Railway Technology Achievements and Issues —Problems Over the Years

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Introduction

Railways have been responsible for the creation, cultivation and development of railway technologies. To effectively use these technologies for railway management, we should start discussions from 'classification' of technologies. As far as I know, such essential debate rarely occurred at the former Japanese National Railways (JNR), and discussions tended to merely preach the importance of technology. Even after the privatization of JNR, there were little changes in such trends, and railway experts who were worried about this worked with me to arrange for talks on related problems at symposia, at lectures, and in railway magazines.

To summarize my assertions, railways use both 'technologies that can be purchased' and 'railway-specific technologies' that railways must develop on their own. There still exist a lot of problems to solve with technologies that fall into the second category, such as theories related to preventing derailment and train operation. Such technologies must be cultivated based on the initiative of management, because individual engineering departments that dominated in the former JNR headquarters ceased to exist. With the JNR's vertically divided bureaucracy, such technical departments defended their own territories, paying heed to cultivating technology. It is good to hear that 'cultivation of railway-specific technologies' is being talked about recently, even if this has not come about by consideration of my assertions.

People might think that 'technologies that can be purchased' means leaving everything up to manufacturers, but that is not what I mean to imply. This problem is emphasized in this article.

Technical Progress in Railway in JRs' 25 Years

Various technologies have been introduced since the JNR division and privatization, helping stabilize the JRs' managements and strengthening their foundations. Examples include fully automated ticket gates using IC card tickets in stations, automatic route control systems in train operations, AC traction motors in EMUs, extensive track inspection by high-performance inspection cars, digital ATC in signalling as shown in the photo below (left), etc. Extensive introduction of new technologies straddling all these areas happened when passenger transport in some

Testing is being done on digital ATC for commuter lines that allows intervals between trains to be kept to a minimum. Maximum operation speed is displayed in the cab. The signal ahead is not lit. Photo taken on May 2010, on the Keio Sagamihara Line. (Author)

Tokens were exchanged at the Kobotoke signal station where passing was impossible. This station was on the longest section between stations (Takao and Sagamiko on the Chuo line) in the greater Tokyo area. (circa 1960. Author)

regions switched from conventional narrow-gauge lines to shinkansen. With the introduction of new technologies, progress was made in automating manual work as shown in the photo below (right). Updating old rolling stock and machinery improved performance and maintainability, reducing labour and equipment costs and strengthening management foundations. Moreover, the switch to shinkansen provides high value-added services, increasing passenger numbers and improving business conditions.

However, most technologies bringing improved business conditions were not railway-specific. Many were new technologies developed by general industry. Railway business improved by riding the wave of technical innovation in such fields as information processing and communications, semiconductors, new materials, sensor and metal processing technologies. In other words, not all but many improvements came from buying technologies developed by general industry with no connection to railway-specific technologies.

IC card train tickets are a typical example. However, there were noteworthy great efforts made by engineers belonging to both railways and manufacturers in introducing IC card technology into the railway ticketing system. Quick response and reliable communications were required with the ticket gate corresponding to the credence to a currency. In just the greater Tokyo area alone, the database for JR East and other private railways includes a staggering number of combinations of departures and destinations, and fares for each combination. This database needs to be segmented and different data for each station must be distributed to all stations. Remember, the instant that a thin IC card with revolutionary high-level functionality and data is touched at the destination ticket gate, the departure station recorded in the card must be identified, the data for the fare from the departure station read from the station database, and that fare subtracted from the amount stored in the card with high reliability. Yet, when this system was developed, there was no system on the market that could instantly process such operations using a thin and small IC card. Railways' purchase of these technologies, helped spread them to other industries and technical innovation would have been encouraged.

The engineers and managers who decided to purchase the technology should be praised for predicting that the huge initial cost would be recovered with additional value-added contribution to railway business. However, from the perspective of the fine details of IC card ticketing, I think it would have been even better if the following special situations had been debated when expanding the system to private railways.

