# Chapter 3 Various Science, Technology, and Innovation Efforts That Take Advantage of Regional Characteristics and Strengths of Universities

Recent years have seen the development of universities and industries that take advantage of regional characteristics as well as those with strengths in specific fields. Chapter 3 features successful examples of innovative technological development that utilizes regional characteristics and strengths of universities, among others, contributing to the regions in collaboration with local governments and industrial sectors.

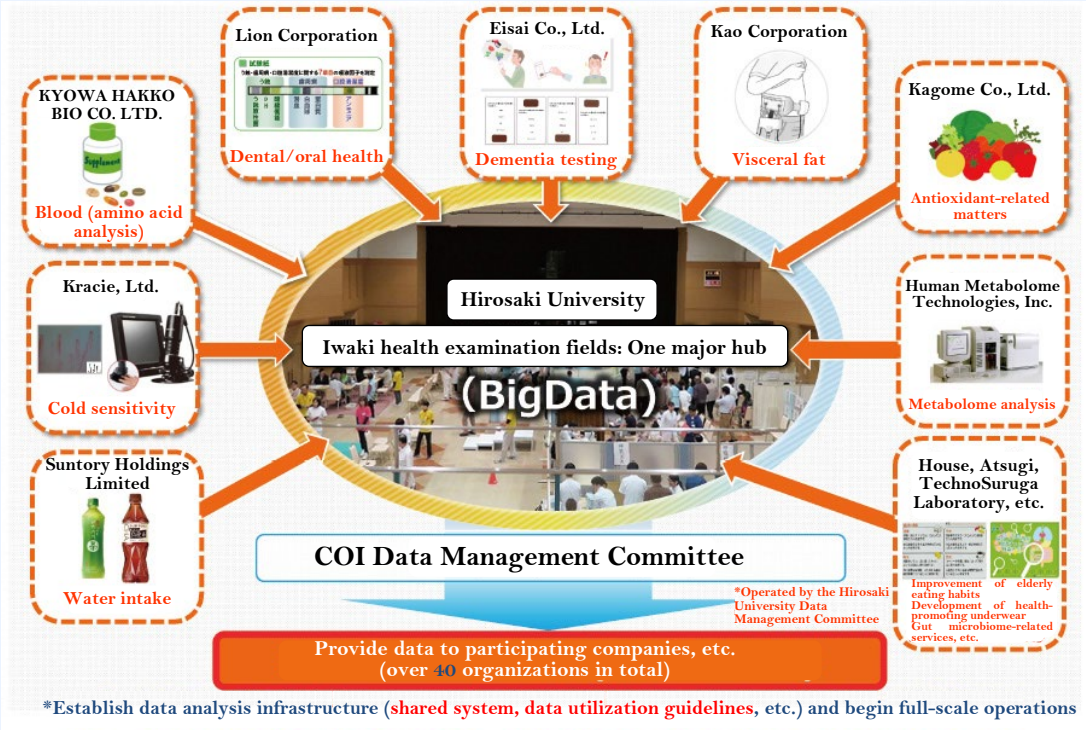


## Section 1 The Center of Well-being Regional Society Innovation, etc. of Aomori Prefecture, Hirosaki City, and Hirosaki University

According to the "Prefectural Life Tables" by the Ministry of Health, Labour and Welfare (MHLW), Aomori Prefecture has long been at the bottom of the national ranking of life expectancy at birth both for males and females (or the lowest life expectancy at birth), remaining the "prefecture with the shortest life-span" in Japan. Hirosaki City, Aomori Prefecture has been working on health promotion with a major goal of "returning the title of the prefecture with the shortest life-span," the issue of the highest priority for the prefecture, under collaboration among industrial, university, governmental, financial, and private sectors.

Hirosaki University has advanced a regional health promotion project titled the "Iwaki Health Promotion Project" (Figure 1-3-1) since FY2005, and as part of the project, the university has carried out large-scale joint health surveys targeting around 1,000 Hirosaki residents every year. For 17 years through 2022, the university has accumulated health information of around 20,000 people in total (health big data), and the big data that consist of approximately 3,000 items shape an exhaustive data structure encompassing a wide range of contents from the genome of each individual to their physiological and biochemical information, life activities, and social environment. Such data structure, along with the sheer number of items and the target population, is unparalleled in the world.

