirement; however, for those who fall into the latter category, such labels may be an overstatement and lead to confusion. Arata suggests that “restaurants and shops offering alcohol drinks could, for example, add additional information such as ‘For adults only’ or ‘OK for kids, too.’”

One issue that has garnered attention in the food business world in recent years is *halal*. According to Arata, *halal* signifies “things allowed in Islam or things legal under Islamic law.” When it comes to halal food, the globalization of distribution and the sophistication of food processing have resulted in an increase in food and drink whose halal status is difficult to verify immediately, which has increased the importance of halal certification, by which certification bodies guarantee that “this is halal.” While there are firms that enter Muslim markets by obtaining halal certification, there are examples of restaurants and accommodation facilities that struggle with how to manage this.

However, “Many people misunderstand this, but halal is not the same as being halal-certified.” Arata explains. “To begin with, certification is a very new institution that came about toward the end of the twentieth century. Moreover, there are diverse interpretations of what constitutes halal among Muslims, depending on their sects or schools of jurisprudence, etc., while food preferences and customs also differ among countries and cultures. Foods are often judged to be authentically halal and consumed by Muslims without any certification, while on the contrary, some halal-certified foods may be suspected to be non-halal. More important than obtaining certification, just as with any other product, is 1) providing reasonably priced products that are in line with consumers’ needs and preferences and 2) gaining their customers’ trust.”

She explains, “What we should worry about the most is non-Muslims arbitrarily deciding what is halal and what is not.” She is concerned that there is an overprotective tendency to avoid risk by judging products to be “non-halal” based on a shallow understanding.

She stresses that “Muslims, Jews, vegetarians, and others each have their own food taboos, but they are the same as any of us, as each possesses a rich culinary world of their own. To help such people from all over the world enjoy Japanese food, it is important that we create an environment in which each and every one can choose freely, following their own judgment.”

How do we accommodate the *food taboos* that apply to one third of the world’s population?

FOODPICT©INTERNASHOKUNAL & NDC Graphics

Foodpicts are the 14 pictograms provided by FOODPICT Inc. accommodating allergies, religious taboos, and vegetarianism, which can be used as an effective tool for disclosing information on ingredients used in a dish to international visitors.

To gain a *better* Understanding of Middle Eastern Politics

As of 2018, the Syrian conflict, said to be the *worst humanitarian crisis of the twenty-first century*, has entered its eighth year. The antagonism between the Assad regime and the opposition was brought out into the open during the Arab Spring of 2011. This antagonism developed into a conflict, and eventually, the extremist group Islamic State (IS) appeared from among the opposition groups. Even after IS lost its clout, with the military intervention of its neighboring countries and major powers, the path to resolution is nowhere in sight. More than half of its entire population has been forced to take refuge from the wartime destruction, either within Syria or abroad, and tens of thousands of lives have been lost already.

"We are prone to believe that the conflicts and political turmoil in the Middle East are due to some unfathomable special causes. There is truth to this in some respects, but we will never be able to develop an understanding by fixating on the differences. I believe that we can *better* understand the politics of the Middle East by discovering uniqueness and peculiarities, as well as commonalities and universalities." These are the words of Kota Suechika, who has been grappling with this problem from the standpoint of Islamism.

According to Suechika, Islamism is "a political ideology rooted in the teachings of Islam that aims to bring about social change and nation-building." Suechika explains the importance of analyzing Islamism from a long-term perspective of more than a century. The issue of the relationship between *politics* and *religion* that came about with the collapse of the Ottoman Empire was long sealed away at the hands of dictatorships. The Arab Spring greatly changed this situation. Movements to reflect Islam in politics came out into the open, and such voices have grown stronger. Suechika moved his attention to this relationship between *politics* and *religion* that was now being re-evaluated and has since studied what influence Islamism has on politics in the Middle East, as well as how the relationship between the two will change in the future.

Numerous studies on the Middle East and Islam have been conducted in Japan as well, but they are still at an early stage when it comes to the attempt to cover both topics. It is for this reason that Suechika's research, which is fleshing out the reality of Islamism and using its clues to reassess Middle Eastern politics, has garnered much attention.

Kota Suechika

Professor, College of International Relations

Subject of Research: Contemporary Middle East politics, with emphasis on Islamic political thought and movements in Syria and Lebanon

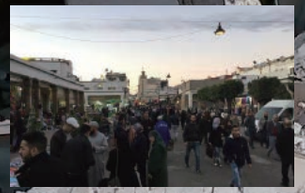
Research Keywords: Middle Eastern area studies, international relations, comparative politics

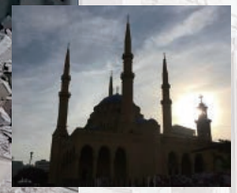
"However," Suechika explains, "it goes without saying that Islam does not influence all political phenomena of the Middle East." The politics of the Middle East contain a diverse range of topics such as dictatorships, democratization, conflict, war, and economic problems relating to oil resources.

Recently, Suechika started a new research project focusing on *conflict* and *state failure* in the Middle East, as a way to add a new perspective on the research he had conducted thus far. He discusses countries like Syria and Iraq that have experienced conflict and tries to clarify why conflicts and state failures occur, as well as what problems are caused by such failures.

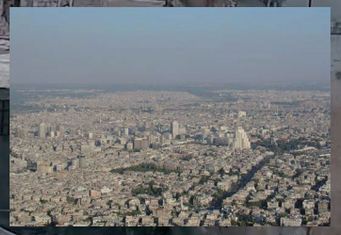
"State failure is by no means a domestic problem. If a state fails and conflict ensues, not only will the people of that country suffer, but it will have a major impact on international society as well." The *Islamic State* that emerged from the Syrian conflict built a "state" that encompassed a vast territory across Iraq and Syria, and then called on Muslims all over the world to become its "citizens." It is well-known that, as a result, terrorism has become rampant, not only in the Middle East but in Europe and North America as well.

However, in the field of Middle Eastern political studies, globally, the research on conflict and state failures has seen limited progress. An indispensable part of area studies is to head out to the actual locations and collect the voices of its peoples, as well as its literature, but this is practically impossible in conflict zones. As such, Suechika's research project has commissioned a local research institute to conduct a large-scale opinion survey, in an attempt to collect the voices of its residents. In 2017, they managed to collect data from about 1,000 people each from Syria and Iraq. Such a collection can reveal the thoughts and attitudes of ordinary citizens, which are difficult to perceive from the macro perspective. "The detailed analysis will take a bit longer, but the data is beginning to show aspects different from what are commonly claimed to be their thoughts or what had been previously thought of as *common knowledge*, in relation to Middle Eastern politics."





Suechika says that a common misconception about conflicts in the Middle East is that the cause is *sectarian antagonism*. For example, the civil war in Syria is a confrontation between the Assad regime, which advocates secularism, and the opposition, which seeks to restore Islam in politics. In other words, the conflict is about *whether or not to have religion*, rather than a confrontation between different sects. Suechika states that the findings of this opinion poll have corroborated the views held by him and his colleagues.



Through the voices of ordinary citizens, the tragedy of state failure and its background come into focus.

Suechika explained that "in Japan and the Western world, where the separation of church and state and secularism are taken for granted, we are prone to think the cause of conflicts in the Middle East is *religion*. However, in reality, not all of politics is driven by religion, and some places are no different from the countries and regions where we live." Perhaps the Middle East may appear different at first glance, but the causes and mechanisms of conflict or peace may be surprisingly universal. Suechika expressed his zeal, saying, "With the current research project, I want to pursue the methodologies and techniques further to gain a *better* understanding of Middle Eastern politics."

A modern Economic System in Hong Kong's Underground Economy

Chungking Mansions faces Nathan Road, which runs through Hong Kong's most prominent business district, Tsim Sha Tsui. Cheap accommodations are concentrated in this five-block complex, which attracts traders and backpackers of all nationalities and ethnicities. Chungking Mansions, which is reputed to be a *den of vice* for the dodgy activities it has housed over the years, is where the cultural anthropologist Sayaka Ogawa resided for over half a year, starting in October 2016. She stayed in the complex in order to conduct fieldwork on small-scale Tanzanian traders and their commercial activities.

Tanzanians in Hong Kong

In Tanzania, East Africa, Ogawa had previously researched and closely observed the commercial practices of small-scale traders called Machinga. She lived there for about three years, became part of the Machinga community, and even sold second-hand clothes by the roadside to better understand their business arrangements. The Machinga approach to business is known as *ujanja*, meaning *slyness* and *craftiness* in the Swahili language. Ogawa was particularly interested in the logic behind their approach, which differs from *formal business practices* of contracts and legal regulations that are often employed in developed nations and other societies.

In recent years, this group of people from Tanzania has been increasingly travelling to China in search of new import products to replace the second-hand clothes they typically sell. Ogawa followed them to Hong Kong and discovered an underground economy run by small-scale traders from all over the world.

Filling a container with bought used cars

The Tanzanians of Chungking Mansions

"The China-based transnational informal trade started appearing in the early 2000s," Ogawa explained. She added, "Small-scale traders from Asia, Central and South America, the Middle East, Africa, and around the world came to China and built their own production and trade system. Although such a trade system has been conducted discreetly, as almost all of their business activities are illegal, it is said that it provides employment to hundreds of millions of people globally and generates huge profits in the tens of trillions of dollars." A vast amount of money flows through this underground economy. "This is intriguing," Ogawa thought to herself and instantly became captivated by the idea.

During her half-a-year stay in China, Ogawa tracked the daily activities of a Tanzanian second-hand car dealer who called himself "the boss of Chungking Mansions." Through him, she explored the kinds of businesses Tanzanian traders conduct in China.

Ogawa explained, "There are two types of Tanzanian traders living in Chungking Mansions. The first one comprises traders who visit Hong Kong for short periods to buy products or look for valuable goods. The second one includes those who live in Hong Kong long-term and earn a living as brokers, dealers, and guides between their visiting

Tanzanian Commerce at the Chungking Mansions in Hong Kong

fellow citizens and the Chinese. Most of them are illegal workers." The Tanzanians export natural stones to China and Hong Kong. Then they bring various products, such as used cars, cell phones, home appliances, clothes, and general goods from China to Tanzania. Ogawa was surprised by their business arrangements.

As most of their transactions are illegal, it is not uncommon for them to encounter fraud, non-payments, and other business troubles. Nonetheless, they have built their own system that allows them to conduct trade reliably. To anticipate business problems, they use their own trade system called TRUST. With TRUST, Hong Kong dealers transact products with African dealers and buyers in an auction format on social media platforms such as Facebook. Once a deal has been concluded, a small capital sum is solicited through crowdfunding and used to procure products. Eventually, these products are sold in Africa and then the profits are divided among dealers, buyers, and investors. These monetary transactions are conducted using electronic money via informal financiers.

The traders have also formed the Hong Kong-Tanzania Association and Guangzhou-Tanzania Association to facilitate mutual assistance in case of unforeseen circumstances, such as injuries, sicknesses, or death. Although they trick one another at times and engage in illegal trades, they use advanced technologies to achieve a form of collaborative commons and form mutual organizations to, ultimately, conduct commercial activities smoothly. Ogawa's research highlights the realities of such a flexible and resilient informal economy that is unimaginable in the context of a formal economy.

"Informal trade might sound like something dubious and *unsophisticated*, but Tanzanian traders and dealers are actually using SNS, crowdfunding, electronic money, and other advanced technologies to the fullest and have built a global business network," Ogawa explained. Most innovative economic systems, such as the sharing economy, free economy, and blockchains, originate from underground economies run by small-scale traders. Ogawa added that "this *globalization from below* paradoxically emerges as a result of dissatisfaction with and contradictions in *formal economies*, which are considered mainstream." With eagerness, she said, "This is the real thrill of cultural anthropology."

Sayaka Ogawa

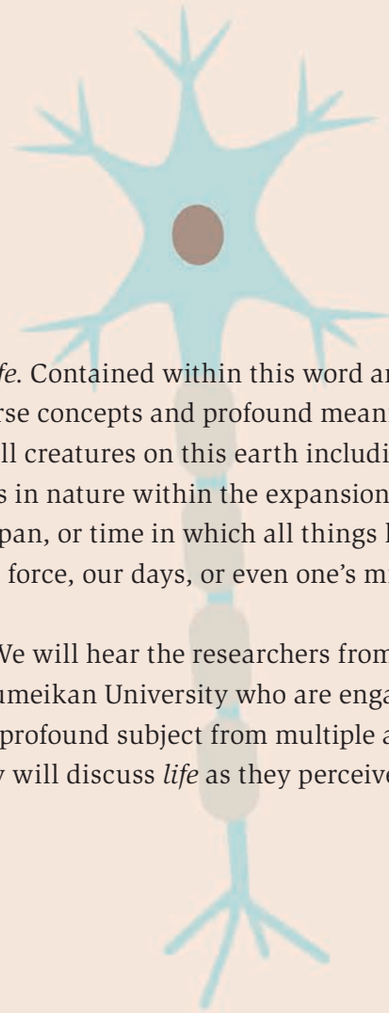
Professor,
Graduate School of Core Ethics and Frontier Sciences

Subject of Research: Study on the consumption culture of present-day Africa as seen in circulation/consumption of used/non-regular goods, dynamics of brinkmanship, anthropology of practice/act, and anthropology of a hand-to-mouth life

Research Keywords: Area studies, cultural anthropology

FEATURE #02

Life



Life. Contained within this word are
diverse concepts and profound meanings:
the lives of all creatures on this earth including humans,
or perhaps in nature within the expansion of space,
lifespan, or time in which all things live;
the life force, our days, or even one's mission.

We will hear the researchers from
Ritsumeikan University who are engaged
in this profound subject from multiple angles;
they will discuss *life* as they perceive it.

Understanding the Experience and Methods of those living with *Disabilities*, *Aging*, *Diseases*, and *Differences*

There is a field of research called *Ars Vivendi*, which comprises the study of *life and living*. What we have sought subconsciously throughout our lives may have taken shape into this form as an area of academic study. In this article, we will explore what *Ars Vivendi* is and focus on the researchers at the Institute of *Ars Vivendi* at Ritsumeikan University (which is the generating hub of the field) and their fascinating research.

"All people coexist with *disabilities*, *aging*, *diseases,* and *differences.* Although we have individual experiences regarding disabilities, aging, illnesses, and sexual identities, these are things that we all face in life, somehow. Nevertheless, until recently, there has been no substantial research or accumulation of information that addresses such issues from the perspective of those who experience them. To understand how people with diseases or disabilities have lived and are currently living their lives, and to consider how their future could be – this is what *Ars Vivendi* is about."

