

Making Railways the Cornerstone of 21st Century Travel

Satoru Sone

Japanese Railways —Good and Bad Points

People take the train in Japan more than anywhere else in the world, both in terms of the absolute number of passengers and in terms of passenger-km, which is about half that of automobile travel and a greater proportion than in any other industrialized country.

Japanese trains offer extremely safe travel and are almost always on time. Even European railways, which boast fairly high standards in these areas, fall considerably behind Japan. But Japanese people generally do not think much of their railways and many would rather not take the train if they can avoid it. This is because the services offered by Japanese railways are not sufficiently passenger-friendly.

First, travelling by rail is often uncomfortable. Ride comfort has improved over the years and almost all carriages are now kept at an optimum temperature of about 25°C year round. But more than anything else, comfort depends on being able to sit down and Japanese railways often cannot offer everyone a seat. The infamous crush on Tokyo's commuter trains during the rush hour is a good example.

It is true that the root of this problem—overpopulation in the Greater Tokyo area—is outside the control of the railway companies, but trains in other parts of the country are also often overcrowded. Even shinkansen passengers discover that they have to stand on crowded services despite paying high surcharges. Even in areas where transport capacity must surely be adequate, overcrowding is seen regularly on some trains—for example, many local trains in the Tohoku district have more standing passengers than before.

Second, service is poor in other ways too. Major stations are so large that travellers may have difficulty finding their way through them. Schedules indicating train connections are posted somewhere, but how is one to know where? Travelling

with large pieces of luggage is a real challenge even for the young and athletic. Buying a ticket is sometimes a real test of mental ability.

Japanese rail fares are higher than those of other industrialized countries and family and group discounts are rare, so it is much cheaper for a family to travel by car. Even if one were to argue that rail fares are not overly expensive, if we consider just the cost of petrol and highway tolls, it is cheaper for two people to go by car than by train.

This apparent contradiction, where passengers pay high fares to board a train only to find they must stand in the aisle, is not necessarily caused by poor railway management. In Japan, most of the capital expenditure of railways must come from fare revenues. In other industrialized countries, it is considered normal for the government to subsidize rail services, but in Japan, passengers must assume the full cost. Japanese railways operate under rules that require them to pay their own way and must cut even basic services to maintain business efficiency.

Rail Averaging Out Means Poorer Services Overall

During the last decade or so, railway management practices have changed worldwide, partly due to the effect of the privatization of Japanese National Railways (JNR) in 1987. This evolution in management has led to changes in rail services.

As one example, many European railways have stopped handling passenger luggage. Years ago, JNR used to handle luggage but the service was poor. This opened the way to privately run, door-to-door delivery services that have been very well received. By the time JNR check-in luggage services were stopped, passengers felt little inconvenience because they had already turned to private services. This was not the case in Europe, where passengers had

been accustomed to consigning their luggage to the railways until the day such services were terminated. Today, luggage in Europe frequently gets lost because of lax handling at borders, or arrives later than it should.

For a while, security problems in Europe forced some stations to shut their left luggage facilities. This problem has been remedied, but a considerable number of Europeans accustomed to carrying many suitcases on their travels, have abandoned train travel because the railways do not handle luggage.

In various parts of the world, one encounters good rail services. For example, passengers in many countries can now board the train with their bicycles. This used to be possible in only a few countries. The practice is still rare in Japan, although a trend is growing.

In Europe, trains in the north used to follow schedules more zealously than those in the south. This north-south discrepancy has practically disappeared with even British and German trains recently showing an increasing tendency to run late or sometimes not at all. Conversely, Italian and Spanish trains now keep quite close to their schedules. Needless to say, dissatisfaction reigns among customers where rail services are deteriorating.

