# Safe and High Quality Railways

## Importance of safety and quality

**Kumagai:** When thinking about future development of railways, one point to consider is how the advantages of railways can be increased. The Shinkansen had its 50th anniversary two years ago. The Shinkansen brought about an innovation in the transport of people. This innovation created not only new rolling stock and signalling systems but also new values of railways. These values were recognized not only in the socio-economic communities in Japan but also outside of Japan. So this technology was propagated to other countries and applied, for example, to the commercial service of TGV and ICE. People used to call railways a mature industry and said that high-speed railways were wasteful, but the Shinkansen shattered such ideas. In other countries, the introduction of high-speed railways is gaining momentum. In particular, the U.K. and U.S.A., where motorization has advanced, showed approval of high-speed railways. We also want to introduce further advanced railways to the world, using new technologies that we will develop. What were the circumstances in which Hitachi delivered a high-speed railway system to the U.K. and what were the requirements demanded by the U.K.?

**Higashihara:** The delivery of the system to the British railways was a rough passage. We started our sales activities around 2000 and our first cars, Class 395, came into service in December 2009. Nearly 10 years elapsed for this project. However, the Class 395 cars came to have exceedingly high reliability thanks to JR, which provided us with various information including the manufacturing technologies for rolling stock. It is snow-resistant. There were many interesting episodes, such as a case in which only the Class 395 cars were running when all the cars of the other manufacturer stopped. I believe that one of the strengths of Japanese manufacturers is that high priority is given to quality. Now that the IoT technology has advanced this much,

**Class395 vehicle of UK**

Class 395 cars have sensors on the body, which are collecting all the train status information as Big Data. Using the data, predictive diagnosis is under way to find when a component is likely to fail and whether it should be replaced soon. We have already developed a technology of raising the availability through combined uses of IT (Information Technology) and technologies for manufacturing rolling stock. In the coming age of IoT, we will be able to supply vehicles with high levels of safety and reliability. When IoT is more advanced, even physical security can be ensured by, for example, detection of explosives on board or discovery of passengers who are exhibiting abnormal behaviors.

**Kumagai:** I think that safety is based on the culture, consciousness, and custom of a country or nation. In addition, there are levels of safety to be maintained, and the same safety level must be maintained by all of the parties involved, including manufacturers of equipment, operators of railways, and research and development personnel. A year after I joined the former Japanese National Railways, I worked as a driver trainee and learned how high a priority was given to safety. The safety system of railways became very apparent to me when a driver drove the train through a station, through a crossing, and down a steep slope. I once wished that there were a system for advancing train safely when a distant signal light was invisible with mist. In this sense, a driver is also a safety checker who stands face-to-face with a safety system. All things including control of a

train or monitoring of the status of rolling stock and tracks are taken into consideration in driving operations. These considerations must be consistent with the principles of automated driving.

## Safety in the era of AI (Artificial Intelligence)

**Higashihara:** I am originally a computer specialist but I don't think computers are panaceas for everything. I believe that, after all, the senses of a driver or the integration of human-based and computer-based systems are essential in improving safety.

**Kumagai:** Pardon me for going off the track. If artificial intelligence is to be used for automated driving of automobiles, it will give rise to new discussions about such things as how licenses and responsibilities for driving should be. We will need to cope with such issues as whether safety of driving is changed by new technologies and determine the directions for further improving safety.

**Higashihara:** At present, various IT manufacturers and automakers are performing considerable research on automated driving. It seems to me that the safety concepts developed by JR, i.e., control, interlock, and protection, are something that must be incorporated into automated driving and that development of laws in this regard will also be required. Technologies are also important. It will not be enough only to find a car ahead and calculate appropriate speeds and inter-vehicular distances. We must consider how the protective device should activate if the checking mechanism is broken. Checks performed by a third party will be required. Such systematic approaches still have many elements that must be studied. In this regard, I hope safety technologies for railways will be applied not only to the world of railways but also to the automated driving of automobiles in the future.

**Kumagai:** Development of artificial intelligence is an effort to give intelligence to machines and make them self-sufficient with pseudo-personalities, isn't it? I envision a world in which machines check each other. There will definitely come a time when computers either have complete control of trains or give support or protection to train control.

**Higashihara:** Alternatively, robots may be introduced to play a supplementary role for drivers and provide second opinions. That may be a starting point.

**Kumagai:** If human errors are known to occur at a certain probability, checks performed by machines may help reduce risks of human errors when conducting operations.

**Higashihara:** Yes, I agree.

## Quality from manufacturers' point of view

**Kumagai:** As a manufacturer, what does Hitachi do to check safety?

**Higashihara:** We already have a checking system for quality control at a factory. Using a considerable number of installed cameras, the behavior of workers is checked to eliminate unsafe behaviors and ensure quality. Additionally, there is already "image surveillance" or image analysis technology that allows users to compare what old hands and novices do and use the result for training of novices. We will apply this technology although I don't know to what degree. In the case of

automobiles that we mentioned earlier, we can naturally prevent drivers from dozing off by installing a camera onboard. At present, GPS (Global Positioning System) is available to provide a function of sounding a warning beep if the vehicle is not taking a correct route.

**Kumagai:** I visited your Kasado Works in March 2016. At all the assembly lines, image processing was used frequently to prevent mistakes and automated measurements, and IT technologies were put to great use. Such efforts for improving reliability are improving the quality of Japanese products.

RTRI is also pursuing improvement of quality when working to provide the outcomes of railway technologies. We hope to further enhance the relationship of trust with research institutes, JR, private railways, and manufacturers. However, different organizations and individuals expect varying levels of quality and therefore we think that coordination of these organizations is an important task.

**Higashihara:** In the future, the Japanese railway technologies will be exported to other countries as one package including things that range from railway vehicles to signalling operations. When the word "quality" is used in such cases, there can be various discrepancies, such as assumption of different levels of quality between Japan and destination countries and, consequently, estimation of different costs. I personally believe that safety must be given top priority for railways and so I am basically against compromising with lower quality. Conversely, we must find a way to help the other party understand the high quality levels of Japan and not to let vehicles and systems be evaluated only by their initial prices or cost. I think that the total life-cycle cost should be used for evaluation, in consideration of how many failures occur after use for several decades. In a case of large package export from Japan, a system of price evaluation should be proposed by us. Otherwise, the true advantages of Japanese products may not be understood.

**Kumagai:** Regarding our products that are commercialized as a result of research and development, I think we need to describe how we think they should be evaluated not only by considering the initial cost but also the life-cycle cost including maintenance and

investment effects.

However, it seems that low cost is often chosen over high quality when Japanese technologies are exported to other countries. I think we will have to show considerable evidence to promote understanding about the importance of quality. Mr. Higashihara, what were the difficulties you had in this regard?

**Higashihara:** I agree that the prices quoted by the Japanese manufacturers seem higher if only the initial prices are compared. In particular, the production in emerging countries offers lower costs because of economy of scale due to mass production. All is well if all of their products are high-quality and inexpensive but no such luck. We may have to spend five or ten years to achieve proper evaluation of our products but we do not have that much time to spare. In these last five years, I talked with various customers overseas and found that the quality awareness was rising in many countries. Recently, I visited several Asian countries and talked with customers and increasingly more of them said quality was more important after all. This trend is accelerating. I certainly would like to make the advantages of Japan known to the world.

**Kumagai:** Just after the WWII, Japanese products


**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