WCRR2016 in Milan

were called inferior goods (Laughs). Then, the Japanese companies started to deliver high-quality goods and improved the productivity on their own efforts. I asked myself why this was possible and concluded that the industriousness, high level of education, craving for high quality on the part of the Japanese people were the causes for improving the quality of made-in-Japan products.

Higashihara: We must cherish these characteristics. I would like to publicize good Japanese characteristics such as craftsmanship in manufacturing and meticulous service in the service industry to let overseas customers properly understand and evaluate them.

Toward 2050

What Lies Ahead of Information Revolution

Higashihara: Our IoT platform called Lumada is currently in use for predictive diagnosis but we are considering in-house whether it can be put to more uses. We are thinking of using Big Data to analyze defects and troubles to find what kind of troubles occurred in what cases, what is the current trend if we analyze the time series, how defects are built into products and cause troubles as a result of remodeling, and so forth. So we started to consider applying AI and Big Data technologies not only to online predictive diagnosis but also to all kinds of data stored in-house.

Kumagai: Engineers who are going to be engaged in such new fields must be persons with totally different specialties. Those who studied mathematical and information sciences and specialize in analyzing complex and massive data, for instance need to have knowledge of different fields applicable to the technologies for building hardware.

Higashihara: We are certainly recruiting and fostering data scientists and data analysts from around the world, but it is not easy. It seems that someone who understands technologies really well look at things based on mathematical expressions and past experiences. On the other hand, the results of using AI only outputs correlations. Only "correlations between this and that events" are output. Only humans can associate them with each other. Humans consider why an event is associated with another and exhibit new points of views and perspectives, which is important. Serious thoughts are possible only when people with abundant engineering experience are faced with a correlation of A and X or B and Z for unknown reasons, rather than when a conclusion is reached using algorithms.

Kumagai: The defeat of a professional Go player by a system came as a shock to me. The system was created by a Google-owned company, not by a manufacturer. In the 19th century, the Industrial Revolution completely replaced horse and water power with mechanical power, specifically steam engines. In the same manner, ICT or information communication technology may cause a New Industrial Revolution if it is recognized as new motive energy for the industry.

Higashihara: The 5th Science and Technology Basic Plan published last year includes a keyword, "Society

5.0." I understand that Version 5.0 means that hunting life was succeeded by agriculture, then the Industrial Revolution and IT Revolution and that the next revolution has arrived. After the Information Revolution, I think that an age has come to pursue fusion of people and the Information Revolution, a human-centric society, and real improvement of QoL or Quality of Life using collected data, physical and cyber alike.

Kumagai: I understand that the 5th Science and Technology Basic Plan puts emphasis on connection between people. Another concept that we must consider is awe of nature, that is, changes of nature that sometimes pose threats to us should be included in the realm of life. I believe if we just continue human-centered thinking, we will pay for it heavily in the future. Severe hazards for railways such as earthquakes, rain, and wind cannot be prevented but can be mitigated. I think, at least, the directions of technologies will include the one of mitigating disaster damages as much as possible.

Research and Development with an Eye Toward 2050

Kumagai: I attended the World Congress of Rail Research or WCRR 2016 that was held in Milan in late May, 2016. I talked about three topics. Increasing the efficiency of R&D, digitalizing railways, and promoting energy innovation. Then, opinions were exchanged on these topics. I think railway digitalization is connected to IoT, Big Data, and AI. However, we at RTRI are thinking of determining targets for introducing AI or ways for approaching human behaviors by studying human errors, such as drivers failing to see a signal or opening doors on the wrong side, that is, the mechanism of brains and physiological changes in them in the process of making decisions in the transport operations. The other day, I had a chance to visit your medical facility office in Kashiwa and I was impressed with the advancement of your measurement technology for medical applications. We have just begun basic research on the possibility of digitizing signs and tendencies of human errors by keeping track of human physiological changes. The advanced measuring technologies that are utilized in your IoT and AI application strategies are widening the possibility of creating knowledge about complex and elusive things.