Under these definitions, the Research Center for Ars Vivendi (currently the Institute of Ars Vivendi) was established in 2007 at Ritsumeikan University as the point of origin and hub for promotion of this new field of research. The experience and knowledge of people from a variety of fields are accumulated in this institute to carry out interdisciplinary and collaborative research that addresses and studies a wide range of issues concerning *Ars Vivendi*.

The term *Ars Vivendi* is the Latin translation of the book title *Sei no Gihou* (The Art of Life), which was co-authored and published in 1990 by Shinya Tateiwa, director of the Institute. Since the 1980s, Tateiwa has been researching about people who are severely and systemically disabled and who have left

What is the difference between *disease* and *disability*?

their birth homes or institutional facilities to pursue independent living, which led him to co-author this book.

Tateiwa says, “For example, we tend to say ‘mental diseases’ or ‘psychosocial disabilities.’ Despite this, how do diseases or illnesses differ from disabilities, or how do they overlap? Then, there are those who suffer from illnesses or disabilities and wish to be cured as soon as possible, while others may feel that they are fine as they are for the time being. When we *heal*, what should be healing? Laying out these issues and considering these *boundaries* is how we approach things in the study of *Ars Vivendi*.”

Tateiwa gives five conditions in which we can distinguish between illnesses and disabilities. An *illness* consists of (1) pain and suffering, and, (2) in certain cases, it can lead to death. On the other hand, a disability manifests itself as (3) the inability to do something, (4) and how the forms, actions, and the way of life differ; (5) there are also discussions concerning harming others. These can manifest together, and at times, multiple conditions exist and overlap simultaneously.

He says, “While we all wish to treat ailments and alleviate pain or wish to avoid death in the case of disabilities, the things that one may *not be able to do* on his or her own could perhaps be sufficiently cared for by others. Rather than trying to fix the disability, it may be even more important to change society in order to support this individual. I think this can help those suffering from these conditions and those who help them *living their lives* to consider the meaning, as well as the advantages and the disadvantages, of *ailments* and *disabilities*.”

Kasumi Ito also acknowledges that the psychiatric treatments and hospitals deemed necessary to treat and heal such ailments are not necessarily meeting the needs and desires of the concerned parties. Her doubts about this reality led her to study the global grassroots movements by those who have psychosocial disabilities.

“There is a global organization of people with psychosocial disabilities that has approximately 70 organizations around the world connected through their network, and my area of research spans the process through which these organizations have emerged into the current reality in each of these nations,” Ito states.

In the summer of 2018, she visited the organizations in Britain, the Netherlands, Germany, Sweden, and Denmark that played leading roles in the global organization, as well as conducted an interview survey on the process of establishment with those who either founded the organization and/or were involved in early operation. Following this, in Taiwan, she studied an organization of people who are sexual minorities and also have psychosocial disabilities. She reveals the reality that such people face when being excluded from organizations, as well as of others who may be involved with one or the other of these aspects for having both of them.

She says, “As each organization has its

Shinya Tateiwa (Left)

Professor, Graduate School of Core Ethics and Frontier Sciences Director of Institute of Ars Vivendi, Ritsumeikan University

Research Themes: Ownership Theory, the History and the Logic of the Physical Body and Society

Fields of Specialty: Sociology (+Ars Vivendi?&Disability Studies△)

Kasumi Ito (Right)

Master’s degree program, Graduate School of Core Ethics and Frontier Sciences

Research Theme: A study on the global grassroots movement of the people with psychosocial disabilities

Research and experience.
A hub is needed to archive the acquired knowledge.

own origin and purposes and carries its own issues, I want to find out how these different international organizations for people with psychosocial disabilities find their common aim and how they could cooperate with each other."

In addition to young researchers such as Ito, a diverse group of researchers and scientists of different ages, experiences, and academic fields gather at the Institute of Ars Vivendi. Their specialties are indeed varied: they are philosophers, anthropologists, economists, sociologists, literary scholars, psychologists, ecologists, and researchers who study interpersonal aid, medical policies, bioethics, and history of science.

This Institute functions not only as a platform for researchers in different fields whose studies revolve around the axis of *Ars Vivendi*, but also as a place to store and archive the acquired knowledge. It has over 40,000 *Ars Vivendi*-related items ranging from books, magazines, newsletters, and other literature and materials; this collection includes but is not limited to records, testimonies, and handwritten notes by the concerned parties that are stored in an accessible and searchable manner and its information are made available online. Tateiwa says, "Collecting books and information and making them available to those who need them broadens research and understanding. I consider maintaining an archive in a permanent location such as this university as a crucial responsibility of this Institute."

With the Institute of Ars Vivendi at Ritsumeikan University at the heart and center, Tateiwa and others strive "to envisage the various ways in which all people could live, pointing to a way in which an ideal society and world could be realized."

Institute of Ars Vivendi, Ritsumeikan University

The Institute of Ars Vivendi at Ritsumeikan University was founded in April 2019 based on its former entity, the Research Center for Ars Vivendi.
The foundation of the current Institute was originally laid when the *Ars Vivendi* Program was acknowledged as a new field of study and adopted as a Global COE (Center of Excellence) by the Ministry of Education, Culture, Sports, Science and Technology in the 2007 academic year. As a five-year program, *Ars Vivendi* was supported by the Graduate School of Core Ethics and Frontier Sciences and the Institute of Human Sciences through an interagency collaboration between faculty members, graduate students, and researchers over various research and educational activities. Since then, based on the achievements and experience of these collaborators, the program has become a core research hub in Japan that envisages, proposes, and practices *Ars Vivendi* while developing it. Furthermore, by strengthening ties of collaboration with researchers from abroad, the Institute aims to become a global hub in which intercommunication on *Ars Vivendi* can take place, both in Japan and overseas.

Institute of Ars Vivendi, Ritsumeikan University
www.ritsumei-arsvi.org/en/

Institute of Ars Vivendi, Ritsumeikan University (Resource Page)
www.arsvi.com/a/

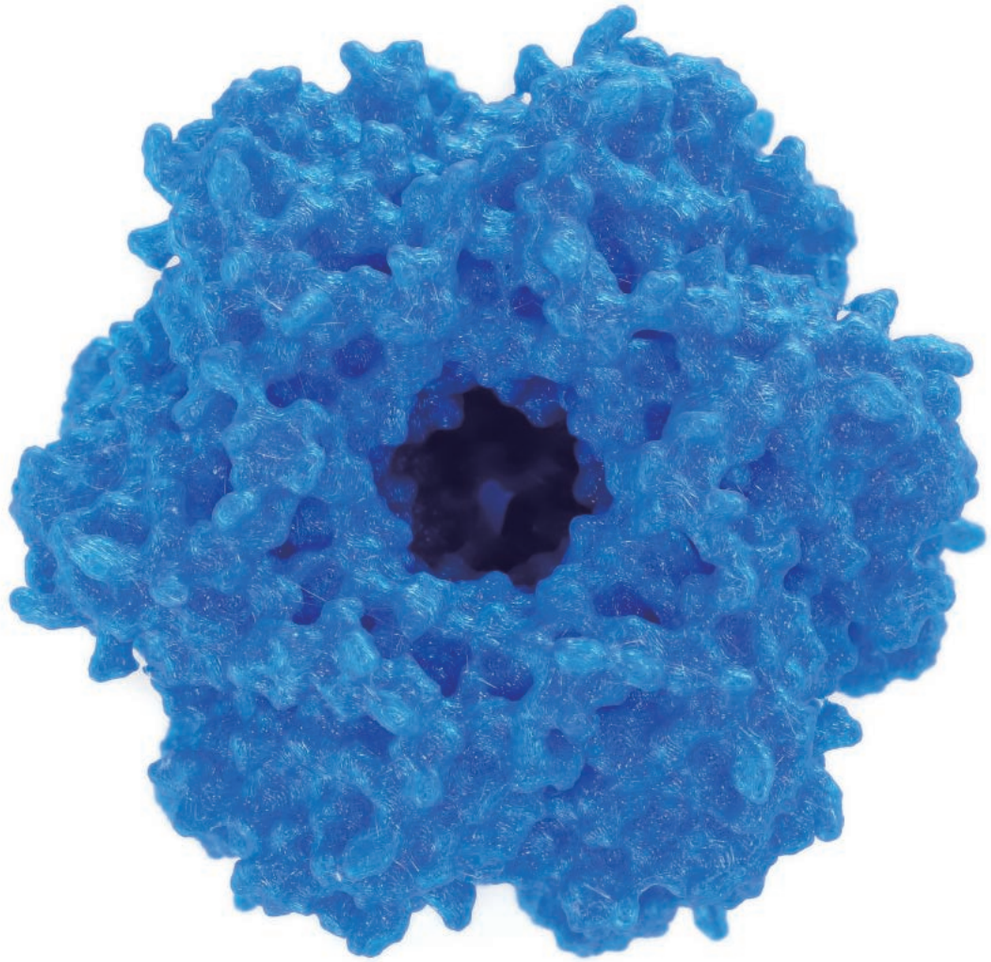
The Circadian Clock:
Unraveling the Mystery of what is responsible for Life Activities

Kazuki Terauchi

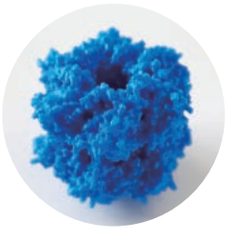
Professor, College of Life Sciences

Research Theme: Circadian clock and cyanobacterial physiology

Fields of Specialty: Functional biochemistry; Plant molecular physiology



A model of KaiC molecule in cyanobacterial cells. This clock-like shape has surprised researchers all over the world.

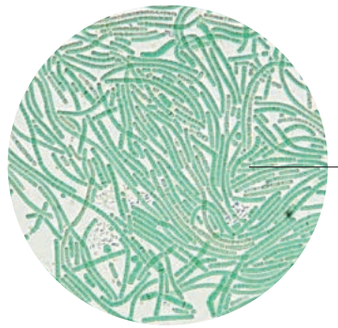


Almost all organisms living on Earth follow a 24-hour cycle. People get sleepy at night and wake up naturally when the morning comes, even when it is still dark. This is quite strange if you think about it. Why do organisms recognize days and nights and understand the 24-hour cycle?

The answer lies in the *clock* that is inside all organisms.

"Life has within its cells a *circadian clock*, and many of the biological activities, such as gene expression and physiological responses, are based on a 24-hour cycle or, in other words, follow the rhythm of the circadian oscillation," explained Kazuki Terauchi. She is among the people who are drawn by the mystery of this circadian clock in organisms. She is trying to discover the mechanism of the circadian clock by using cyanobacteria—a bacterium considered the simplest of living creatures that have the qualities of this circadian clock.

"The cyanobacterium is the oldest of the photosynthetic prokaryotic organisms, inhabiting the Earth for approximately three billion years. They were first observed to have a circadian rhythm in 1986. As research progressed, by 1993, it was proven that even the simplest of organisms, such as bacteria, also possessed circadian clocks. Furthermore, in 1998, three genes that produce proteins that regulate this clock were found in cyanobacterial cells." These genes have been named KaiA, KaiB, and KaiC by the Japanese researchers who discovered them, from the term *Kaiten,* which means "to go around." Furthermore, what was shocking in the study of this circadian clock was that, in 2005, it became possible to reconstruct this circadian clock *in vitro* using KaiA, KaiB, and KaiC. "While the genes that constitute the proteins that play a role in the circadian clock have been identified in organisms such as drosophila, it was only with cyanobacteria that we were able to reproduce the circadian rhythm of proteins *in vitro*. With this, the research on circadian clocks has made a giant leap," says Terauchi.



It is believed that cyanobacteria, the oldest among photosynthetic microorganisms, have existed on Earth for approximately three billion years.

Of the three clock proteins, KaiC has an overlapping structure with two hexamers with ATPase having phosphorylation sites. As a result of the capacity to reproduce the clock protein activities *in vitro*, it was discovered that KaiC hydrolyzes ATP, takes in a phosphate group (phosphorylation), and releases them (dephosphorylation), creating a repetitive 24-hour rhythm, revealing that KaiA and KaiB were assisting the KaiC function. "However, it is inconceivable under any other circumstances that chemicals go through reactions in a 24-hour cycle without any external stimulation." Terauchi is trying to unravel the mystery of this circadian clock and get to the heart of its mechanism.

So far, as a research result, Terauchi has found that the circadian clock of cyanobacteria is determined by KaiC's ATP hydrolyzation. "Of the three clock proteins, KaiC, which is the central oscillator, uses the energy provided by the ATP hydrolysis to maintain its circadian cycle. However, since the energy the protein clock uses is extremely minute, it has not been known for a long time that ATP hydrolysis is its energy source."

Therefore, Terauchi produced KaiC mutants with shorter and longer periods of oscillation rhythms compared to that of the 24-hour cycle and conducted experiments to compare them with the original KaiC's ATP hydrolysis of cyanobacteria. "As a result, I discovered and confirmed that the frequencies, which were reciprocal of the period, were directly proportional to the ATPase activities." This meant that the speed at which KaiC hydrolyzes ATP determines the 24-hour period. This made it evident that the foundation of the circadian rhythm timing generator is in the ATPase activity.

"In addition, circadian clock exhibit *temperature-compensation* characteristics, which means that, regardless of the temperature surrounding the cells being higher or lower, the 24-hour cycle would hardly be affected. In addition, another characteristic feature is seen in the entrainment phenomenon, which is its ability to synchronize with its surrounding circadian rhythm. When you go to foreign countries and your days and nights switch around, you temporarily experience *jet lag* due to changes in time. However, you would eventually adapt to the environment, and the circadian clock would reset to its local time. This is the entrainment phenomenon. I would also like to be able to discover the mechanism behind this unique characteristic of the circadian clock," says Terauchi.

ATPase determines the 24-hour cycle of the circadian clock.

At the same time, she is also trying to discover why primitive organisms such as cyanobacteria have begun to compromise this 24-hours cycle, which is the Earth's rotation cycle, in the cell's memory. "I believe it developed the circadian clock to match the Earth's rotation so that it could efficiently carry out photosynthesis, which is essential for the survival of life. However, there are still no scientific answers," she says. A study that is approaching this answer comprises an experiment in which changes occurring in cyanobacterial cells according to the light environment were investigated. The results obtained suggest that light intensity is related to the length of the circadian clock cycle.

Research to reveal the secrets behind the mystery of the "24-hour memory" in living organisms that have existed from ancient times to the present day will lead to a better understanding of life, including that of humans.

Creating a new Chemical Synthesis that can reform our Lives and Medical Fields

Today, our lives are surrounded by a myriad of chemical products. Organic synthetic chemistry is one of the basic technological fields that make their creation possible, and the synthesis of new compounds is indispensable in the development of pharmaceuticals, electronic products, and functional materials. Among the various methods available, *cross-coupling reaction* has often been used to synthesize new compounds. As you may see from the fact that the 2010 Nobel Prize in Chemistry was awarded jointly to Drs. Ei-ichi Negishi, Akira Suzuki, and Richard F. Heck, who developed the *cross-coupling reaction*, this reaction has been vital technology for the humankind.