■Figure 1-3-1/Strategic data sharing between COI Hirosaki site's corporate participants and the university and their joint analysis




Source: Website of the Iwaki Health Promotion Project, Hirosaki University

In 2013, Hirosaki University was selected as one of the national sites of the COI STREAM program run by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The university utilizes the "Iwaki Health Big Data," information accumulated from large-scale resident health surveys, to develop a system for collaboration among the industrial, university, governmental, and private sectors, while using diverse data such as cognition function, bodily water content, visceral fat amount, and circulating metabolites to conduct research on and commercialization of sign-detection and preventive methods for dementia and lifestyle diseases, among others. Furthermore, a number of practical initiatives have been carried out to improve the health literacy of citizens in the region (Figure 1-3-2). Health education at local companies is designed to maintain such literacy, with a variety of efforts to improve the health of children, students, and young people being under way at schools and in the region. These initiatives have led to various improvements in life expectancy data of Aomori Prefecture. Especially in terms of the increase in average life expectancy, the prefecture ranked third for males and 25th for females for the period from 2010 and 2015.

Such resolution of regional issues is believed to have a major impact on society in economic terms, including increase in production amount, job creation, and lower medical costs, and will significantly contribute to regional revitalization. Moreover, the knowledge and technologies gained may help improve the situation of other countries faced with similar challenges, raising expectations for the expansion of this COI model to various parts of the world.

In addition, Hirosaki University has developed a technology to extract proteoglycan, a component of the nose cartilage of salmon. This is used for

products related to the health and beauty fields under the name of "Aomori PG." It was greatly difficult to extract this content. However, taking a hint from "Hizu Namasu," a local dish of Aomori, the university successfully developed a technology to safely extract it with edible acetic acid and alcohol at a low cost. This technology was achieved with long-term support and cooperation through industry-university-government-financial collaboration.

In March 2021, Aomori Prefecture formulated the "AOMORI Life Innovation Strategy Action Plan 2021-2025," looking ahead to the next generation and aiming to promote further economic growth, and is working on the development of businesses in life-related fields, such as medical services, health, and welfare. The prefecture is striving to help brand "Aomori PG" and expand its sales channels under one of the priority areas of the strategy, "Goods- and Experience-Oriented Health and Beauty Industry Area."

■Figure 1-3-2/Scene from a two-step test

Provided by: Hirosaki University

## Section 2 Iwamizawa City/Hokkaido University Industry-Academia Regional Co-Creation Project

Located in the mid-western part of Hokkaido and with 42% of its administrative area covered by farmlands, Iwamizawa City faces urgent issues of a rapidly shrinking population as well as a decreasing birth rate coupled with advanced aging and thus puts forward "economic vitalization measures" including those for agriculture. The city has implemented programs related to information and communications technologies (ICTs) in a wide range of areas such as education, healthcare, and agriculture since around 1993 and successfully produced positive impacts including job creation in the city.

Above all, Iwamizawa City and the "Innovative Food & Healthcare MASTER" site, which was created by Hokkaido University in collaboration with relevant companies and selected for MEXT's COI STREAM, are utilizing ICTs since 2015 to build a new type of community where people of all generations, from first-time mothers-to-be and infants to elderly people, can live healthy and enriching lives. Specifically, the COI has performed groundbreaking maternal and child cohort research (maternal-child health survey), which makes a comprehensive analysis of mothers' influence on children, utilizing samples (big data) such as feces, blood, cord blood, and breast milk of expectant and nursing mothers as well as feces and others of infants gained from residents mainly via an app and hospitals. Subsequently, using "α-defensin" as a health indicator discovered through research on intestinal environment foundations, the COI identified factors and causes related to maternal-child health, alongside realizing Japan's first at-home/remote checkups of expectant and nursing mothers and a meal delivery service optimal for each individual. As a result, the number of low-birth-weight infants decreased considerably (10.4% in 2015 to 6.3% in 2017). According to an estimate by Hokkaido University and Hitachi, Ltd, a 4% reduction in the ratio of low-birth-weight infants across Japan would create approximately 200 billion yen worth of combined annual effects, consisting of reduced medical costs, consumption activities over 20 years, and labor economy effects, and is expected to help counter the declining birth rate in the future (Figure 1-3-3).

Maintaining production and solving labor shortages have emerged as pressing issues, with primary industry workers in Hokkaido graying

■Figure 1-3-3/Scene from an infant health examination

Provided by: Iwamizawa City

■Figure 1-3-4/Demonstration test of robot farm machines (robot tractors) (Iwamizawa City)