Higashihara: What draws our attention in particular? The best way to solve a problem or meet a challenge of, for example, preventing human errors is to create a simple mathematical model. However, this is rather difficult to do, so the important thing is an analogy or where to find similarity. I understand that the autonomous decentralized model you mentioned earlier is an analogy to an ecosystem, that is, a model of a system that heals on its own if it gets injured. Additionally, we are doing joint research with Kyoto University on herds of animals. We study questions like why herds of sardines do not collide with each other and the ecology of gorillas. Using a herd as a keyword, we are conducting research with a view to 2050 to gain wisdom on the ways of living of humans.

Abnormal weather is occurring frequently in these years. We are thinking of studying the technologies of sensing for mitigating the natural threats and disasters and detecting signs of them by dividing them into those to be achieved with short-term goals and middle- and long-term goals. For this purpose, we reorganized the our research laboratories, the Design Division and overseas research bases into three centers in fiscal 2015: the Global Center for Social Innovation, which implements social innovation projects in collaboration with customers; the Center for Technology Innovation;

Research and Development System of Hitachi for Fiscal 2016

and the Center for Exploratory Research. There are 2,700 researchers in total; of which 600 at the Global Center for Social Innovation, 200 at the Center for Technology Innovation, and 100 at the Center for Exploratory Research. Middle- and long-term research projects are conducted at the Center for Exploratory Research.

Kumagai: I understand that the concept of not pursuing near-sighted, short-term results forms the basis of study conducted at the Center for Exploratory Research.

Higashihara: We must look ahead as far as 2050. Otherwise, I suspect we may go off the track. If we keep on looking ahead to the world of 2050 from 2016, including such aspects as how the nature will be and how the technologies will change, I think we can maintain a correct direction of research.

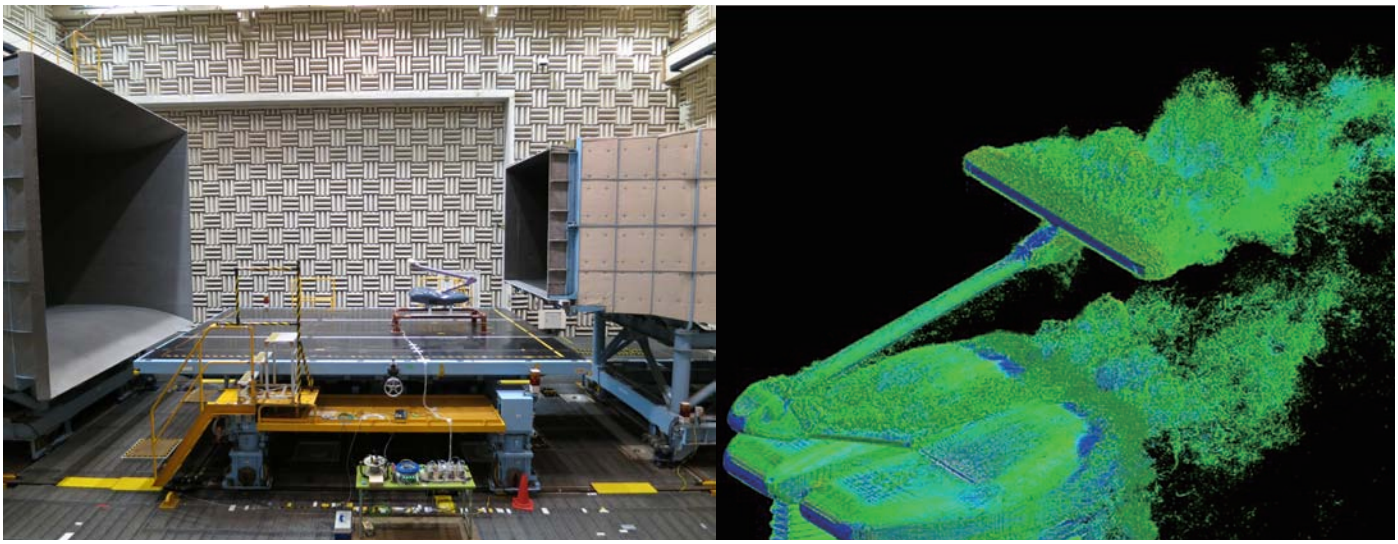
Kumagai: Our human resource team for research consists of 550 researchers. There is an important problem to solve in research management because research has two roles: middle- and long-term basic research and practical research that delivers solutions within three years. We are faced with a dilemma about whether to let all the researchers handle both or divide them into two groups, one handling basic research and the other addressing short-term, consulting-oriented issues. Currently we are operating based on the assumption that we should let researchers assume both of the roles as long as they can, because a sense of achievement resulting from practical application is important in keeping them more motivated.