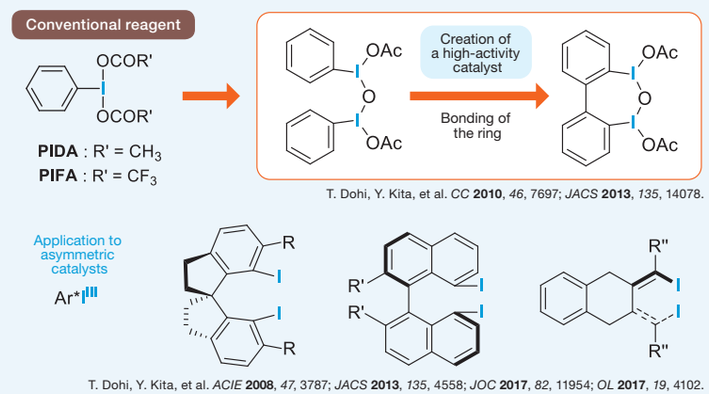
Cross-coupling is a chemical reaction that allows two organic molecules with different structures to connect. What was so revolutionary about this reaction method was that, by using the transition metal as a catalyst, it became possible to connect low reactive and hard to be functionalized carbon atoms together. However, this reaction method presents issues to this day, which leads researchers from all over the world to develop new ways of inducing a coupling reaction. Toshifumi Dohi is one of them.

He says that “one of the issues surrounding the conventional cross-coupling method is that it requires expensive rare-metals, such as palladium, as a catalyst. In addition, to connect carbon atoms with low reactivity, we use activated substrates that have pre-installed functional groups, such as halogen or metallic elements already implemented. For this reason, the functionalization reaction process takes a long time and, after the reaction, unwanted metal salts are generated, which is not ideal neither economically nor environmentally.”

In 2008, Professor Yasuyuki Kita, who was the Dean of the College of Pharmaceutical Sciences at the time, had already made some waves when he announced the successful formation of carbon-carbon bond through the use of oxidative cross-coupling reaction, in which hypervalent iodine served as the catalyst instead of the conventional transition metal catalyst.

Dohi, who was one of the members of this research group, designed a new hypervalent iodine catalyst that presents not only higher reactivity but also better selectivity against aromatic rings. Through this method of

Design of the hypervalent iodine catalyst



The World's first successful Catalysis of Metal-Free Oxidative Cross-Coupling using Iodine

oxidative cross-coupling, in which substrates without functional groups can connect directly with each other, the practicability of the process has improved dramatically. For example, since a hypervalent iodine catalyst can convert C-H bond into an aromatic ring without introducing a functional group, the reaction can take place in just a single process. In addition, side reactions such as excess oxidation are prevented, and unnecessary metallic salts are also not generated. What Dohi developed was a revolutionary catalyst that solves all the issues surrounding the conventional method. "In addition to this, iodine is one of the few resources that Japan, a country known for its limited resources, has one the largest production in the world. Hypervalent iodine reaction is an environmentally friendly green chemistry. This is an extremely powerful resource for the development of Japan's chemical industry.

Currently, Dohi is also working on applied research based on his development achievements. Expanding this application to the pharmaceutical field is one of them. Kotaro Kikushima, who conducts his research along with Dohi, is working on the application of this method in the synthesis of fluorine-containing organic compounds. Kikushima explains: "Pharmaceuticals containing fluorine atoms not only have high metabolic stability and gradually break down within the body, but are also currently contained in approximately a quarter of all pharmaceuticals because of its advantage of having high solubility in lipids. Thus, the implementation of fluorine atoms in the drug design process is of strategic importance."

In the past, when synthesizing fluorine-containing organic compounds, for example, a method combining the trifluoromethylation agent and transition metal catalyst has been developed. However, the issues remained because the reaction process is long, costly, and generates unnecessary metal salts. Kikushima believes that it is possible to solve these issues by applying an oxidative cross-coupling reaction using the hypervalent iodine catalyst.

"Fluorine atoms are widely used not only in pharmaceuticals, but also in agrochemicals, functional materials such as Teflon coatings, and as surface processing materials for touch screen panels. The development of a safe, cost-effective, and environmentally friendly coupling method is bound to make a tremendous contribution to the production of industrial materials," he says.

Furthermore, using hypervalent iodine, Dohi is now venturing into uncharted territory, where he is trying to develop a new synthetic method for nanocompounds.

To synthesize nanomolecules (10^{-9} to 10^{-8}m), the typical method would be to connect low molecules of smaller size repeatedly. However, since this would make the reaction process long, it could hardly be considered an efficient method of synthesizing. Therefore, Dohi is now attempting an entirely novel method to synthesize useful nanomolecules, which consists of selectively dissecting the covalent bonds of 10^{-7} to 10^{-6} m polymers in height. "As part of this attempt, I am working on the synthesis of aromatic compounds using lignin as the raw material. Lignin is a high polymer compound that constitutes the cell walls of the wood and its bark, and its structure contains many aromatic rings." Dohi is seeking after a method to dissect only the strong covalent bonds between carbon atoms and oxygen atoms in the lignin polymer in order to extract only the useful aromatic compounds. "So far," he says, "I have succeeded in severing the bonds between carbon atoms and oxygen atoms to synthesize useful organic compounds using hypervalent iodine oxidizing agent in room temperature water. I believe this method can be applied because lignin is also water-soluble."

Dohi says, "I would like to develop synthetic methods for the creation of nanomolecules using both methods, one that can be achieved through the cleavage of the bonds between the atoms of such polymers, and another that would be to use the traditional method of forming bonds between low molecules." Through this new synthesizing technology, an organic compound capable of bringing great innovation to the future society can arise.

Toshifumi Dohi (Left)

Professor, College of Pharmaceutical Sciences

Research Theme: Research on the generation of pharmaceutical and functional materials based on sustainable methods of organic synthesis

Fields of Specialty: Synthetic organic chemistry, Catalyst/Resource chemical processes, Functional material chemistry (Chemistry-based pharmaceutical science)

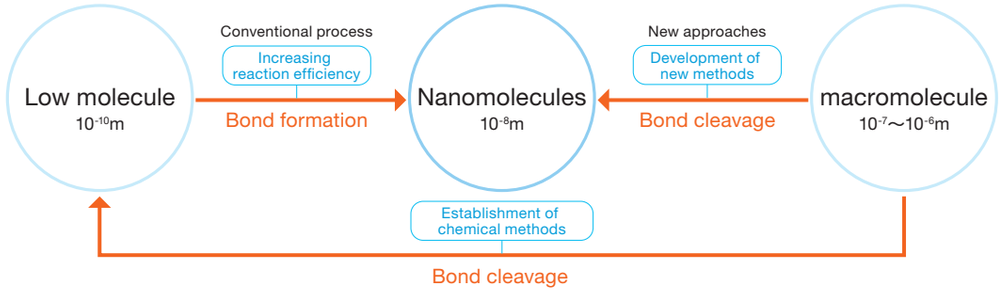
Kotaro Kikushima (Right)

Assistant Professor, College of Pharmaceutical Sciences

Research Theme: Development of a new synthetic method for fluorine-containing organic compounds

Fields of Specialty: Synthetic organic chemistry, Green sustainable chemistry, Functional organic chemistry

Increasing the molecular size in organic synthesis



Technology changes what it means to *Live*

The development of science and technology is about to change even the meanings of *illness* and *life.*

From technologies such as functional MRI and those surrounding brainwaves, clinical methods of scanning brain activities have been developed. For example, it has been reported that Yes or No answers present only in the minds of those who have become bedridden due to ALS (amyotrophic lateral sclerosis) are now being captured. This research spread into other areas, and it was discovered that there are some cases where those who were considered to be in a vegetative state and without any consciousness were actually awake and able to engage in cognitive activities.

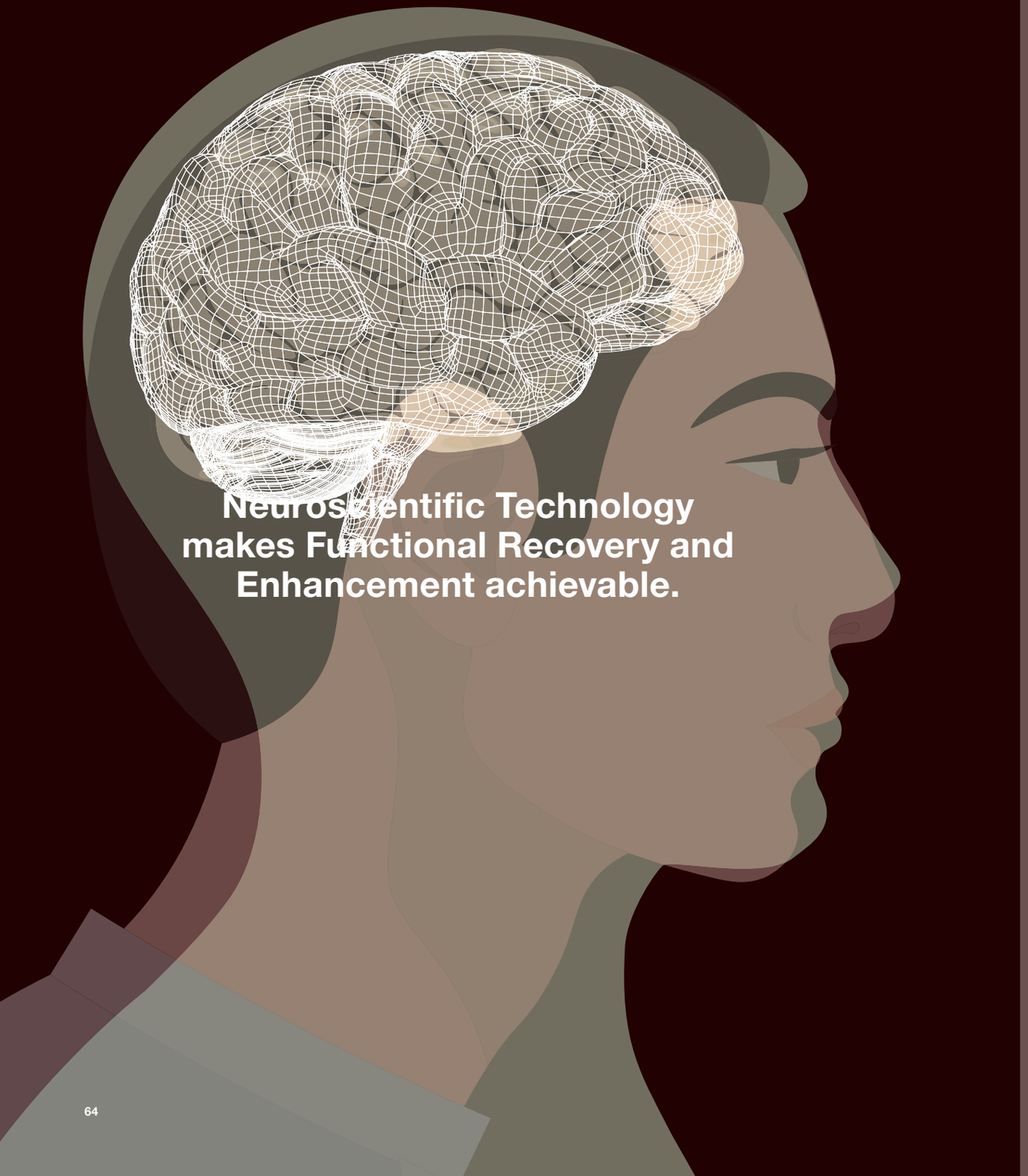
"One feels much fear and despair when trapped in an immobilized body and not being noticed by others. If we are able to communicate with them again, not only would this bring hope to the patients, but also to those around them," said Tatsuya Mima, who has long been involved in measuring human brain activity as a neurologist. Communicating with those who are in a vegetative state would greatly change the meaning of life for them and would provide more lifestyle options for both the individual in this condition and those around him or her. "With the assistance of this technology and machines, perhaps they would eventually gain control over their bodies. However, it is not possible to fundamentally heal such an intractable disease. There is a limit to what technology can do." Mima, the author of these words, is in pursuit of such technology from the angle of clinical medicine while adopting a medical and sociological approach based on his interest in the *thoughts and feelings* as well as the *way of life* of those with illnesses or disabilities.

As a specialist in neurology, Mima focuses his attention on the neural *reorganization.* "Human cells are all differentiated into various organs and tissues from a very early age; thus, if a part of one's stomach is resected because of cancer, the stomach will be lost forever. In contrast, the brain function has plasticity, allowing it to recover even if it has been injured," said Mima. When one part of

Tatsuya Mima

Professor, Graduate School of Core Ethics and Frontier Sciences

Research Themes: Brain Death and Organ Transplants, Sociology of Mental Illness, Brain Plasticity.
Fields of Specialty: Medical Sociology, General Neurophysiology and Neuroscience, Neurology



Neuroscientific Technology makes Functional Recovery and Enhancement achievable.

the brain is damaged, neurons from another part change their form and functionality to replace the functions of the damaged areas. This phenomenon is called *reorganization*. Mima is trying to improve this capability and use it in such a way that those who have had remaining paralysis in their limbs after a stroke, for example, can regain their lost functions.

"One of the methods that are getting some attention in recent years is *transcranial direct current stimulation*," Mima explains. The idea is to apply electrodes to the scalp and apply a direct current of approximately 2mA to the brain to help the reorganization of neurons. Some researches reported that patients who had hemiplegia after stroke could achieve the same level of recovery as the intensive rehabilitation when direct current is applied through the skull to stimulate the part of the cerebral cortex that governs the movement of the arm.

However, this revolutionary technology is starting to have a ripple effect on areas that were not its initial target. "Some people have begun to wonder what would happen if we used this technology on healthy people," says Mima. There are currently several studies on *enhancements*, which consist of applying electrical stimulation to the brains of healthy people to control their emotions or physical capabilities, and now findings are being continually reported, such as the discovery that the application of electrical current in the frontal lobe enhances memory, or that the application of electrical stimulation to the hippocampus has the effect of suppressing fear. "Furthermore, as reported cases indicate that the application of this method to athletes is enhancing their records, some are beginning to question this practice by pointing out that it may be a form of doping. Advancement in technology also brings new issues that involve medical ethics and bioethics," Mima states.