Source: Joint website of the Cabinet Secretariat and the Cabinet Office, "Regional Revitalization" Social Implementation of Future Technologies

and decreasing in number. As such, Iwamizawa City has promoted the utilization of ICTs in the agricultural sector and has been offering a 50-meter mesh weather observation service within the city since 2013. In addition, it is advancing demonstration projects to make use of drones and robot tractors, among others, under the programs of the Cabinet Office, the Ministry of Agriculture, Forestry and Fisheries (MAFF), and other agencies (Figure 1-3-4). In particular, the city has produced outstanding results in the field of unmanned agricultural machines. It started demonstration tests of the unmanned driving system of such machines via remote monitoring and control in FY2018, and concluded an industry-university-government collaboration agreement with Hokkaido University and the NTT Group (Nippon Telegraph and Telephone Corporation, Nippon Telegraph and Telephone East Corporation, and NTT DOCOMO, INC.) toward the realization of a "Smart Agri-city" primarily with the aim of solving agricultural issues and improving living environments. The city has promoted the installation of wireless base stations that enable unmanned agricultural machines to operate in agricultural rural areas and demonstration tests with an eye on social implementation of equipment that can move between farms. Iwamizawa City commenced initiatives under the Smart Agriculture Demonstration Project in FY2020, and since FY2021, it has been working mainly on (1) unmanned operation of multiple smart agricultural machines on the same actual farmlands via remote monitoring and control with 5G technologies, (2) integrated remote monitoring and control of different types of smart agricultural machines deployed in different places, (3) unmanned autonomous driving on agricultural (public) roads between farmlands, and (4) demonstration of remote control necessary to avoid obstructions and other objects. The demonstration tests have shown that completely unmanned operations can reduce tractor operation hours by approximately 40% to 50%, compared to conventional manned operations. The sheer impact has drawn attention both in Japan and abroad, with various policymakers, including those from overseas, visiting the site.

As seen above, Iwamizawa City is engaged in "improving the livelihoods of its residents" and "vitalizing the regional economy" through agricultural, food, and health programs that work in lockstep with one another.

## Section 3 Initiative of the Tsuruoka Science Park in Yamagata Prefecture

The Tsuruoka Science Park (Figure 1-3-5), located in Tsuruoka City, Yamagata Prefecture, has evolved with Keio University's Institute for Advanced Biosciences (IAB), which was founded in 2001, playing a core role. Under the trilateral agreement among Yamagata Prefecture, Tsuruoka City, and Keio University, and with administrative support from Yamagata Prefecture and Tsuruoka City, the IAB conducts research on "Integrated Systems Biology" (a relatively new area of life sciences that makes full use of cutting-edge biotechnology combined with IT to process large amounts of data derived from comprehensive measurements, such as metabolomics[1]). Start-ups that emerge from such research activities are constantly coming up with new technologies and products. Approximately 600 people, including IAB faculty members and students and corporate researchers, belong to the Tsuruoka Science Park. Combined with their families, those related to the

1 A comprehensive study of metabolites generated by proteins and enzymes within cells and tissues of organisms

Science Park account for approximately 1% of the population of the city .

■Figure 1-3-5/Panoramic view of the Tsuruoka Science Park

Provided by: Tsuruoka City

■Table 1-3-6/ List of startups related to the IAB, Keio University

| Year of establishment | Startup name |
|---|---|
| 2003 | Human Metabolome Technologies, Inc. |
| 2007 | Spiber Inc. |
| 2013 | MOLCURE Inc. |
| 2013 | SalivaTech Co., Ltd. |
| 2014 | YAMAGATA DESIGN Co., Ltd. |
| 2015 | Metagen, Inc. |
| 2016 | Metcela Inc. |
| 2021 | INCEMS Technologies, Co. Ltd. |
| 2021 | Fermecutes, Inc. |

Provided by: Tsuruoka Science Park

The Tsuruoka Science Park has seen the continuous establishment of many startups that take advantage of their distinctive technologies, as shown in Table 1-3-6, from among rice paddies. One such example is Spiber Inc., which was established as a university-launched startup in 2007 and developed "Brewed Protein™," a structural protein material produced through a fermentation (brewing) process that uses microorganisms. Spiber Inc. has constructed and operates a factory for mass production in the Kingdom of Thailand, in addition to the base factory in Tsuruoka City. Spiber is also preparing for an even larger facility in the United States. The company's efforts to create a sustainable recirculating society through the widespread use of its structural protein materials are now attracting attention not only in Japan, but also around the world.

The IAB, Keio University is carrying out unique educational programs in collaboration with the local community, accepting local high school students as "High School Student Assistants" who work part-time after school to provide technical assistance, and as "High School Student Interns" who conduct research activities under the theme of their choice. These initiatives started more than a decade ago, and now we are beginning to see examples of high school students from those days going on to study at Keio University's Faculty of

Policy Studies / Faculty of Environment and Information Studies and its Graduate School of Media and Governance (Fujisawa City, Kanagawa Prefecture), and returning to Tsuruoka City after graduation to find jobs in the startup companies. The IAB also contributes to regional revitalization by organizing events such as the "Bio Summit in Tsuruoka," an event where high school students from all over the country studying life sciences gather in Tsuruoka City to present their research. These on-site events at Tsuruoka Science Park will demonstrate to future researchers, engineers, and managers that settling in Tsuruoka City can be an option in various aspects such as research, entrepreneurship, and partnership formation, thereby creating a synergistic effect.