Higashihara: I agree with you. I want to leave researchers to do their work freely. I don't think the management should squeeze them into fixed frames. If only immediate profits are something to be pursued, we can have all of them focus on somewhere close to activities on the front end and then short-term results can be achieved more easily, but this will surely weaken the middle- and long-term basic research. However, basic research is something on which we should place importance.

Kumagai: If the national government offers subsidies to universities ready to follow a policy of shifting to practical research, results will be achieved in 20 years but I think, on the whole, Japan's capability for basic research will be lowered.

As a corporate strategy, promotion of efficiency of R&D is a must. If there is a goal of realizing 360 km per hour in five years, for example, a research institute must make efforts to shorten the turnaround time in order to accomplish the mission of solving the aerodynamic and noise problems in two years. For problem solving, we conduct theoretical analysis, bench tests, and tests on commercial railway lines. However, the advent of advanced simulation technology using supercomputers has greatly contributed to reducing development periods and costs. In research and development, we are often unable to see events in reality. So the research processes by means of simulation-based visualization is indispensable. I expect computers and advanced simulations will have increasingly higher value from now on.

Higashihara: Yes, indeed. As you just said, use of supercomputers for development is exceedingly important. In business, simulation technologies are emerging one after another and we are collaborating with customers to find and correct problems. One example is traffic congestion caused by urbanization. If we run a tram, we want to know how much the traffic congestion can be alleviated at a certain vehicle occupancy and a certain minimum fare, or how soon the initial investment can be paid back. To discover answers, we can enter different parameters into computers to conduct simulations. Our tool for this purpose is NEXPERIENCE/Cyber-Proof of Concept. Using this simulation tool that we developed, we can conduct Proof of Concept simulations on computers to easily determine, for example, how the east-west and north-south lines should be laid out, how many stations should



Left: Testing aerodynamic performance of an actual pantograph in RTRI's large-scale wind tunnel
Right: Simulation of air flow by RTRI's supercomputer (courtesy of JR East)

be created, and whether a belt line should be formed. This trend of conducting feasibility study on computers is growing considerably stronger.

Kumagai: That's good because, in that way, we can expand the range of trials and shorten the required time. I assume that an objective numerical technique is also effective in quantifying effects of countermeasures applied to traffic congestion.

Higashihara: I agree. It will be useful in preventing traffic congestion and predicting flow of people when we plan urban development in the future. Using data collected from cameras, we can predict, for example, how women around 30 or children will move. Then, we can propose that a tenant in a certain position in a station building should be a boutique or a toy store. We are already in an age when we can easily simulate how many shoppers will come per week and multiply it with a purchase rate to know how much the sales will be.

Kumagai: The use of computer tools for the sake of systemization is expanding to a wider range of applications, isn't it?

Energy Optimization for the Entire Society

Kumagai: Railways are characterized by mass transportation capacity, high speed, punctuality, and high energy efficiency in comparison with other transport modes. We are thinking of promoting research and development on two topics: reduction of energy consumption of railways ranging from urban transport to high-speed train service; and achievement of zero emissions. Possible methods are regenerative brakes, use of renewable energy, linking of power supply in the user's network, use of fuel cells on railways, and introduction of no-resistance superconducting technology. Hopefully, a low-energy-consumption transportation society built using these methods will constitute one of the industrial foundations of Japan in the future.

Higashihara: Talking of zero emission, a society

dependent on automobiles will never be free from CO_2 problems. A society with focus on railways must be pursued. Fuel-cell cars and electric vehicles (EV) will increase in the future but railways will always be important in mass transportation. As for energy in the train service, we can introduce various power supply systems, use batteries for stable power supply to exploit renewable energy, or use regenerative energy of brakes for the next start. I expect that, in the next generation, there will be unification between a railway system and a town, which include buildings, tenant shops, and shopping malls, to achieve total energy optimization. Mutual exploitation of surplus power will be possible. Surplus power in a city will be used on railways and surplus energy on railways will be used in a city as electricity or energy.