Although there is no doubt that the pursuit of science and technology can save those who suffer from ailments, there are still many issues that cannot be solved simply through technology. For this reason, Mima has made the Institute of *Ars Vivendi* his research hub and is trying to understand not only neurology but also diseases and disabilities from various angles, all stemming from one question, "what does it mean to live a life?" As part of this quest, he is interested in understanding how those who have diseases or disabilities "find meaning to their conditions."

Mima says that "stroke patients with speech disabilities tend to avoid words they find difficult to pronounce and, instead of using words to respond, they nod to express their thoughts as a way of hiding their disabilities and making their social lives smoother. Such actions are not limited to those with diseases; for example, foreigners living in Japan who are linguistic minorities do the same thing." For him, it is important to understand the various minorities in our society in terms of their experiences and meanings they give to the world, as he believes that this would shed a different light on what is considered *righteousness* or *common sense* that the social majority tends to unconsciously shape.

At the Institute of *Ars Vivendi*, researchers and graduate students collaborate across their respective organizations and conduct a variety of research and education initiatives around the *Ars Vivendi* axis. For the future, we can expect Mima's research to expand further as we see the fusion of insights and knowledge gained in different fields occur.

FEATURE #03

Kyoto

Kyoto, which was formed over a thousand years ago, has continued to attract attention as the place where modern and traditional cultures merge. The Japanese government acknowledged its appeal as a center for the dissemination of the cultural power of Japan and decided to have the Agency for Cultural Affairs relocated to Kyoto by FY2021.

Researchers at Ritsumeikan University—which has campuses in three prefectures: Kyoto, Shiga, and Osaka—are studying, from various perspectives, what Kyoto has inherited over the generations, such as its historical arts and traditional industries, cultural assets, and the ways in which previous generations lived. Through these studies, these researchers are working towards discovering fascinating and new aspects of Kyoto as well as contributing toward furthering its development by making full use of state-of-the-art technologies and by interacting with local residents.

"Koto Gion sairei Shijogawara no suzumi"
(Cooling off at the Shijogawara during the Gion Festival in the Imperial Capital)
Utagawa Sadahide, 1859, ARC Collection: arcUP2544, arcUP2545, arcUP2546.
This triptych depicts Kyoto at the end of the Edo Period. The central print depicts a bustle of people enjoying teahouses and the shows put up on the dry riverbed of the Kamo River on the night of the Gion Festival. Beyond the Shijo-Ohashi Bridge, one can see Mounts Hiei and Daimonji. In the south is Mount Inari, and in the north, one can see as far as Ohara.

Tracing the Footprints of Printing Blocks to Discover the Publishing Industry of the Edo Period

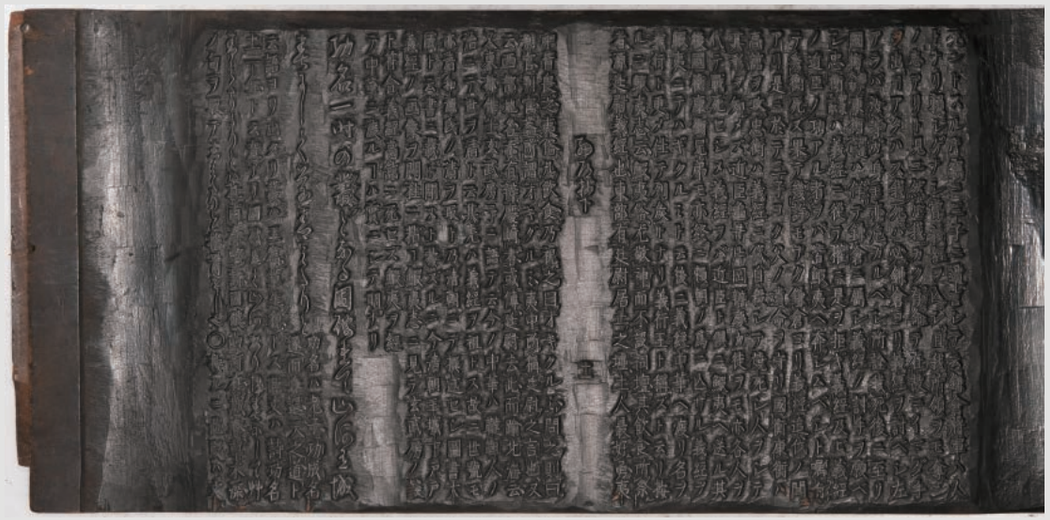
Takaaki Kaneko

Associate Professor,
Kinugasa Research Organization

Subject of Research: bibliography of woodblock-printed books and study on publication in early modern times with woodblocks as basic materials

Research Keywords: modern history of publishing, *hanpon* (Japanese woodblock print books), bibliography of *hanpon*, digital archive

Oku no Hosomichi Sugagomoshō (1778, ARC Collection, arcBK02-0256).
Parts posted are the cover of the last volume, namely, the back-side of page 11 and the front-side of page 12, the two facing pages of the last volume.



The same *hangi* (ARC collection, arcMD01-0714, partial, mirror image); the part posted is from page 11.

The invention of printing technology dramatically changed the amount and spread of information transmission. What is known as the oldest printed material in Japan is the 8th century *Hyakumantō Darani* (“One Million Pagodas and Dharani Prayers”). It is the oldest printed material in the world as an object with a verified production period.

What was mainstream in Japan until the Edo Period was no means of movable types printing but woodblock printing, which consisted of carving letters and illustrations on a wooden block (*hangi*), put the black ink (*sumi*) on it, and then placed paper on top of a block, printing it onto paper by rubbing. “Thanks to woodblock printing, which made possible the printing of a large number of repetitions, publishing became commercially viable, and the publishing industry expanded instantly. It can be said that cultural matters in the Edo Period, such as thought, religion, academic studies, and entertainment, as well as literature, could not be described without the *hanpon* (books printed from woodblocks) made by woodblock printing. The majority of *ukiyo-e* (prints or painting which reflect the popular culture in the Edo Period) that Japan boasts to the world are multicolor prints using woodblocks.” Takaaki Kaneko, who said this, is an unusual researcher who focuses not only on *hanpon* itself but also on *hangi* for printing.

“*Hanpon* bibliography and study on publishing, which focused on physical ‘things,’ are indispensable for research on early modern art and literature. Nevertheless, there is definitely a lack of information about *hangi*, which have

Picture by Toyokuni III, *Nijūshi-kō imayō bijin chanoe zuki*
("Twenty-four Enjoyments of Beauties of the Present Day, Fond of Tea Ceremony")
(1863, ARC collection, arcUP6633)

The same *hangi*
(ARC collection, arcMD01-0657, mirror image)

Digital Archives Preserving Japanese Art and Culture and Making Best Use of It

a prominent part of it," Kaneko said. One of the reasons is the difficulty in handling *hangi* materials. They are not widely used for research because the original number of *hangi* is overwhelmingly lesser compared with *hanpon*, and there are almost no reproduced materials. Kaneko is trying to solve this problem by using digital archives.

"[Between] Edo (Tokyo) and Kamigata (Osaka and Kyoto), which were the center of the publishing industry during the Edo Period, Kyoto, which escaped fatal damage from earthquakes and wars, is the only one where many *hangi* still exist. One cannot expect to enhance the archive without the location of Kyoto." Kaneko, who said this, digitalized about 5,800 *hangi* materials managed by Nara University as part of an ARC project and released the digital archives on a website.

Lighting is crucial in digitalizing *hangi* with a surface covered with *sumi*. After three digitization trials, Kaneko and others adopted a bird's eye imaging method using a digital single-lens reflex camera. In addition to shooting with flash from the front of the photographic subject, they captured the three-dimensional unevenness of the surface of the *hangi* from four directions using oblique lighting. They took a total of 20 cut images per *hangi*. After building an archive of images totaling 90,000 cuts, they are currently promoting the digital preservation of *hangi* owned by publishing houses that used woodblock printing in Kyoto from the old times, such as Hōzōkan and Unsōde.

"A trace of the thought of publishing houses and craftsmen appear on *hangi*, from which the existence of the early modern publishing industry has come to be understood to a great extent." Kaneko discussed the necessity of research on *hangi*. For example, it has been known for a long time that *ireki* (wood piece inlay) was put on woodblocks when it was necessary to modify the content of the *hanpon*. *Ireki* is a technique of carving out parts of a character that should be modified and incorporating the newly carved piece. Even in the bibliography for *hanpon*, *ireki* has long been regarded as a technique for making corrections, but research by Kaneko reveals that this is a misunderstanding. Kaneko said, "It turned out that *ireki* was not necessarily carried out only for corrections; it was also used in situations such as when there were wood knots on the board and it was difficult to carve it, such knots were removed and replaced with *ireki* in advance; or in case of difficult characters and *kunten* (guiding marks for rendering Chinese into Japanese)." Such things cannot be understood only by looking at the *hanpon*. Facts that overthrow the common knowledge of the bibliography have been revealed by examining the *hangi* in detail.

ARC possesses the *hangi* for *Oku no Hosomichi Sugagomoshō*, which is the oldest one that published as an annotated edition of *Oku no Hosomichi* ("The Narrow Road to the Interior") by Matsuo Bashō. Kaneko comprehensively examined this *hangi, hanpon*, and also the records of publishing, and subsequently revealed the history concerning the publishing, which had not been clarified in previous research, along with facts on commercial publication in the Edo Period.

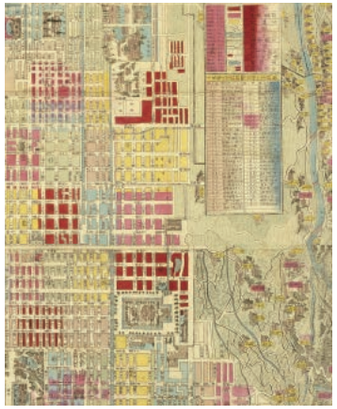
There are publishing records showing that profits were distributed by the ownership ratio of sharing the *hangi*, when conducting a joint publication. The *hangi* used were divided for safekeeping so that the counterpart publisher could not reprint without permission. In another case, *hangi* was taken as hostage, so to speak, by the holder of the publication rights, so that the book could not be completed without the participation of that person. By following the footprints of *hangi*, it is possible to see the several-fold information obtained from *hanpon*, such as the process of printing *hanpon*, who owned the *hangi*, to whom the *hangi* were sold, and how publication rights were transferred. Researchers are extremely few compared with the attractiveness of the research on *hangi*. Kaneko hopes that "the digital archive of ARC will spread research on *hangi*."

Art Research Center, Ritsumeikan University

www.arc.ritsumei.ac.jp/en/

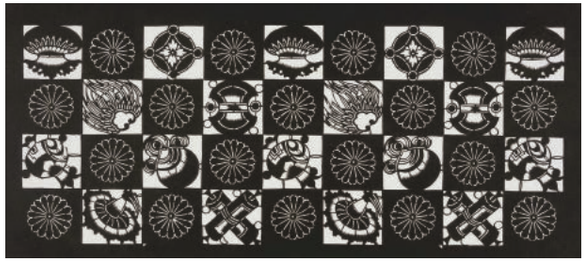
The Art Research Center (ARC) of Ritsumeikan University was established in 1998, whose mission has been not only to conduct historical and social research and analyses of both tangible and intangible cultural properties such as visual and performing arts and craftsmanship, but also to record, organize, preserve and disseminate the research outcomes. The vast digital archives of Japanese culture and art such as *ukiyo-e* and early Japanese books, accumulated since its establishment, has become essential research resource for scholars of Japanese culture both in and outside of Japan. At the ARC, we also focus on promoting advanced research and education in diverse fields through collaboration and integration of the humanities and information sciences, while promoting international collaboration as a representative center for digital humanities in Japan, as well as developing young researchers.

Print artist: Hasegawa Sadanobu, "Jitsukawa Enzaburo as Ashikaga Yoshinori," and "Mimasu Gennosuke as Yuki no sho," (1841, ARC Collection, arcBK01-0038_02)



Hashimoto Chogetsu, ed., "Detailed District Division Map of Kyoto Prefecture," (1879, ARC Collection, arcBK03-0116)

Author: Kyokutei Bakin; and print artist: Teisai Hokuba, *Eiyu gafu* ("Illustrated Book of Heroes"), (1838, ARC Collection, arcBK02-0165)



Paper stencils mainly used for dyeing fabrics, with patterns such as *komon*, *yukata* and *yuzen* (ARC Collection, arcKG00122)

The Potential for New Kimono Businesses in Kyoto

Very few people in contemporary Japan still wear a kimono every day. Nevertheless, a researcher at Ritsumeikan University, Mari Yoshida, has investigated the potential for new business models for Kyoto's allegedly outmoded kimono industry. Yoshida is interested in corporate innovation and value creation for customers, and has been exploring the "value of the kimono from the consumer perspective," an approach that has not yet been adopted within the kimono industry.

In examining the reasons for the decreased size of the kimono market, Yoshida notes that, to begin with, there is a common misunderstanding. While many kimono-related businesses believe that consumers' loss of interest in kimonos is related to the clothing being incompatible with modern lifestyles, she found that this trend was already evident in the latter half of the 1970s. Kimono production peaked during Japan's period of high economic growth, but then decreased rapidly in the 1970s. However, manufacturers' prices of kimonos continued to increase, despite the drop in production, until the collapse of Japan's asset price bubble economy in the early 1990s. According to Yoshida, what is notable is that, with the downturn in production, kimono-related businesses began to base their business models on the sale of "high-end/high-value-added" merchandise. She explains that such models were successful principally because both production and distribution were centered in Kyoto.

Kyoto had established the necessary brand power on which the production of high-value-added merchandise could be based, and was home to the techniques and production systems used for *Kyo-Yuzen* dyeing and *Nishijin* textiles. In addition, Kyoto's Muromachi district, with its experts in wholesale and retail sales, was the center

Homongi (semi-formal kimono for women), white silk with Ritsumeikan's "R" background pattern, and "Snow, Reeds and Mandarin Ducks" by Jakuchu Ito in Yuzen dyeing

Production/photography: ZONE Kimono Design Institute (Collection of the Art Research Center (ARC) of Ritsumeikan University); original painting: "Snow, Reeds, and Mandarin Ducks" by Jakuchu Ito, Etsuko & Joe Price Collection

Mari Yoshida

Associate Professor,
College of Business Administration

Subject of Research: value co-creation, market formation process analysis, effectuation (logic of entrepreneurial decision-making)
Research Keywords: marketing, strategy

In FY2013, the ARC, which conducts digital archiving of Kyo-Yuzen designs and research on actual conditions of Kyo-Yuzen, ordered and produced hand-painted Yuzen and stencil-printed Yuzen kimonos, and recorded the process using videos, photos, and interviews in order to investigate and record the current Kyo-Yuzen situation.

for trading in kimono-related products. The industry adopted a survival strategy of shifting from *Kyo-Yuzen* dyeing and *Nishijin* textile production to hand-painted dyeing on pure silk and lavish *obi* sash textiles, made with gold and silver thread. Owing to the price increases, kimonos came to be considered as formal attire for special occasions only, and were treated as "assets." In addition, prices rose even higher as a result of the industry's peculiarly complex modes of distribution.