## Section 4 Collaboration between Universities and Regions to Strengthen the Semiconductor Industry in Kumamoto Prefecture, etc.

Semiconductor integrated circuits with over billions of connections of electronic components mounted on a single substrate are an important underlying technology toward the realization of "carbon neutrality by 2050," which aims to achieve net-zero carbon dioxide emissions by 2050, as well as further development into a digital society. As the long-term expansion of the semiconductor market is expected, the government has been forging ahead with efforts to strengthen semiconductor industrial infrastructure, including supporting Japan Advanced Semiconductor Manufacturing, Inc., a joint company founded by Taiwan Semiconductor Manufacturing Company Limited (TSMC), Sony Corporation, and DENSO CORPORATION in Kumamoto Prefecture. Moreover, global competition for the next-generation semiconductor integrated circuit is at a turning point. Going forward, importance will be attached to research and development (R&D) of a new axis, which is entirely different from two-dimensional miniaturization technologies to make circuits smaller to achieve higher integration, as has been the case so far.

Against this background, Kumamoto Prefecture's "Reinforcement of the Semiconductor Industry and the Formation of a New Industrial Ecosystem Including User's Industries" project was adopted for the Cabinet Office's "Grants for Revitalization of Regional Universities and Industries," with which the government support integrated initiatives for the creation and promotion of core industries in regions under industry-university-government collaboration as well as the creation of universities with strengths in specific fields. Under the project, Kumamoto Prefecture is strengthening joint industry-academia research on the development of front-end semiconductor manufacturing equipment (process up until the formation of semiconductor circuits) which the prefecture has an edge in the semiconductor industry, while aiming to achieve Japan's first mass production of semiconductors utilizing the three-dimensional stacking technology for enhancing the performance of integrated circuits by stacking multiple chips. The prefecture is also striving to form a new ecosystem where collaboration with semiconductor user's industries will lead to the creation of new industries.

The government, on its part, is promoting initiatives to develop and secure human resources to enhance the foundations of Japan's semiconductor industry. In addition to individual efforts of industrial sectors, educational institutions, and administration, the "Kyushu Semiconductor Human Resource Development Consortium" was established in March 2022 as the

first of its kind in Japan, with the participation of 76 entities, such as Japan Advanced Semiconductor Manufacturing, Inc., Kyushu University, Kumamoto University, and National Institute of Technology (KOSEN), Kumamoto College, in order to advance initiatives on a regional level under industry-university-government collaboration. Following this, we have so far witnessed the establishment of the "TOHOKU Study Group on Design of Semiconductor and Electronics Industry" with the participation of 71 entities including KIOXIA Iwate Corporation, Tohoku University, and National Institute of Technology (KOSEN), ICHINOSEKI College in June 2022, the "Chugoku Region Semiconductor Industry Promotion Council" with the participation of 95 entities including Micron Memory Japan, K.K., Hiroshima University, and National Institute of Technology (KOSEN), Kure College in October 2022, and the "Liaison Council for the Development of Semiconductor Human Resources, etc. in the Chubu Region" with the participation of 25 entities including KIOXIA Corporation, Nagoya University, and National Institute of Technology (KOSEN), Gifu College in March 2023. In addition, similar groups are slated to be established in the Kanto and Hokkaido regions in the time to come, with initiatives under way in various parts of Japan.

Toward the creation of next-generation semiconductor integrated circuits, the government has implemented the "MEXT Initiative to Establish Next-generation Novel Integrated Circuits Centers (X-nics)," launching three new bases in the University of Tokyo, Tohoku University, and the Tokyo Institute of Technology, and is working on R&D from a new perspective and development of human resources to drive the future semiconductor industry, in collaboration with universities with leading prototype lines in Japan such as Toyohashi University of Technology and Hiroshima University (Figure 1-3-7).

■Figure 1-3-7/Production process of semiconductor integrated circuits


Provided by: Tokyo Institute of Technology

## Section 5 Formation of a Research Complex in Tohoku University

The next-generation synchrotron radiation facility "NanoTerasu"[1] will begin operations in FY2024. Under development based on Japan's first public-private regional partnerships between the National Institutes for Quantum Science and Technology and its regional partners,[2] NanoTerasu is the highest level facility in the world, as it has strength in the soft X-ray field and is capable of generating synchrotron radiation 100 times brighter than that which existing facilities in Japan can generate. NanoTerasu has wide-ranging fields of application, and as a facility that also contributes to the resolution of social issues such as the realization of a decarbonized society and countermeasures against infectious diseases, it raises expectations for utilization ranging from academic research to development for industrialization in a variety of areas including materials sciences, life sciences, development of agricultural products, and forensic science. In February 2023, the government submitted the "Bill Partially Amending the Act on Facilitating the Shared Use of Specified Large Advanced Research Facilities" to the Diet, so as to make NanoTerasu available to various researchers and other stakeholders in the industrial, academic, and governmental sectors. The Diet then unanimously approved and passed the bill in May, providing NanoTerasu with legal status as the Specific Synchrotron Radiation Facilities among the Specific Advanced Large Research Facilities.