Kumagai: That is the electric energy control.

Higashihara: Yes, electric and thermal power interchanges. I think it is a good way to promote energy saving and CO_2 reduction in an entire city.

Kumagai: Power interchange will be possible if there is a technology for stabilizing a wide range of power sources for everything from houses to railway companies. I want it to be a system that minimizes power supply and consumption via a network.

Higashihara: I said earlier ATOS took us 20 years, and this new system is also something that will probably take 20 or even 50 years to connect partial systems to achieve total optimization. I am dreaming of a day when we can do this.

Kumagai: Then, regenerative power can be interchanged regardless of substations of railway companies. In Tokyo, for example, the power consumption of all the railway companies in the metropolitan area can be controlled as one system.

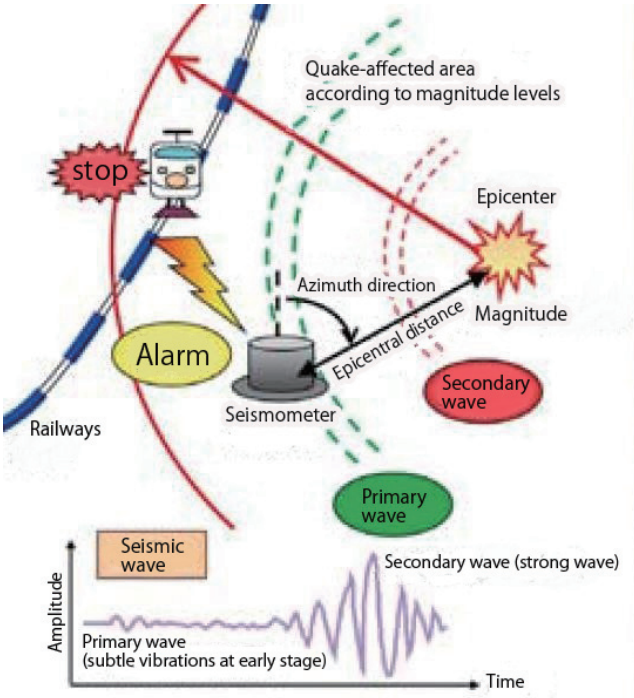
Higashihara: I believe such a day will come if we know what to select as the KPI (Key Performance Indicator).

Kumagai: For a railway company, lowering the power consumption is a positive factor for business because it accounts for up to 85% to 90% of the operating cost. Energy innovation is much required and will benefit both the global environment and the business result of an individual company. So we are going to put more effort into it. I hope we will be able to make the most of our collective strength to improve the energy efficiency by way of IoT and AI.

Railways for Connecting People

Kumagai: Two years ago, we created a vision statement, "We will develop innovative technologies to enhance the rail mode so that railways can contribute to the creation of a happier society." It was stipulated

Effective power distribution by Hitachi at Kashiwanoha Smart City



Left: Early Earthquake Warning System
Right: Earthquake Information Distribution System for Railways

on the assumption that the physically affluent society at present would pursue affluence with ties between people and spiritual connections.

Higashihara: I had a chance of participating in a project of a national newspaper, where I asked readers how they thought IoT would be used in the future and received answers from them. In this project, I also had discussions with the coordinator. I said people would be able to record everything they want to do on their smartphone and, when they wanted to go to a movie, for example, digital signage would navigate them all the way to a movie theater. I wondered whether it was really convenient and something they wanted and whether it was an improvement of their QoL. Of course, some of the people think that way but spending more time with nature or having more time away from IoT is also an improvement of QoL. The important thing for us to pursue in the future is to allow each of the individuals to define a worthwhile lifestyle or real QoL for him or her and to respect different values.

Kumagai: There will be an increasingly stronger trend toward information exchange via SNS and smartphones in the future. However, people will invariably feel it necessary and important to transport themselves to meet other people in work or family situations. I expect that a wide variety of communication patterns including smartphones will come to be used. In the future as in the past, I hope railways will promote the concept of "connecting people."

Higashihara: The important thing is that railways should be in a position to connect people, children and parents, and friends, isn't it?

Kumagai: In that sense, we are determined to ensure that railways will contribute to social innovations. I hope to welcome everyone's continued patronage of the railway sector.