In the past, European rail companies did not return the express surcharge if a train arrived late. (Actually, many countries never had an express surcharge to begin with.) It is interesting to note that the surcharge return policy is now being adopted, partly as a result of the influence of Japanese railways. Spanish National Railways (RENFE) found that its drastic policy of returning both the surcharge and the fare if the AVE high-speed train is late by 5 minutes or more actually raised income because advertising this policy boosted revenues by more than the amount needed for such reimbursements. Rail schedules have recently become less dependable in Germany. Ironically, after

Deutsche Bahn AG (DB AG) began giving DM50 to passengers on some high-speed trains arriving 90 or more minutes late, instead of reassuring travellers, passenger levels fell because the policy gave the impression that German trains are frequently late. Incidentally, in some small European countries like Switzerland, the Netherlands and Denmark, trains continue to run on time.

In Britain, where the national railway was split up and privatized, rail service levels have actually declined. Railtrack became responsible for tracks, stations, and signalling equipment throughout the country, and as track conditions quickly deteriorated due to long-term lack of maintenance, so too has ride comfort. In addition, rolling stock is leased from rolling stock companies (Roscos) and a greater number of defects are being reported. Railtrack and the Roscos have been able to obtain government subsidies while racking up questionably high profits, leaving the railway operators struggling to do their best to improve services while earning neither praise nor profits for their efforts.

These are some of the problems that can occur when splitting up a large organization. From such examples, it appears that there is a general downward trend in services to levels that are not welcomed by the travelling public.

Ever since the USA practically eliminated passenger rail services many years ago, the nation's transportation system has revolved almost exclusively around the auto and airplane. But the inevitable resultant problems of congestion and pollution are now starting to be taken seriously. For example, there have been recent huge public capital investments in new guided city transportation systems; Portland (Oregon) and a number of other urban areas have seen remarkable improvements in their light rail systems.

I feel this turning point in rail services throughout the world offers an opportu-

nity for Japan to improve its rail services to the point where they become a model for other countries. Much needs to be improved—during the first 4 years after the JNR privatization and division, the JR group of companies adopted a number of innovative measures, but some of this energy has subsequently lost steam. A few companies in the group have been backsliding towards the careless JNR days, something that can only make passengers lose confidence in rail travel.

Future of Rail Travel in Asia

Over the last few years, Japan and other Asian countries have been suffering from a severe recession. Ten years ago, it was generally accepted wisdom that whereas Europe and North America had been the locomotives of the global economy in the 20th century, Asia would drive it in the 21st century. Some people argue that this wisdom was false. Whatever the truth, an Asian age is certainly approaching, although it remains to be seen whether this is entirely a good thing or not. Futuristic predictions often miss their mark, but we can generally trust predictions of future population levels. When we consider future population growth and look, no matter how cautiously, at predictions of future economic growth, there is no doubt that Asia's influence on the global economy and environment in the next century will be very great indeed.

China's economy continues to grow steadily and its population is stabilizing. If per capita income in China continues to increase at the same rate, and if per capita ownership of motor vehicles in China approaches that of the West and Japan, the number of traffic accidents and the environmental pollution will be horrendous. These are grave concerns, especially for Japan which is downwind of the prevailing westerly winds blowing from China. The acid rain carried by these

winds would cause serious damage to Japan's forests and crops. Although Chinese railways are developing more rapidly than in other parts of the world, both in terms of quality and quantity, some people in China are beginning to abandon the railway—once their only means of travel—for other transport modes.

Asian railways have much to learn from Japan's advanced railway system but the European railway industry is keener to promote rail's advantages and to help modernize rail systems in Asia. It is certainly true that some Asian countries have much to learn from European railway technology and services. Compared to their Japanese counterparts, European consultants are far more adept at giving flexible advice based on the local situation. And because rail markets in their own regions are relatively limited, European railways are actively exploring profits in overseas markets for their survival. Consequently, the European railway industry is different from the Japanese one. And yet many aspects of Asian culture may be difficult for Westerners to understand. There are bound to be differences between cultures—for example, the extent to which people are uncomfortable in crowded conditions, the importance of safety and crime prevention, opinions on optimum lighting and partitions, tolerance of noise, and expectations of a public transportation system. On the whole, these matters are seen quite differently by Asians and Europeans. However, when advising people of another culture, there is an unconscious tendency to assert one's own values. In this sense, it may very well be easier for Asian nations to adopt a similar rail system to that of Japan—where comfort levels are slightly lower but dependability and safety levels are higher than in Europe—than to adopt the rail system of a European country.