Thus, a new business model developed, in which added-value was based on the perception that kimonos are "formal attire," which changed the structure of the industry. According to Yoshida, while the managerial ability within the Kyoto kimono industry deserves recognition, the condition of today's kimono market is the result of the collapse of the aforementioned business model. This collapse began when the asset price bubble burst, reducing the number of high-income earners who purchased kimonos.

In terms of why businesses have not yet been able to identify a strategy that could drive a recovery in the kimono market, in addition to their lack of understanding of the market, she notes that these businesses have not been able to identify the "value of kimonos for consumers." Without understanding consumers' needs, it is not possible to provide products that will sell. Thus, she conducted a survey research of today's kimono users and identified six factors related to consumers' opinions on the "appeal of kimonos" and the "value of kimonos." Then, she performed multiple regression analyses on variables related to these factors and consumer behavior. Her results show that the "value of a kimono" differs for *kimono wearers* (indicated by a high frequency of wearing kimonos) and *kimono buyers* (indicated by a high annual expenditure on kimonos), who purchased them for formal occasions.

Kimono wearers find value and enjoyment in relatively cheap antique or ready-to-wear kimonos, made from synthetic fabrics by mixing and matching colors and designs. In contrast, *kimono buyers* find value in the "sense of specialness" they obtain from ordering from a reputable kimono maker and choosing the materials and colors of the threads. Based on her analysis, Yoshida notes that businesses have not recognized these different types of consumers and, thus, are all competing for the same consumer market. She believes that the overall kimono market should grow if businesses recognize each consumer market and pay attention to each other's markets.

According to Yoshida, the main requirement for halting the decline of the kimono industry is a clear understanding of the different markets and consumers. As a successful example, she cites one of Kyoto's largest wholesale producers of dyed kimonos, Chiso Co., Ltd., which has been in business for more than 450 years. While high-end *Yuzen* kimono accounts for 90% of wholesale sales of Chiso, it opened its own retail store, called Sohya, in 2006. By selling merchandise at prices well below the usual Chiso prices, the company succeeded in reaching the *kimono wearer* market, who enjoy kimonos as fashion items. She believes that Chiso has been successful because it has been able to differentiate the value of kimonos for different customers, thus adapting flexibly to that market.

According to Yoshida, the key to reviving the kimono industry is actively marketing to different markets and customers, something that has been lacking in the industry to date. In this regard, she is of the opinion that solutions can be generated by combining Kyoto's location and craftsmanship. As an example, she cites a new entrant to the market that will be partnering with a maker of *Nishijin* textiles to identify a target market. She believes this is probably the "biggest and last chance for the kimono trade." In addition, demonstrating her enthusiasm for the topic, she says, "As a researcher, I'd like to contribute to the support and cultivation of entrepreneurs who will build new businesses that will inject momentum into the kimono trade."

Revisiting the Kyoto kimono industry's high-end/high-value-added survival strategy

Kijaku (a bolt of cloth necessary for making a kimono), silver gray silk with Ritsumeikan's "R" background pattern, and "Grapes" by Jakuchu Ito in stenciled *yuzen*

Production/photography: ZONE Kimono Design Institute (Collection of the Art Research Center (ARC) of Ritsumeikan University); original painting: "Grapes" by Jakuchu Ito, Etsuko & Joe Price Collection

Archiving photographs, picture maps, culture, and memories of *places*.

Digitally Archiving the *Space of Kyoto* Across Place and Time

Since the transfer of the capital to Heian-kyo, Kyoto still lives its over 1,200 years of history. If we could see the transition of Kyoto across time and space, from the past, present, and into the future, what kind of landscape will be reflected in our eyes?

Keiji Yano is working on making a *digital diorama* by digitally archiving *the space called Kyoto as a whole*, based on geospatial information, such as maps and picture maps. In *Virtual Kyoto*, which he first worked on in 2002, he tried to reconstruct the townscape of modern Kyoto in three dimensions on a computer, by using a Geographic Information System (GIS), which was state-of-the-art at the time, and Virtual Reality (VR) technology. “In addition to producing a 1:25000 scale three-dimensional topographic map using GIS software, I also added information obtained by measuring the heights of 400,000 buildings, and built a precise three-dimensional model of the urban

Virtual Kyoto
www.dmuchgis.com/virtual_kyoto/

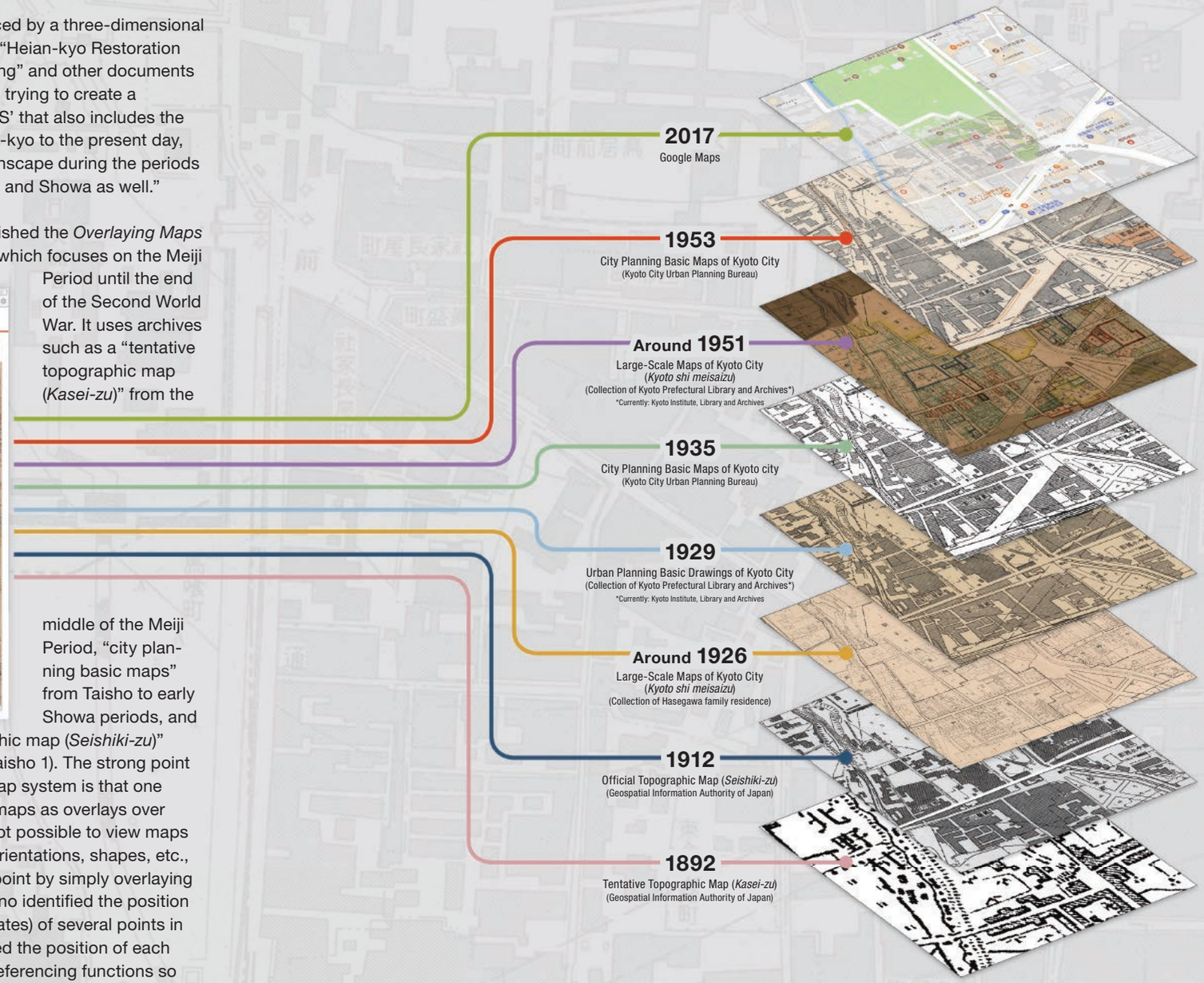
Kyoto is recreated in 3D on web browsers with databases, such as *Ukiyo-e*, *Rakuchu Rakugai-zu* (paintings and drawings both inside and outside the Kyo capital), and the photographic materials by Yutaka Kondo are embedded in it and, also, it is possible to go back and forth among the townscapes in the Heian Period, the Edo Period to the present day.

Please plug in after launching IE. The picture is a representation of the Virtual Kyoto function as an image, and it is partly different from the actual screen

area of modern Kyoto," Yano explained. *Virtual Kyoto* provides fly-through and walk-through functions. These functions allow one to change their vantage points from one instant to another. You can be viewing Kyoto from the sky with a birds-eye view at one moment, then in the next moment be walking along the Shijo-dori Street, looking around the interior of the Minami-za (the primary kabuki theater in Kyoto) or the *Kyo-machiyas* (traditional Kyoto wooden townhouses), and so on. The Google Earth service started only in 2005. It is amazing to think about what Yano was able to achieve a few years before that. "A new academic field named 'Digital Humanities' that combines human studies and information technology, which traditionally did not have anything in common has become popular around the world in recent years," Yano explained. *Virtual Kyoto* was precisely the forerunner in this.

"*Data with information on locations* are not limited to modern maps," says Yano. The creative aspect of Yano's research is that the Kyoto of various periods is represented three-dimensionally using old maps and historical picture maps. In *Virtual Heian-kyo*, based on information obtained from excavations and historical documents, the inside of the capital of Heian-kyo is represented using three-dimensional VR. Buildings, such as the *Rajomon* Gate and the *Daigokuden* (Council Hall in the Imperial Palace), are also realistically reproduced by a three-dimensional CG model using the "Heian-kyo Restoration Model Design Drawing" and other documents as a reference. "I am trying to create a 'four-dimensional GIS' that also includes the time axis from Heian-kyo to the present day, reproducing the townscape during the periods of Edo, Meiji, Taisho, and Showa as well."

In 2016, Yano published the *Overlaying Maps of Modern Kyoto*, which focuses on the Meiji Period until the end of the Second World War. It uses archives such as a "tentative topographic map (*Kasei-zu*)" from the middle of the Meiji Period, "city planning basic maps" from Taisho to early Showa periods, and an "official topographic map (*Seishiki-zu*)" published in 1912 (Taisho 1). The strong point of this web based map system is that one can display several maps as overlays over Google Maps. It is not possible to view maps of different scales, orientations, shapes, etc., from the same viewpoint by simply overlaying them as they are. Yano identified the position information (coordinates) of several points in each map and aligned the position of each point using the georeferencing functions so that the different maps can be displayed on the same screen. By changing the degree of



Overlaying Maps of Modern Kyoto
www.arc.ritsumei.ac.jp/archive01/ theater/html/ModernKyoto/

It is possible to overlay maps of Kyoto City in the Meiji, Taisho, Showa, and present-day periods and compare them in detail while changing the transparency with a slider.

transparency of the maps, it becomes possible to see through the maps and compare each one.

Two types of “large-scale maps of Kyoto City (*Kyoto shi meisaizu*)” that are extremely meaningful for academic research are also published in the *Overlaying Maps of Modern Kyoto*. One is a collection of 291 paper maps discovered at the Kyoto Prefectural Library and Archives (currently the Kyoto Prefectural Institute, Library, and Archives) in 2010. Although these maps were produced and published prior to 1927 (Showa 2), it is estimated that many entries continued to be made until a few years after the end of the war. Buildings in Kyoto City are depicted one by one, and color-coded according to the purpose of the building, such as shops or conventional residences, as well as the type of business of the establishment and the number of floors of the building. “However, an original version of these maps where no entries had been made, actually exists,” Yano says. They were the “large-scale maps of Kyoto City (*Kyoto shi meisaizu*)” comprised of 288 sheets discovered at the residence of the Hasegawa family in Minami Ward, Kyoto City in 2014. It has no coloration or retouches. Yano and others scanned these two types of drawings one at a time with high resolution, and aligned and synthesized them one by one using georeferencing. “We can compare the buildings in Kyoto City in the Taisho Period and the postwar period exquisitely by using the two detailed maps. It is also very interesting as research material,” Yano says.

Other unique and valuable archives include the *Folding Screens of Scenes In and Around Kyoto*. It is said that there are about 170 pairs of *Folding Screens of Scenes In and Around Kyoto* in Japan and overseas, including items considered as national treasures and important cultural assets. As part of the project of the Art Research Center at Ritsumeikan University, where Yano and others play a key role, they are trying to consolidate and archive these assets in a single place. In addition to collecting data regarding well-known digitized folding screens, such as the *Uesugi Version* and the *Funaki Version*, Yano and others handled some other items from photographs, such as the *Shoko-ji Temple Version* and the *Seigan-ji Temple Version*, and some are published in the *Portal Database of Rakuchu Rakugai-zu* (paintings and drawings both inside and outside the Kyo capital).

The achievements of Yano and others have a big impact because they are generously publishing a valuable and large digital archive on the Internet. It is a treasure trove of historical and geographical documents that are useful as research materials for researchers. Recently, a discussion on the occupation of Kyoto after the Second World War was published using maps accumulated in this way. Interdisciplinary research is progressing using archived information. Also, the archive is widely used as sightseeing and learning tool for the general public. It is also meaningful as a material to understand the past, including in the field of community development by local residents, which has flourished in recent years.

Other databases introduced in the text

Photo database of railway and buses in Kyoto
www.dh-jac.net/db1/photodb/search_shiden.php

Portal database of Folding Screens of Scenes In and Around Kyoto
www.dh-jac.net/db1/rakugai/search_portal.php

Photo materials by Yutaka Kondo (beta version)
www.arc-ritsumei.com/

The *Digital Archive of the Historical City of Kyoto* that Yano is aiming to produce includes not only three-dimensional space but also content such as literary works, paintings, and photographs, as well as intangible cultural assets such as festivals including the Gion Festival and traditional arts. Yano does not simply list them but has released them with geospatial information, such as maps, as a platform linked to a *place*. One of the recent achievements is the archiving of about 80,000 photographic negatives of the architecture historian Yutaka Kondo, who photographed Kyoto from the 1930s to the 1970s. They are collaborating with Kyoto Prefecture to scan the photographs that were donated to the Kyoto Prefectural Library and Archives, one by one. They have also identified location information from the photographs, and have constructed a system that allows users to view the photographs from the map. Approximately 50,000 pictures have already been released.