The public-private installation of a synchrotron radiation facility is a challenging initiative even in global terms, attracting investments from private companies, universities, and research institutions from the installation phase.

At the same time, Tohoku University is developing a "Science Park," a site of co-creation among the industrial, academic, governmental, and financial sectors over an area of approximately 40,000 m² in the Aobayama New Campus. The university is actively attracting industry-university-government research groups from both Japan and abroad and is pushing ahead with initiatives aimed at establishing a "platform of creation," which produces outstanding research results through the fusion of different disciplines, solves social issues, and creates new social value. Specifically, these efforts include the utilization of the university's shared cutting-edge research equipment and devices, joint research and initiatives toward social implementation with the International Center for Synchrotron Radiation Innovation Smart and the Research Center for

■Figure 1-3-8/NanoTerasu under construction and the Aobayama New Campus

Provided by: Photon Science Innovation Center (left) and Tohoku University (right)

1 The official name is 3 GeV high-brilliance synchrotron radiation facility, with the nickname of NanoTerasu.
2 The five regional partners are the Photon Science Innovation Center (PhoSIC), Miyagi Prefecture, Sendai City, Tohoku University, and the Tohoku Economic Federation, with PhoSIC representing these entities.

Green X-Tech, [1] provision of opportunities for exchanges and interactions with university officials, and other social co-creation activities with NanoTerasu at their core. In addition, the "Aobayama Universe (tentative)," a facility equipped with rental laboratories for corporate R&D, will be newly established in FY2024, in the hope that university-launched startups and private companies will thrive by utilizing data and research results gained at NanoTerasu (Figure 1-3-8).

Sendai City is carrying out activities as a local government to promote concentration of R&D and other companies to build a research complex with a cluster of R&D bases and related companies around NanoTerasu. In addition, the city is promoting activities to raise awareness among local companies and others of the facility's potential for industrial use, such as by introducing good examples of diverse R&D activities that make use of existing synchrotron radiation facilities.

## Section 6 Various Initiatives for Overseas Development

### (1) Establishment of the Global Aqua Innovation Center by Shinshu University, etc.

According to the United Nations Children's Fund (UNICEF) and other sources, 2.2 billion people do not currently have access to safely managed drinking water in the world. Additionally, lack of water for industrial and commercial purposes has been recognized in various regions in the world. The environment surrounding water resources has been worsening due to the influence of desertification, world population increase, and economic growth, especially in developing countries. In regions not blessed with freshwater resources such as river water, seawater is desalinated to produce freshwater for use as urban and industrial water. However, the reverse osmosis membrane technology, which is dominant in existing desalination facilities, requires a vast amount of electricity to apply high pressure for desalination. Desalination costs are assessed at approximately one dollar for each ton of freshwater, and international conferences on seawater desalination aim to reduce the costs by half, so that the technology will be available to developing countries. In addition, the structure of the reverse osmosis membrane to remove salt is prone to clogging by contaminants called foulant, posing another challenge.

They key innovation toward the resolution of these issues is the reverse osmosis membrane that incorporates nanocarbon materials, which was developed by Endo Morinobu, Distinguished Professor of Shinshu University, under rigorous industry-university-government collaboration with Hitachi, Ltd, Toray Industries, Inc., Resonac Holdings Corporation, RIKEN, Nagano Prefecture, and others. Shinshu University originally had an edge especially in nano-structured carbons and fiber technologies, based on which the university created the nanocarbon technology and then took advantage of it to develop the reverse osmosis membrane. The newly developed membrane has a structure that prevents the accumulation of foulants on its surface, enhancing the durability of the membrane system and reducing operational costs by 10% to 15%, compared to the conventional membrane. This membrane technology drew

1 Established under the Green Goals Initiative on January 1, 2023. It is a research organization that promotes research based on the analysis and utilization of various big data gained by NanoTerasu and other leading-edge facilities through industry-academia co-creation with companies related to the green fields, is engaged in planning and designing regarding social implementation of the results of such research, and is working toward the realization of Society 5.0.