Japan adopted western technology as the basis of its railways and other transportation systems and then developed these

systems to suit its own needs. As a result, the nation's transportation systems now offer services that, although considered commonplace in Japan, would sometimes be regarded as unusual in the West. To plan an ideal transportation system for Japan and other Asian countries, it would seem obvious that the advantages offered by both Japanese and European transportation systems should be followed, while avoiding the respective disadvantages.

**Motor Vehicles
—Can Problems be Avoided?**

Whenever people become increasingly affluent they choose to purchase a car. The door-to-door convenience, privacy, ability to travel with luggage easily, and ability to come and go at will cannot be matched by other transportation modes. On the other hand, there is growing alarm over the damage caused by motor vehicles. In Japan, about 10,000 people die in road accidents each year with another 1 million injured. Automobile exhaust pollutes the air of cities worldwide. For many people, these problems are becoming unacceptable. In today's automotive society, automobile manufacturers want to sell cars but hope that cars will not be used. Meanwhile, car owners want to drive but hope others will cut down on car use. If car owner-

ship could be limited to an elite group, the car would be an ideal form of transportation for that group, but in democratic societies, where everybody can own a car, the social and environmental repercussions are too great.

Of course, the convenience of owning a car is very difficult to give up, so it is no wonder that many people, including those in the automotive industry, are working hard to eliminate the negative effects.

With all this in mind, what does the future hold for the automobile in terms of safety and the environment? Motor vehicles can be made safer in three basic ways: by improving vehicle safety, by better controlling traffic and by enabling safe driving using Intelligent Transport Systems (ITS).

Literally, an 'automobile' would appear to be an automatic mobile vehicle. Although today's cars have a number of control mechanisms, the fact is that they are operated by humans. Airplane pilots, ship captains, and train drivers are all professionals with specialized knowledge and skills. Cars are driven mostly by amateurs who simply want to go somewhere.

Therefore, safety measures must attempt to overcome the inadequacies of human drivers. For example, automatic controls such as the anti-skid braking system (ABS)

can prevent long, uncontrolled skids, compensating for driver inexperience; improvements to the car's structure can reduce injuries in an accident; and seat belts, airbags and other safety devices can reduce injuries too.

Safety can also be improved considerably by regulating traffic flow. Linked traffic signalling systems have been used for many years in heavy traffic areas to permit larger traffic flows in the most heavily used direction. The result is groups of cars travelling at moderate, more regulated speeds—in effect, improved safety. Special signal controls at complex intersections also reduce accidents.

Japan has already adopted computerized traffic controls in many urban areas. In the future, cities may use Traffic Demand Management (TDM) systems to control traffic flow into urban centres and reduce traffic jams. The system is not designed specifically to increase traffic safety, but more regulated driving and reduced driver frustration make for safety. The long-term drop in annual road deaths in Japan from about 15,000 to 10,000 is mainly due to safety measures like those mentioned above.