As part of this effort, Naomi Kawasumi has archived about 2,000 photographs of the Kyoto City Tram from around the 1960s. “We organized a research group, identified places reflected in the photographs with the collaboration of experts, and released those photographs and data with location information. There were some pictures which their location could not be identified. We also added a system that allows people from the outside to enter information into the published database,” Kawasumi says. Furthermore, the *Kyoto Memory Map Project* was launched, and *memories* of places and periods reflected in old photographs and maps are being collected and released as well.

Recently, Yano and others are also moving forward in the archiving of about 1,000 items as part of the same intangible content as *memories*. Included in these items are folding screens and hanging scrolls, tools used in seasonal and annual events, and daily necessities, which are all stored in the *Nagae Family Residence*, a *Kyo-machiya* designated as a cultural asset of Kyoto City. He revealed his intentions by saying “I would like to record the way of dwelling and living through *Machiyas* and collected items.” “We believe that the understanding of Kyoto will be further deepened by accumulating diverse information through such a space and by its analysis and interpretations.”

It must surely be fun to be able to experience Kyoto in each era across time and space, just like a time machine, with a *three-dimensional digital map*, representing a multifaceted *Kyoto* with picture maps, pictures, culture, and memories.

Keiji Yano (Left)

Professor, College of Letters

Subject of Research: digital humanities, GIS of the historical city of Kyoto, geodemographic research
Research Keywords: human geography, geographic information science

Naomi Kawasumi (Right)

Associate Professor, College of Letters

Subject of Research: study on reconstruction and change of landscape focusing on modern Kyoto, digital humanism by using Historical GIS, history of relations between environment and human beings in modern Japan
Research Keywords: historical geography

Fune-hoko archived using 262 million points and color measured by laser. See-through visualization using the Stochastic Point-based Rendering method was achieved for the first time in the world as one solution to processing the vast amount of data obtained by laser measurement.

Technology That Can Visualize and Reproduce the Interiors of Festival Floats

During the month of July, in which the Gion Festival takes place, the city of Kyoto is filled with an atmosphere more spectacular than usual.

The Gion Festival is the festival of Yasaka Shrine and has been celebrated for more than 1,100 years since the Heian Period. It is not merely an event; it is said to be a microcosm of Kyoto's history and culture, subsuming manners and customs, religion, art, and entertainment. Its highlight is the heroic and magnificent *Yamahoko Junko* (parade of decorated floats). A total of 33 floats are towed through the city twice, once during *saki matsuri* (first half of the festival) and then during the *ato matsuri* (second half of the festival), to the iconic sounds of the *Konchi-kichin* of *Gion Bayashi* (Gion Festival music).

With the development of digital technology, attempts to archive such tangible and intangible cultural assets digitally have become more popular worldwide. "By leveraging the strengths of digital technology, the possibilities will expand not only to preserve the cultural assets themselves but also to *utilize* them," said Satoshi Tanaka, one of the world's leading researchers in the technological development of digital archives of cultural assets and historical heritage. One representative achievement is the digital archiving of the *Yamahoko* (decorated floats) of the Gion Festival. Tanaka succeeded in accurately measuring the "*Fune-hoko*," which is a famous festival float with the unique shape of a boat, using stereoscopic measurements, such as laser measurement, and in creating a three-dimensional see-through visualization of the internal structure using his original technology.

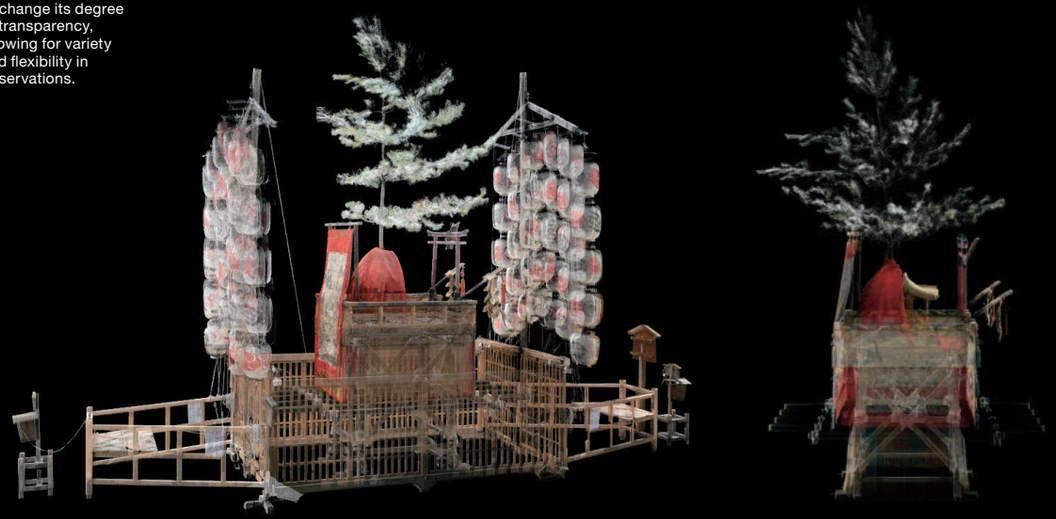
Laser measurement is a method of obtaining shapes by measuring the distance to the object with laser beams. The score of the three-dimensional point group (point cloud), the data obtained by measurement, ranges from tens of millions to hundreds of millions of points. While it is possible to obtain extremely subtle data, processing such a massive amount of data can become a challenge. Tanaka considered the massive amount of data to be an advantage and devised a method to utilize the information proactively. He developed the world's first technology that creates a three-dimensional see-through visualization model using the three-dimensional point cloud data that constitute the point cloud with the Stochastic Point-based Rendering method, which utilizes the fact that "the light emitted from objects closer to one's viewpoint has a higher probability of reaching the eyes." Using this method, it is possible to achieve precise see-through visualization, not only of the external appearance of the three-dimensional shape but also of the interior, including the hanging decorations, the surrounding lanterns, and turrets. This can all be done without performing polygonization,

Satoshi Tanaka

Professor, College of Information Science and Engineering

Subject of Research: visualization and visual analysis of cultural assets, high-quality medical visualization, visualization of scientific simulation, precise visualization of complex surfaces

Research Keywords: computer graphics, visualization, visual analysis, high performance computing, large-scale simulation analysis, digital humanities



See-through visualization image of *Hachiman-yama*. One can rotate the image or change its degree of transparency, allowing for variety and flexibility in observations.

a process which is usually indispensable when generating three-dimensional images with computer graphics (CG). In addition to reproducing the exact shape based on actual measurement values, the method also enables opacity adjustments, allowing one to view the *hoko* from various viewpoints, such as seeing the inside from a semi-transparent exterior of a *hoko* or enhancing the clarity of only the parts that one wants to see. “Being able to reproduce what the human eye cannot see is one of the strengths of a digital archive,” Tanaka said.

In recent years, the scope of digital archives has expanded from archiving tangible things to encompass intangible things, such as performance arts (e.g., dance and theater), lifestyles, folkways, customs, ceremonies, and festivals. In *Fune-hoko*’s digital archive as well, Tanaka collaborated with researchers from other fields and recorded and reproduced in high definition and high fidelity not only the three-dimensional shape, but also the process of assembly, the circumstances of the parade, and even the accompanying musical sounds during the festival.

Tanaka has also been working on digitally archiving the *Hachiman-yama* float since 2016. “The *Yamahokos* of the Gion Festival are assembled before the parade every year and disassembled again when the parade is over; the disassembled floats are kept in storage until the following year. There are no records on how to assemble the hundreds of components and objects used as their decoration; this has been passed down through oral tradition. We are trying to archive the range of processes in its entirety, starting from the assembly of the *Yama* and *Hoko* floats (known as *Yama-date* and *Hoko-date*), all the way down to their disassembly,” Tanaka revealed.

The *Hachiman-yama* has four pillars as a framework and is assembled in the order of base, tow bar, balustrade, pine tree, and objects used for decoration. Tanaka and others went to the place where *Yama-date* takes place several days prior to the parade and expeditiously conducted laser measurements and SfM photogrammetry so as not to interfere with the progress of the event.

“We calculated the reference point from the coordinates of the laser measurement; then, by setting the reference point of the coordinates of SfM photogrammetry to those common areas, we were able to set the point group data of the laser and photograph to common coordinates. Also, we carried out a process aimed at minimizing errors in the point group, and then completed a three-dimensional semitransparent see-through image combining the point cloud data of both laser and photographic measurements.”

What is so rare about the Gion Festival, as well as *Yamahoko Junko*, is that they were passed down for over 1,100 years with hardly any changes in their substance. What has made this possible is the strong passion for preservation within the Kyoto locals who are involved in this divine service. “In digitally archiving traditional events, it is necessary to spend time not only on the technology but also to build a relationship with the people in such areas,” Tanaka said. It can be said that this archive has only been realized because Ritsumeikan University’s research structure and the research led by Tanaka were so rooted in Kyoto.

To make full use of the three-dimensional see-through visualization technology on a global scale, Tanaka is currently undertaking a project of three-dimensional measurements of World Heritage Sites in Indonesia. With Tanaka’s technology, it may be possible to see the cultural assets and cultural heritage from around the world through a fresh, new perspective.

Digitally archiving the tangibles and intangibles relating to cultural assets and historical heritage.

The *Yama-date* (assembly of a *Yama* decorative float) of *Hachiman-yama*.
A process taking five days, in which the base, tow bar, balustrade, pine tree, and objects used for decoration are assembled in order with four pillars as its framework.

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37% Female

2,416
International Students

70
Countries and Regions

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169 PD, RA

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RESEARCH

6 Research Organization

29 Research Center

14 Research Institute

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INTERNATIONAL COLLABORATIONS

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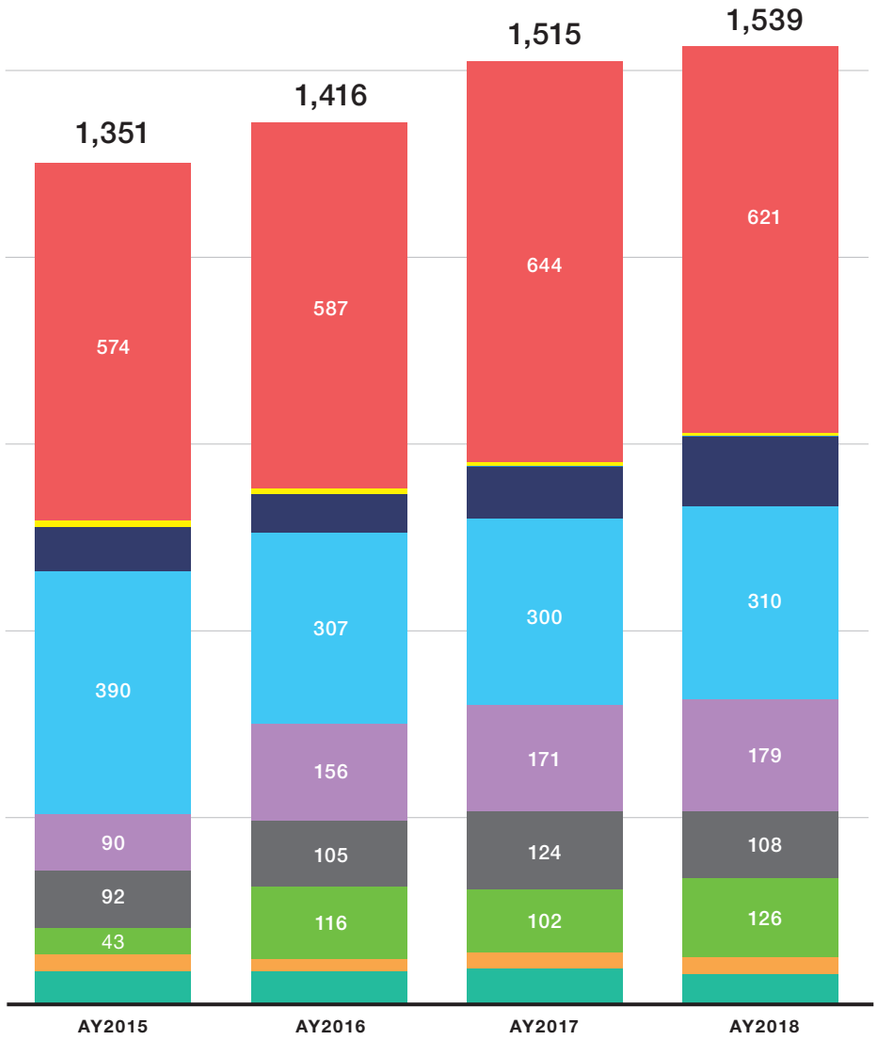
SABBATICAL FOR WORKING ON RESEARCH

USA	26	HUNGARY	1	DENMARK	3
GERMANY	10	SPAIN	3	SINGAPORE	1
ITALY	3	AUSTRIA	2	THAILAND	2
IRELAND	2	CAMBODIA	1	LUXEMBOURG	1
AUSTRALIA	1	MONGOLIA	1	ESTONIA	1
SOUTH KOREA	4	SWEDEN	1	GHANA	1
TAIWAN	4	NETHERLANDS	2	NORWAY	1
CHINA	4	CANADA	6	COLUMBIA	1
UK	13	POLAND	1	INDONESIA	1
FRANCE	6	PERU	1		

External Research Funding

No. of Projects by Funding Source

	AY2015	AY2016	AY2017	AY2018
Grants-in-Aid for Scientific Research*1	574	587	644	621
MEXT-Supported Program for the Strategic Research Foundation at Private Universities	10	9	7	5
Private University Research Branding Project	0	1	1	1
Other Public Research Funding	72	62	83	113
Contracted Research	390	307	300	310
Joint Research	90	156	171	179
Grants and Subsidies	92	105	124	108
Private Research Funding	43	116	102	126
Revenue from Patents etc.*2	27	20	25	28
Other revenue*3	53	53	58	48
Total	**1,351**	**1,416**	**1,515**	**1,539**