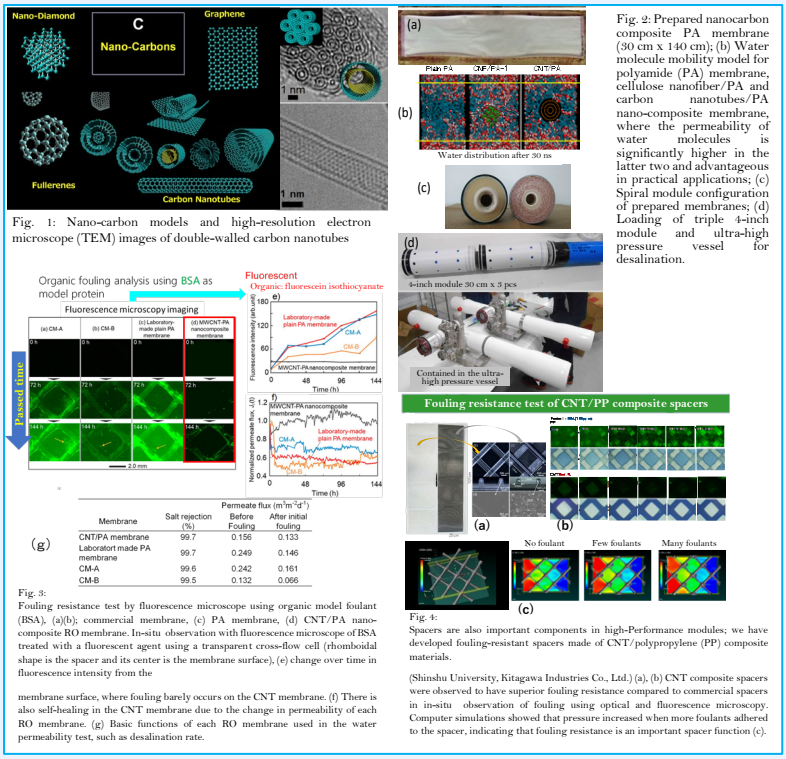
attention of the government of Saudi Arabia, which sought to enhance the sustainability of its seawater desalination project, leading to the conclusion of a basic agreement (conclusion of an MOU[1]) on technical cooperation between Shinshu University and Saudi Arabia's Saline Water Conversion Corporation (SWCC) in March 2023, and both sides are strengthening their collaboration in a broad area of R&D and education projects related to saline water conversion. In addition, the university is developing this membrane technology and promoting its applications as super-ultra-low-pressure-driven RO membrane purifiers, which are useful for countries struggling with the drinking water issue (the university acquired an ANSI 58 certification from NSF).

Toward mass production of water purification systems with nanocarbon materials, Shinshu University is working together with Nagano Prefecture to promote the participation of many local companies, share responsibility for manufacturing parts, assembling the whole system, and exploring new applications, among others, thereby contributing to the vitalization of local industries and aiming to enable the system as a product "made in Shinshu" to make a leap not only within Japan, but also into the world, starting from countries and regions with water issues. Local companies have made a number of proposals, such as industrial water treatment, food production, and joint development of air conditioners using nanocarbon reverse osmosis membrane mainly for improving cooling efficiency, showing how the advanced membrane technology has started to permeate the local industry.

The "Global Aqua Innovation Center," which revolves around the nanocarbon membrane technology, was adopted for MEXT's COI STREAM in FY2013. Currently, there are said to be only about ten countries where people can drink safe tap water directly without taking some precautions. Hence, the mission of this COI is the production of drinking, industrial, and agricultural water from seawater, polluted surface water, and other water sources, as well as the technology for the production of daily life water for island countries, so that people around the globe can always have safe and secure access to a sufficient amount of water. Furthermore, the COI is jointly developing with companies an ultrapure water production technology for the increasingly important semiconductor industry, and a membrane technology that allows for the recycling of its effluent into ultrapure water, thereby seeking to construct an innovative "Water Production and Circulation System" that makes contributions to the wellbeing around the world (Figure 1-3-9, Figure 1-3-10).

1 Memorandum of Understanding

## Figure 1-3-9/Structure and various functions, etc. of nanocarbon membrane




| Membrane | Salt rejection (%) | Permeate flux ($m^3 m^{-2} d^{-1}$) Before Fouling | After initial fouling |
|---|---|---|---|
| CNT/PA membrane | 99.7 | 0.156 | 0.133 |
| Laboratort made PA membrane | 99.7 | 0.249 | 0.146 |
| CM-A | 99.6 | 0.242 | 0.161 |
| CM-B | 99.5 | 0.132 | 0.066 |

Fig. 1: Nano-carbon models and high-resolution electron microscope (TEM) images of double-walled carbon nanotubes

Fig. 2: Prepared nanocarbon composite PA membrane (30 cm x 140 cm); (b) Water molecule mobility model for polyamide (PA) membrane, cellulose nanofiber/PA and carbon nanotubes/PA nano-composite membrane, where the permeability of water molecules is significantly higher in the latter two and advantageous in practical applications; (c) Spiral module configuration of prepared membranes; (d) Loading of triple 4-inch module and ultra-high pressure vessel for desalination.