Japanese railway operators maintain their own individual fare systems. When travelling with an IC card on different railways, there are some junctions where ticket gates are not

Yoshinoguchi Station where JR West and Kintetsu trains arrive and depart at the same platform has limits on use of IC card tickets as noted on the bulletin signpost. Photo taken on December 2009, on the JR West Wakayama Line. (Author)

installed (see above photo), and in some other cases, two different railway companies operate a through service where passengers are not required to go through a ticket gate at such junctions.

This situation creates a major problem system-wise with the lack of accurate records of transfer between different railway operators. However, this problem has not been overcome completely even today. Another example can be seen when going from JR East's Musashi-Nakahara Station (Nambu Line) to JR East's Harajuku Station (Yamanote Line) via Tokyu's Toyoko Line, changing trains at Musashi-Kosugi and Shibuya stations. In such a case, the charging distances of the two JR lines should be aggregated by the rule, .but the passenger travelling with an IC card ticket between the two station has to be charged higher fare than the specified fare. Regrettably, the solution to this problem has not been found so far.

I do not mean to criticize these hard-to-imagine IC card ticketing problems nor the people who put tremendous effort into development of IC card ticketing. What needs to be said is that when introducing technologies from general industry to the core of railways, detailed discussions on railway operations are needed even if the manufacturer has many engineers who specialize in railways.

It goes without saying that it would be best for railway engineers in charge to be knowledgeable about the details of current work being done by railways when replacing equipment by purchasing new technologies. However, there are actually very few experts with good knowledge of rules dealing with transportation between different operators and the structure of joint stations. So it may be necessary to foster specialists in operations spanning all railway fields, rather than limiting specialization to technology.

Example of Technical Issues

The previous section explained problems occurring when introducing technologies that seem to have little to do with railways. Such problems are seldom thought to occur with purchased railway-specific technologies because both railways and manufacturers have many experienced engineers. However, many problems have occurred in this field over the last 25 years. Rolling stock is a good example.

Rolling stock is one of the most complicated railway technologies. In the heyday of railways, the Ministry of Railways had a group of many engineers specializing in rolling-stock technologies. In steam locomotives, specific parts were designed under direct supervision of the Ministry and some steam locomotives were built by several workshops of the Ministry during World War II. As traction was modernized from the 1950s, more new stock came into use and steam locomotives were cut back; design under direct railway supervision was no longer possible. However, shinkansen and difficult-to-build heavy-duty diesel locomotives were developed by something close to direct supervision. In the early 1960s, when a lot of new rolling stock was built, there were some 200 people working in the Rolling Stock Design Office presiding over development.

The name was changed when it was integrated with the head-office Rolling Stock and Mechanical Department just before the JNR division and privatization, but the office functions remained unchanged. However, some of its functions were simultaneously discontinued when the JRs were founded. The reasons are unclear, but it was said that the huge authority of deciding specifications related to rolling stock had been, on occasion, used inappropriately.

The word 'rolling stock design' evokes an image of working in front of a computer, drafting drawings and making calculations. But the primary work is deciding specifications of purchased parts along with reviewing and approving designs offered from manufacturers. This is much the same as automobile manufactures' designing. In the process of deciding specifications and approving designs, engineers are often forced to make critical decisions that might have an impact on manufacturers. Establishment of specifications and approval of diagrams must be strictly impartial to assure safe and better rolling stock, so high-level professional knowledge about rolling stock is needed. However, I am inclined to think that when JNR was said to be falling into ruin, the aforementioned inappropriate use of authority might have occurred on rare occasions due to the labour issues and political pressure.

About 20 years after most functions of the JNR Rolling Stock Design Office were discontinued, the head offices of JR East and JR West created groups of rolling-stock engineers with roles very similar to those of the JNR Rolling Stock Design Office. It meant creating technical sections that were not directly related to day-to-day business at each head office, such as rolling stock inspection, operation and repair. Meanwhile, JR Hokkaido created the Rolling Stock Department in the head office as a separate entity in late 2011; previously it was simply a section within the head-office Transportation Department.