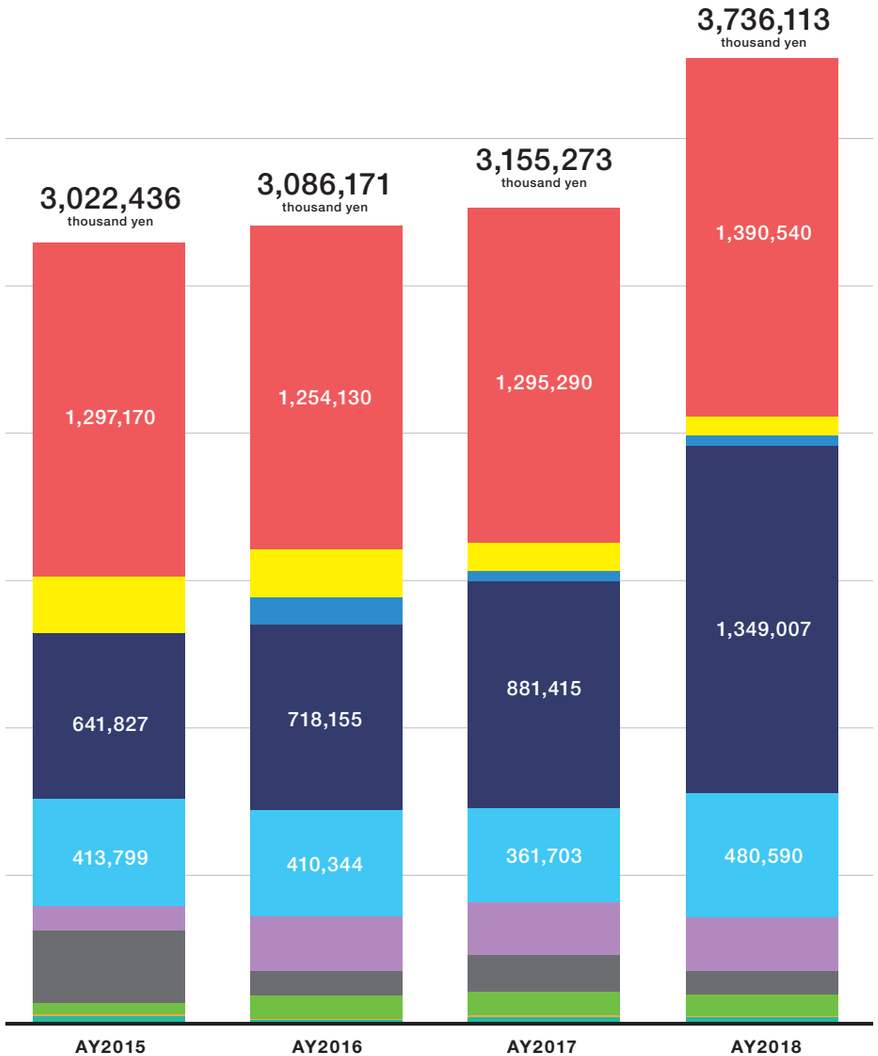


*1 Including Grant-in-Aid for JSPS Research Fellow and Fund for the Promotion of Joint International Research (Fostering Joint International Research)
*2 Royalties, materials, program license, and transfer, etc.
*3 Annual fee income of research consortiums and income from outside use of SR Center

Monetary Amount by Funding Source

(unit: thousand yen)

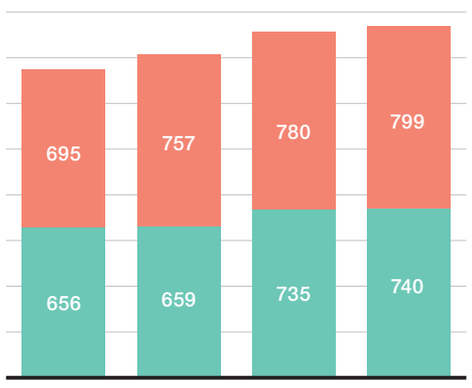
	AY2015	AY2016	AY2017	AY2018
Grants-in-Aid for Scientific Research*1	1,297,170	1,254,130	1,295,290	1,390,540
MEXT-Supported Program for the Strategic Research Foundation at Private Universities	218,139	185,524	111,922	70,299
Private University Research Branding Project	0	106,009	39,000	40,000
Other Public Research Funding	641,827	718,155	881,415	1,349,007
Contracted Research	413,799	410,344	361,703	480,590
Joint Research	94,502	214,664	205,780	206,065
Grants and Subsidies	280,703	96,633	139,687	92,364
Private Research Funding	46,495	87,707	94,808	83,306
Revenue from Patents etc.*2	7,675	4,096	6,184	4,127
Other revenue*3	22,126	8,909	19,484	19,815
Total	**3,022,436**	**3,086,171**	**3,155,273**	**3,736,113**



*1 Including Grant-in-Aid for JSPS Research Fellow and Fund for the Promotion of Joint International Research (Fostering Joint International Research)
*2 Royalties, materials, program license, and transfer, etc.
*3 Annual fee income of research consortiums and income from outside use of SR Center

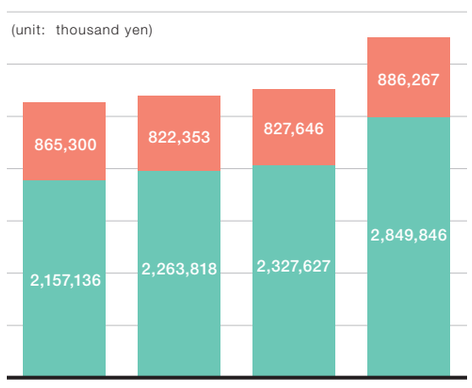
No. of Projects by Funding Source

Research funding for industry-academia cooperation / Public research funding



Monetary Amount by Funding Source

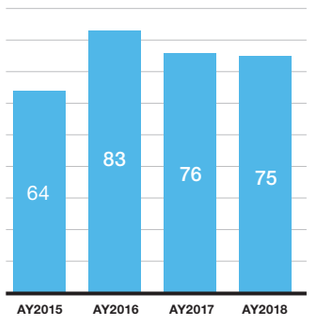
Research funding for industry-academia cooperation / Public research funding



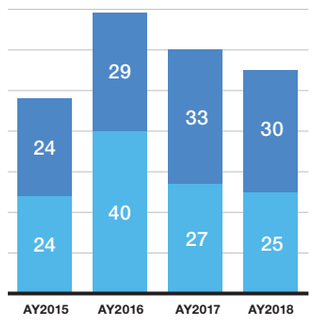
Research Funding for Industry-Academia Cooperation
Contracted research, joint research, grants and subsidies, private research funding, revenue from patents etc., and other revenue

Public Research Funding
Grants-in-Aid for Scientific Research, MEXT-Supported Program for the Strategic Research Foundation at Private Unviersities, Private University Research Branding Project, other public research funding (government subsidies, contracted research, jont research, etc.)

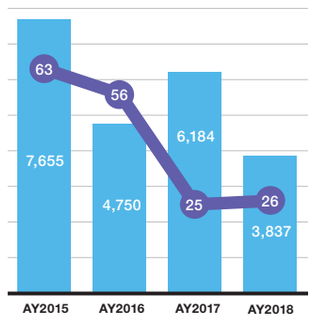
No. of Invention Disclosures



No. of Domestic Patent Applications



Royalties and Other Income / No. of Rights

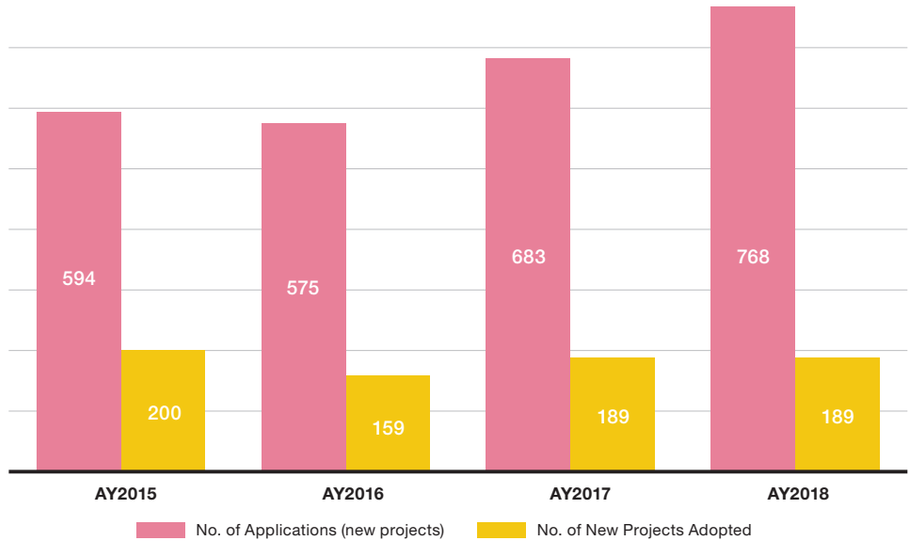


Including patent,utility model right, design right, trademarkright, copyright, plant breeder's rights, right of layout-designs of integrated circuit, know-how and materials.

Year-on-year Comparison of the No. of Projects Selected for Grants-in-Aid for Scientific Research

		AY2015	AY2016	AY2017	AY2018
No. of Applications (new projects)		594	575	683	768
A.Grant awarded (for new projects)	No. of Projects	200	159	189	189
	Amount (unit: thousand yen)	455,650	413,270	432,120	596,180
B.Grant awarded (for continuing projects)	No. of Projects	320	368	375	373
	Amount (unit: thousand yen)	666,510	748,800	738,010	745,290
Total (A+B)	No. of Projects	520	527	564	562
	Amount (unit: thousand yen)	1,122,160	1,162,070	1,170,130	1,341,470
National Ranking	No. of Projects	26 (4)	26 (4)	25 (4)	25 (4)
	Amount	28 (3)	26 (3)	27 (3)	24 (3)

Created from the funding results published by the Ministry of Education, Culture, Sports, Science and Technology.
The figures in parentheses for National Ranking indicate the rank among private universities.



Research Organizations, Research Institutes and Research Centers

Ritsumeikan University heralds "striving to become a unique university for research that contributes to humanity, nature and society" as part of its Academy Vision of 2020 and is actively taking on the challenge to achieve this goal.
Towards receiving acceptance from the Grants-in-Aid for Scientific Research (Research Fund), where the government assists creative and pioneering research and the formation of a world-class research base, the university has established research organizations to promote research in fields such as the humanities, social sciences and natural sciences.
45 research institutes and centers under individual research organizations promote a wide range of activities from the basics to applications.
These organizations are actively engaged in research exchanges with the government, municipalities and industry, thereby returning their achievements to society.

Ritsumeikan Global Innovation Research Organization (R-GIRO)

R-GIRO is a research organization under the direct control of the University President, and was established in 2008 with the goal of “forming a research hub specifically for policy-driven research topics” and “strengthening the development of young researchers who will lead the next generation. “ The organization’s goal is to contribute to the next generation of society by producing valuable research findings and actively disseminating them through the promotion of interdisciplinary research activity which aims to integrate the natural science fields with those in the humanities and social sciences toward the realization of a symbiotic society that the 21st century demands.
In programs of the 1st stage of R-GIRO (AY2008-2011), we focused on the "realization of a society that is capable of coexisting sustainably with nature (return to the earth's nature)" and started research in the natural sciences field, followed by the addition of the humanities and social sciences fields, promoting cross-university projects integrating humanities and science.
In 2nd stage programs (AY2012-2015), 33 projects that promoted research in 1st stage programs have been integrated into seven research bases and nine projects, developing them to be applied to society, such as in the commercialization of research results.
For 3rd stage programs started in AY2016, while continuing with the research we have accumulated thus far, we are further narrowing them down by focusing on and striving to solve themes that should be faced from global perspective and that are urgent challenges for Japan, such as its declining birthrate and aging population and environmental issues, in consideration of how to create a sustainable society where people can experience affluence and happiness in the 21st century.

Ritsumeikan Global Innovation Research Organization
en.ritsumei.ac.jp/research/r-giro/

Ristumeikan Asia-Japan Research Organization

This research organization, founded in December 2015, is directly managed by the President and strives to form partnerships with Japanese and international research institutes, including Ritsumeikan Asia Pacific University (APU), to exert its role as the core of a diverse research network, drive Asian studies from global viewpoints and promote international academic communication and exchange. Additionally, not only research activities but also the results are turned into educational projects, open projects or public relations projects, allowing the institute to have a capability for comprehensive Asia Pacific educational exchange and act as a base for information transmission. The institute further serves a support role as a forum to develop global human resources by, for example, offering experience to help communicate with local residents.

Ristumeikan Asia-Japan Research Organization — Asia-Japan Research Institute

Asia-Japan Research Institute

en.ritsumei.ac.jp/research/aji/

On the themes of co-existence, co-creation and reconciliation, this research institute takes on a diverse range of research, including cultural and civilization studies on the culture, climate, ethnic groups, religions, etc. of Asia, in addition to joint studies, general studies and practical studies and a wide variety of studies regarding security and diplomatic political history of Japan and Asia.
We accept young researchers from the Australian National University, one of the leading research universities in the world, and focus on the development of international joint studies and the global transmission of results through international joint theses, etc.

RESEARCH PROJECTS BEING PROMOTED

Co-existence

Studies on culture and civilization brought about by human awareness and historical entities based on the culture, climate, ethnic groups and religions of East and Southeast Asia

- Transition of Asian thoughts and philosophies in the global era
- Civil ethics and political thoughts in Asia
- Religions, philosophies and thoughts in Southeast Asia
- Mutual understanding of modern and classical Asian literature
- Traditional entertainment in Asia and the meaning of new "festivals" and "rituals"
- Islamic social changes, thoughts and life
- Islamic religion and arts
- Japan in Asia and Asia in Japan

Co-creation

Joint, general and practical studies between Japan and Asia, on the basis of setting actual challenges

- Essence of management with Chinese and Japanese management styles
- Current Asia, involving natural resources
- Industrial strengths, manufacturing capabilities and educational policies in Asia
- Software power in the Asian century
- The food situation and agriculture in Asia
- Asian tourism
- Research and development in environmental and energy fields, contributing to the sustainable development of Asia
- Preventative measures against natural disasters in Asia
- Architecture in Asia

Reconciliation

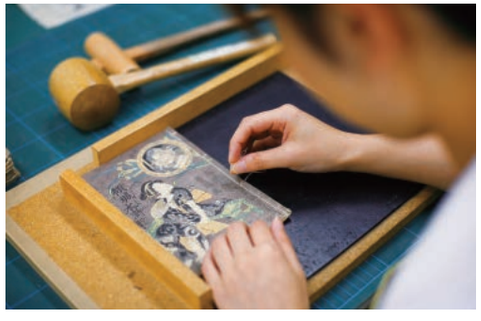
Studies on security and diplomatic politics (and their history) in East Asia, Southeast Asia, South Asia and the Islamic sphere

- Diplomatic political studies
- Discussions on the "recognition of history" in East Asia
- Studies of US diplomatic policies in Asia
- Rules and liberation in Southeast Asia: From the century of development from dictatorship to democracy
- Studies on modern history and political trends in Japan
- Studies on the history of political balance and diplomatic politics in Asia
- Studies on the Arab revolution and Middle Eastern politics
- History of relations between India and Pakistan

Kinugasa Research Organization

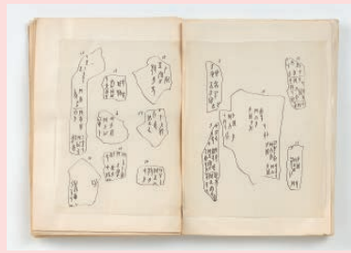
Kinugasa Research Organization was founded in 1998 and it supports research activity as a research organization which manages the research institutes and research centers. The organization's goal is to contribute to human welfare and social progress under the four principles of "autonomy," "democracy," "openness," and "peaceful use".
In April 2019, the Institute of Ars Vivendi was established with the goal of becoming a base for education and research practice that is built on a standpoint of the "parties concerned" who suffer from disabilities, old age, diseases and differences. Thus, the institute is working towards achieving its goal by exploring the ways in which humans are able to live with their "*disabilities, aging, diseases, and differences*." In addition, the Creative Media Research Center was also established in April of the same year, which was then followed by the establishment of the Center for Middle Eastern and Islamic Studies in October. At each of these centers, research activities are conducted synergistically and learning and knowledge are circulated in a way that transcends the boundaries between different fields. Furthermore, the centers also aim to spread learning and knowledge socially, expand academic networks in Japan and abroad, and to develop next-generation researchers and experts.