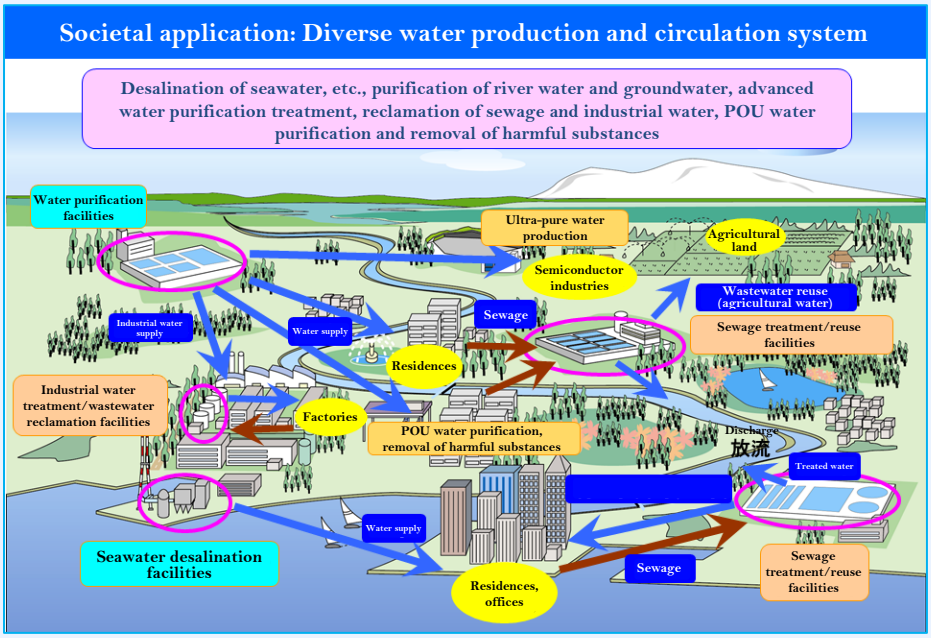
Fig. 3:
Fouling resistance test by fluorescence microscope using organic model foulant (BSA). (a)(b); commercial membrane, (c) PA membrane, (d) CNT/PA nano-composite RO membrane. In-situ observation with fluorescence microscope of BSA treated with a fluorescent agent using a transparent cross-flow cell (rhomboidal shape is the spacer and its center is the membrane surface), (e) change over time in fluorescence intensity from the membrane surface, where fouling barely occurs on the CNT membrane. (f) There is also self-healing in the CNT membrane due to the change in permeability of each RO membrane. (g) Basic functions of each RO membrane used in the water permeability test, such as desalination rate.

Fig. 4:
Spacers are also important components in high-Performance modules; we have developed fouling-resistant spacers made of CNT/polypropylene (PP) composite materials.

(Shinshu University, Kitagawa Industries Co., Ltd.) (a), (b) CNT composite spacers were observed to have superior fouling resistance compared to commercial spacers in in-situ observation of fouling using optical and fluorescence microscopy. Computer simulations showed that pressure increased when more foulants adhered to the spacer, indicating that fouling resistance is an important spacer function (c).

Provided by: Global Aqua Innovation Center

## Figure 1-3-10/Conceptual scheme of the "Innovative Water Production and Circulation System"




Provided by: Global Aqua Innovation Center

### (2) Development of Autonomous Driving Technology by a Startup Originating from Nagoya University

TIER IV led the development of "Autoware,"[1] the world's first open source software for autonomous driving developed at Nagoya University, and aims to build an ecosystem where various individuals and organizations can contribute to the development of autonomous driving technology. The startup was founded in December 2015 by Kato Shinpei, who then served as an assistant professor at Nagoya University (currently the company's CEO and CTO and a Specially Appointed Professor at the University of Tokyo), and others. Now the company works on the development of systems and vehicles and operates the platform business toward the commercialization of autonomous driving. "Autoware" is characterized by its ability to recognize its location and surrounding environment, such as vehicles and pedestrians, traffic lanes, and traffic lights, even in urban areas with heavy traffic, estimate its three-dimensional location, and generate maps and routes. The development of autonomous driving technology and autonomous driving vehicles based on this software is going on around the world, with the software adopted by more than 500 companies in 20 countries as of February 2023.