In the JNR era, there was the Structure Design Office for establishing standard designs and specification documents for railway infrastructure, such as bridges and tunnels. Although its role was slightly different from that of the Rolling Stock Design Office, it too was disbanded at privatization. Yet JR East and JR West restored groups with the same roles as the JNR Structure Design Office at about the same time as creating the new groups of rolling stock engineers.

Looking at the recent organizational changes, if railways are to gain technologies contributing to railway management, they should foster railway engineers who have professional knowledge and can purchase technologies appropriately.

Future Issues in Progress of Railway Technologies

Although the technologies mentioned so far may contribute to management, their main purpose is to reduce management costs. As the Japanese population size declines, the number of railway passengers must drop too, especially in the rural areas. Taking this into account and the fact that it is practically impossible to abandon local lines, engineers should develop new markets for railways and actively increase the work of people involved in the Japanese railway industry. This is in addition to ideas to encourage users of other transport modes to switch to railways.

Many of the old JNR local lines that the JRs are making painstaking efforts to sustain are blessed with scenic beauty and famous sightseeing spots. Examples include the Senmo Line in Hokkaido, the Gono and Ban'etsu West lines in northern Honshu, the mountainous sections of the Koumi, Oito, Iida, and Kisuki lines in central and western Honshu, the Kisei and Kure lines in western Honshu, the Dosan Line in Shikoku, the Kyudai, Hohi and Hisatsu lines in Kyushu. The Uetsu and San'in *de facto* local lines on the Sea-of-

Japan coast could be included too.

Only JR East and JR Kyushu have trains departing from major urban areas for the explicit purpose of enjoying the scenery on these lines. As a result of those companies' long efforts in promoting revitalization of regional lines, sightseers comprise a large percentage of passengers on the Gono and Kyudai lines. Tourism stimulates trackside communities, and in the case of the Gono Line, tourists presumably make a large contribution to the company management by increasing shinkansen ridership from the Tokyo area. JR Kyushu is now planning a new luxurious sightseeing train to circumnavigate Kyushu Island, which is expected to drum up new passengers, including some from the Tokyo area. I hope to see such activities performed by all the JRs.

The *Resort Shirakami* sightseeing train on the Gono Line running between Akita and Hirosaki/Aomori is now more convenient for transport from the Tokyo area after the shinkansen extension to Shin-Aomori . Photo taken in May 2006, at Higashi-Noshiro station. (The Transportation News)

Management decisiveness is needed when setting up sightseeing trains, but purchase of new technologies is not always necessary. However, setting up sightseeing trains requires high-level operations knowledge. It is difficult to operate newly created sightseeing trains on these local lines because there are fewer stations where trains can pass as a result of years of declining operations. In fact, to operate additional sightseeing trains on the Kyudai Line, a large investment was made to restore a discontinued passing station by JR Kyushu.

When timetabling such new trains, railway engineers must have professional knowledge about the standard gradient on mountainous sections, nominal tractive capacity of locomotives according to the gradient, type of DMUs and its negotiating speed to the gradients on the way, effective track length of terminal and intermediate stations, the availability of equipment such as side tracks or pool tracks if trains stand for a long time, shunting signals or shunting indicators at the station where the train was shunted, crew transfer points and car maintenance depots when the train operates over long distances, and locomotive waiting tracks at stations where locomotives are changed. Moreover, when trains are parked overnight in very cold regions, personnel must be stationed on the train to keep the cooling water warm and prevent freezing, and careful consideration is needed on selection of the pool track to avoid complaints from residents near the station about noise from idling diesel engines. Under such circumstances, highly experienced engineers in train operation and rolling stock management are needed for quick and appropriate judgments.

While JNR only had a few engineers in charge of operational equipment who were well versed about main lines across Japan, they did exist. But how many people in charge at the JRs today know by heart the equipment at major stations although the length of their revenue lines is much shorter and the station operational equipment has been simplified? Cultivating such railway-specific operations knowledge is a precondition to setting up new sightseeing trains. ■

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