- Kinugasa Research Organization
  - Institute of Humanities, Human and Social Sciences
  - Institute of International Relations and Area Studies
  - International Institute of Language and Culture Studies
  - Institute of Human Sciences
  - Art Research Center
  - Institute of Disaster Mitigation for Urban Cultural Heritage
  - The Shirakawa Shizuka Institute of East Asian Characters and Culture
  - Institute of Ars Vivendi
  - Ritsumeikan Center for Korean Studies
  - Research Center for Intercultural Phenomenology
  - Ritsumeikan Center for Game Studies
  - Research Center for the Pan-Pacific Civilization
  - Research Center for Shuichi Kato and the Japanese Contemporary Thoughts
  - Reseach Center for Financial Gerontology and Finance/Legal Education
  - Research Center for Social Studies of Health and Community
  - Creative Media Research Center
  - Center for Middle Eastern and Islamic Studies



The Shirakawa Shizuka Institute of East Asian Characters and Culture

The Shirakawa Shizuka Institute of East Asian Characters and Culture was established in May 2005 to commemorate Emeritus Professor Shizuka Shirakawa's receipt of the Order of Cultural Merit. Emeritus Professor Shirakawa has left behind outstanding research achievements that extensively cover all of Oriental society, with a focus on ancient Chinese culture and research on Chinese characters (oracle bone scripts, bronze inscriptions, seal scripts). Even after the passing of Emeritus Professor Shirakawa in October 2006, the institute, while using research work and culture work as the standard, still aims to spread information and provide extensive education that is catered towards the general public, in addition to promoting and enhancing the research on oriental characters and culture. Furthermore, the institute also aims to become a base for research on Oriental characters and cultures in East Asia by spreading the "Shirakawa Grammatology" both domestically and internationally in the East Asia region in particular.



Shizuka Shirakawa (1910-2006)

Shizuka Shirakawa had a broad outlook as he believed that there were cultural similarities between Japan and China. Shirakawa conducted research on oracle bone scripts as well as bronze inscriptions from the Yin and Zhou Dynasties, which are the earliest forms of Chinese writing. In addition, he also compiled his own original research on the ancient cultures of Japan and China. By tracing and copying all the tens of thousand pieces of oracle bone, which is a fundamental task that cannot be done by others, Shirakawa was able to systematically organize the original meanings of Chinese characters and undertake a typographical analysis that clarified the religious and ritual-based background surrounding the creation of oracle bone scripts and bronze inscriptions, which are the early forms of Chinese characters. His theory behind this research was often called the "Shirakawa Grammatology." This theory went on to receive high acclaim from academic societies in Japan and abroad, and Shirakawa was also awarded the Order of Cultural Merit.

BKC Research Organization of Social Sciences

BKC Research Organization of Social Science was founded in 1998 in order to promote research activity in business-related fields. Its goal is to advance research with greater social connectivity by promoting research which fuses economics and technology.
In April 2018, at the same time at the establishment of the "College of Gastronomy Management" on the Biwako-Kusatsu Campus (BKC), the gastronomic science research base "International Research Center for Gastronomic Science (established in January 2014)" was constructively reorganized into the new "Research Center For Gastronomic Arts and Sciences". This Center aims to form a global core base for gastronomic research.

- BKC Research Organization of Social Sciences
  - Institute of Social Systems
    - Research Center for Finance
    - Research Center for Gastronomic Arts and Sciences

Research Organizations, Institutes and Centers

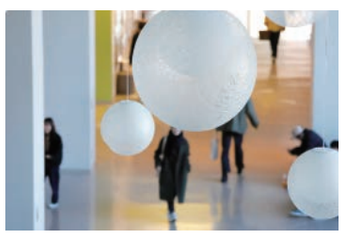
Research Organization of Open Innovation and Collaboration

Based on the OIC's educational concepts of Asia's Gateway, Urban Co-Creation and Regional Cooperation, the organization promotes activities towards being a research organization that develops world-class human resources, creates new innovations and serves as a core presence in the local community.
While taking advantage of the academic nature and neutrality of our university, we aim for the creation of new values by connecting diverse people and organizations accumulated in the cities around Osaka, fully drawing out the potential scattered in this diversity and creatively link them together. Furthermore, utilizing its location in the largest city in West Japan and its capital city for trade, Osaka, we also strive to develop education, research and the creation of knowledge by taking advantage of the plentiful number of cases from the local economy, industry, community and society.
Taking on the challenge of solving issues in the community and society as forms of education and research while utilizing connections with the community and society, we will move forward with contributions to the community and human resource development.

- Research Organization of Open Innovation and Collaboration
  - The Research and Development Institute of Regional Information
    - Research Center for Innovation Management
    - Research Center for Design Science
    - Center for Global MOT Research
    - Ritsumeikan Inamori Philosophy Research Center
    - Research Center for Sustainability Science
    - Research Center for Cognitive Sciences
    - Research Center for Medical and Long-Term Care Management
    - Center for MONODUKURI Qualitative Research

Center for Global MOT Research

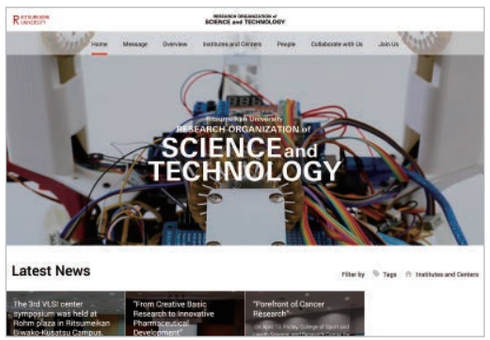
For companies to develop and grow sustainably, it is important to secure and maintain competitive advantages in certain business fields. Otherwise, in a harshly competitive market, companies cannot maintain healthy corporate management. Nowadays, we find common challenges faced by Japanese companies, especially those based on technology.
"Even by securing competitive advantages with excellent development technology, are the means to maintain them sufficient?" As an academic and practical method to study this challenge, technology management or management of technology (MOT) has attracted attention. At our Graduate School of Technology Management, we provide education for companies that emphasize technological development and innovation creation on the basis of technology. Further, as a research organization that can take care of Project-Based Learning (PBL), we established the Center for Global MOT Research in April 2014.
This center deals with not only studies on a variety of technology management issues in relation to the creation and promotion of the wider practice of new technologies and new businesses, realization of the sustainable business practices, and accounting, finance and intellectual assets for MOT, but also present and future analysis based on specific cases of MOT, research medium and small-scale companies and community invigoration from an MOT viewpoint and provide international cooperation with global companies and international research organizations. In addition, the center actively hosts training, visiting lectures, technological instruction and clinical sessions for companies for the purpose of returning the achievements of MOT studies. MOT training for employees conducted with one of the major manufacturers in Japan (a series of 11 lectures over a year, including training at a camp) has been implemented for over 10 years. Also, we work closely with research offices and other research centers, focusing on securing external financing and strengthening relationships with industry.
The center will continue to create excellent innovations, the creation of profitability throughout their life cycles and the establishment of business models having both of them. Your continued support would be very much appreciated.



Research Organization of Science and Technology

The Research Organization of Science and Technology was established in 1994 as the Research Organization of Science and Engineering (changed to its present name in 2012) to contribute to the development of science and technology and local society. The organization's goal is to contribute to local society through joint research in industry-academia-government partnerships.
The organization sets its mission as the contribution to the development of science technology and communities and society through the promotion of industry-government-academia joint research and develops research across fields, beyond conventional research domains. It also drives research activities closely related to the humanities and social sciences as well as provides sophistication and invigoration of our research in the field of science technology.

- Research Organization of Science and Technology
  - The Institute of Science and Engineering
  - Synchrotron Radiation Center
  - VLSI Research Center
  - Frontier Research Center for Natural Disaster Mitigation
  - The Bio Medical Devices Center
  - Research Center for BIWAKO Σ
  - Research Center for Drug Discovery and Development Science
  - Research Center for Sport and Health Science
  - Robotics Research Center
  - Research Center for Energy-innovation Materials
  - Research Centre for Palaeoclimatology
  - Research Center of Advanced ICT for Medical and Healthcare
  - Center for Systems Vision Science
  - Research Center for Biological Resources
  - Ecological Technology & Management Research Center for the Energy and Environment Field



Research Organization of Science and Technology
en.ritsumei.ac.jp/research/sci-tech/

Research Centre for Palaeoclimatology

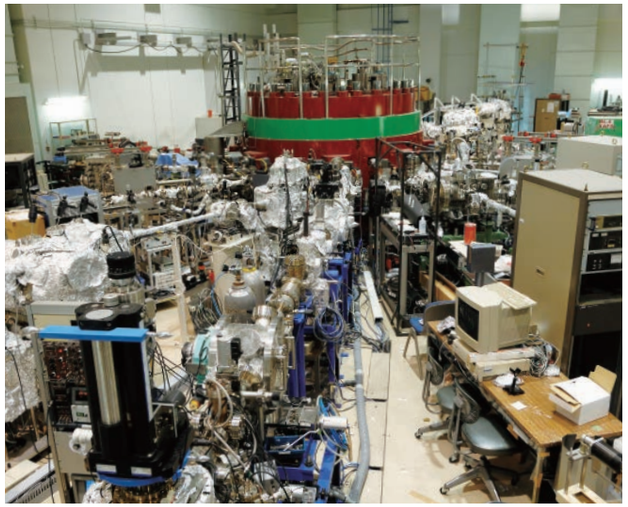
The earth's climate is constantly changing, but the way it has changed has only been understood through observations over the last few hundreds of years. Over the long history of the earth, climates have repeated great changes that are beyond the imagination of humans. In April 2014, to promote studies to learn about the past, discover the causes of changes and consider what will happen in the future, the Research Centre for Palaeoclimatology was established at the Biwako-Kusatsu Campus.
The Research Centre for Palaeoclimatology is especially talented at climate reconstructions of great detail, using sediment varves. Geology has set long periods of time in the form of tens of thousands of years or hundreds of millions of years as main subjects of study. However, for humans, the changes that take place in a short span of time like a few years or tens of years are more important. To know about such "drastic" changes in the true sense, the yearly records found in sediment varves are ideal. Detailed ancient climate data is essential for checking the performance of climate models used to predict the future. To understand the past and future in a more thorough manner, the Research Centre for Palaeoclimatology will continue with its activities and efforts.

Research details of the Research Centre for Palaeoclimatology

- Climate reconstruction using the sediment varves of Lake Suigetsu in Fukui Prefecture
- Climate reconstruction using the sediment varves of Lake Petexbatún in Guatemala
- Timing comparisons of drastic climate changes by region
- Higher precision of radiocarbon dating
- Higher precision of climate reconstruction using pollen fossils

What is a varve?

A thin stratum formed by the accumulation of sediment with the change of the season. As a pair of light and dark stripes is equivalent to a year, if the varves are preserved perfectly, the number of stripes directly represents the number of years. Sediment varves of Lake Suigetsu in Fukui Prefecture have been adopted as an international standard timescale to define the previous 50,000 years. As quality information on natural environments (temperatures, water temperatures, flora, etc.) and natural disasters (earthquakes, tsunamis, floods and volcanic activities) are recorded in varves, research has been making progress both in Japan and overseas.



Research Office

The Research Office has a goal of contributing to society through research exchanges, technological transfers, support of ventures, etc., utilizing the intellectual assets of the university. To centralize information on researchers in the university and their diverse external needs and to promote industry-government-academia activities more smoothly, depending on the challenges involved, we serve as an integrated point of contact for all the various matters associated with research.

Research Office at Kinugasa Campus

Humanities and Social Sciences

- College of Law
- College of Social Sciences
- College of International Relations
- College of Letters
- College of Image Arts and Sciences
- Graduate School of Science for Human Services
- Graduate School of Language Education and Information Science
- Graduate School of Core Ethics and Frontier Sciences
- Graduate School of Public Policy
- School of Law
- Graduate School of Professional Teacher Education

56-1 Toji-in Kitamachi, Kita-ku, Kyoto 603-8577, Japan TEL: +81-75-465-8224 FAX: +81-75-465-8245
Mail: k-kikou@st.ritsumei.ac.jp

Research Office at Biwako-Kusatsu Campus

Social Sciences Natural Sciences

- College of Economics
- College of Sport and Health Science
- College of Gastronomy Management
- College of Science and Engineering
- College of Information Science and Engineering
- College of Life Sciences
- College of Pharmaceutical Sciences

1-1-1 Noji-higashi, Kusatsu, Shiga 525-8577, Japan TEL: +81-77-561-2802 FAX: +81-77-561-2811
Mail: liaisonb@st.ritsumei.ac.jp

Research Office at Osaka Ibaraki Campus

Social Sciences

- College of Policy Science
- College of Business Administration
- College of Comprehensive Psychology
- College of Global Liberal Arts
- Graduate School of Human Science
- Graduate School of Technology Management
- Graduate School of Management

2-150 Iwakura-cho, Ibaraki, Osaka 567-8570, Japan TEL: +81-72-665-2570 FAX: +81-72-665-2579
Mail: oicro@st.ritsumei.ac.jp

Contact Us

Latest information on research activities

Ritsumeikan University
Research and Industry-Academia-Government Collaboration website
en.ritsumei.ac.jp/research/

For inquiries in relation to RADIANT, the Ritsumeikan University research report, contact:

Office of Research Planning & Development, Division of Research, Ritsumeikan University
TEL +81-75-813-8199 FAX +81-75-813-8202 E-Mail radiant@st.ritsumei.ac.jp