The company takes advantage of the feature of "Autoware" that is "not bound by specific vehicles or configurations of autonomous driving kits" to develop various types of vehicles. For example, eve autonomy., a joint venture of the company and Yamaha Motor., has implemented practical application of "eve auto," an autonomous transport vehicle for distribution based on a commercial golf cart. "eve auto" is utilized in a wide range of environments excluding public roads, such as factories and warehouses, and runs at a maximum speed of 10 km/h during autonomous driving. In addition, TIER IV continues demonstration tests of "GSM8," a pilot EV bus developed by the company for short-distance transport of passengers (with a maximum speed of 19 km/h), on public roads throughout Japan. Short-distance passenger transport (the so-called "last mile") is where early application of autonomous driving is expected in order to resolve social issues such as driver shortages and the maintenance of regional transport.

The company focuses on fostering autonomous

Provided by: TIER IV, INC.

1 Autoware is a registered trademark of the Autoware Foundation.

driving engineers by sponsoring the "Japan Automotive AI Challenge" held by the Society of Automotive Engineers of Japan, and conducts joint development of an AI driving training system that makes use of AI and the autonomous driving technology in collaboration with a driving school. The company is thus engaged in activities with an eye on the development of society related to autonomous driving from various perspectives. The company is expected to put effort into R&D and proceed with the development of more sophisticated autonomous driving vehicles and systems, so that it can continuously contribute to the development of autonomous driving technology.

In Aichi Prefecture, the "Aichi Autonomous Driving Promotion Consortium" was established with the participation of local municipalities in the prefecture, companies, universities, and other organizations related to the autonomous driving system, with Aichi-wide activities aimed at social implementation of autonomous driving being under way.

This consortium enjoys the participation of four universities, including Nagoya University, and a good number of related companies, such as TIER IV, and performs demonstration tests of autonomous driving in various parts of the prefecture by matching companies, universities, and others with local municipalities.

## Section 7 Other Various Efforts

We can see other various efforts made in a variety of locations.

The Okinawa Institute of Science and Technology (OIST) seeks to realize an innovation ecosystem in Okinawa, which facilitates the commercialization not only of the world's most advanced research activities, but also of ideas originating therefrom, and lays the foundations of future employment. The institute invites Japanese and overseas startups and entrepreneurs from other countries and support commercialization at its incubation facility "Innovation Square Incubator." EF Polymer Private Limited, a startup originating from OIST that was founded by an Indian entrepreneur, developed water-absorbing organic polymers made from waste generated during food production. While they have a high water retention capacity, the polymers decompose into soil after a half year. Hence, they not only provide nutrition for the soil, but also reduce costs, as they do not require disposal costs. The company sells the polymers both in Japan and India and aims to expand into drought-stricken areas. In addition, OIST promotes community-based R&D activities, including the identification of strains of fast-growing and disease-resistant varieties through genome analysis of sea grapes, flat lemons, and other plants, as well as the development of rice containing starch conductive to obesity prevention.

Higashihiroshima City, Hiroshima Prefecture, which was founded with the integration and relocation of Hiroshima University, is home to five universities, including a Japanese campus of a foreign university, and the city has built up a concentration of academic and research functions, along with the establishment of industrial, urban, and living infrastructure as well as a network of high-speed roads. However, after concentrated investments were over, creation of innovation through technology transfer with universities at the core did not progress as originally envisaged, and an outflow of human resources from the city emerged as a problem. Once again, the city needs new community development, looking 50 and 100 years into the future. In FY2019, Higashihiroshima City and Hiroshima University

launched the "Town & Gown Initiative," which seeks to resolve regional issues under close collaboration between the community (Town) and the university (Gown). Under this initiative, the city and the university share the same vision for a sustainable future and aim to realize regional revitalization by integrating administrative resources from the city and research/educational resources from the university and utilizing science, technology, and innovation, while seeking to achieve sustainable development of the region and improvement of the university. Specifically, they regard students and faculty and staff of Hiroshima University as virtual citizens and its campus as a virtual urban area, and plan to build a smart city with the university and its surrounding areas as a place of demonstration and application. For example, it is planned that companies conduct experiments for social implementation of multilingual communication infrastructure for overseas students and residents. These R&D activities under industry-university-government collaboration are expected to help discover a new vision of a society where residents and visitors find it comfortable to live.

Innovation starting on the regional level is not limited to the efforts described above. We can see new developments in various forms throughout Japan. Vigorously promoting strengths unique to these regions under industry-university-government collaboration will enable the realization of technological development ecosystems that will have ripple effects both in Japan and abroad, without depending on large urban areas. Universities, industrial sectors, local governments, and the national government must work as one, in order to accelerate these developments.