In Japan, it is thousands of times safer to travel by train than by car (Table 1). No matter what safety measures are taken, automobiles will never be as safe as railways because automobiles are more prone to driver error. Even with their high-safety signalling systems, railways suffered from repeated serious accidents until the Automatic Train Protection System (ATS) was introduced to prevent human error. Intelligent Transport Systems offer a new automobile safety concept that is not merely an extension of existing safety techniques. The systems promote automatic and therefore safer, driving based on a 'track' system. Research in this field is being conducted on a global scale, and involve far greater investments of capital and human resources than R&D investments being made to improve rail

Table 1 Train and Motor Vehicle Safety (FY1997)

	Motor vehicles (M)	Trains (T)	M/T
Passenger-km (V)	944972	394933	2.393
Number killed (D)	9640	1	9640
Number injured (I)	958925	250	3836
Death rate (D/V)	1.02	0.00025	4029
Injury rate (I/V)	101.48	0.0633	1603

Unit for V = 1 million passenger-km
 Unit for D/V and I/V = Number of people killed (injured) per 100 million passenger-km
 Note: The number of people killed or injured in train-related incidents only indicates passengers and does not include train crew.

systems. In the initial stage, steps are being taken to develop information systems, automated navigation systems, and technologies to pay expressway tolls without stopping. The objective is to smooth traffic flow (an obvious advantage to users). Positive results have already been seen.

A well-known safety element in this project is the Advanced Highway System (AHS). Research has already begun in Japan into AHS-i (which provides information), AHS-c (which supports control systems), and AHS-a (which permits automated driving). The system promotes safe driving by guiding motor vehicles along electronic 'tracks' on expressways and other major highways, in the same sense as rails guide a train. Signal wires are laid under traffic lanes and aerials mounted on the left and right sides of cars detect field variations; the car's automatic controls use this information to keep it in the centre of the traffic lane. Speed is controlled automatically by regulating the distance between vehicles ahead and behind, preventing front, rear and side collisions. Basic research into the system started in Japan in the Mechanical Engineering Laboratory of the Agency of Industrial Science and Technology (under the Ministry of International Trade and Industry) as long ago as the 1960s. Small-scale experiments have shown good results but it will take time to put the system into practical use. Although ITS research has become a huge international project, practical application is not anticipated before 2010 at the earliest. The high cost involved in modifying highways and vehicles is one major reason for this delay. Even if the AHS works well, it will be limited to special roads, especially expressways. Furthermore, every vehicle using such a road would have to be equipped with AHS-a devices, otherwise the collision risk would be too great.

We should note that only about 3% to 4% of the annual 10,000 road deaths in

Table 2 ITS Developments and Achievements

1. Advanced navigation systems: Vehicle Information & Communication System (VICS) now in use
2. Electronic Toll Collection system: ETC systems now in use in some cases
3. Support for safe driving: Development of AHS started
4. Fine-tuning of traffic management systems: Traffic signals give priority to public transport
5. Raising road management efficiency: Construction information provided
6. Support for public transportation: Provision of traffic information
7. Raising commercial vehicle traffic efficiency: Support for dispatch planning
8. Pedestrian support: Provision of information regarding routes and facilities
9. Support for emergency vehicle traffic: Emission of alarms; guidance mechanisms

Japan occur on expressways, i.e., on roads where this system would be used. This suggests that ITS will have limited results as a road safety measure.

The other major negative aspect of the automobile is pollution—air pollution, of course, but also noise and vibration pollution. These latter two types only affect people in the immediate vicinity of a heavily used road, and are transient inconveniences that can be mostly alleviated by spending the required sums of money. However, motor exhaust is a serious global problem that threatens the existence of every person. Automobile manufacturers have spent many years attempting to remove harmful particulates from exhaust gases. For their part, many governments have gone to great lengths implementing strict regulations to cut down on harmful emissions, and have had some success in reducing gases caused by incomplete combustion. However, carbon dioxide and sulphur oxides are much harder elements to remove because they are intrinsically part of the combustion cycle.

Zero Emission Vehicles (ZEV) that emit no harmful gases are now being developed. These vehicles cannot be used to the same extent as conventional vehicles, but if governments provide tax incentives to compensate for the slightly higher purchase cost, electric cars will soon become widely accepted. Can we assume that this is good news? While the ZEV itself does not emit any harmful gases, if the electric energy used to charge the batteries comes from a fossil-

fuel power station, it is certainly causing air pollution indirectly.

A comparison of conventional cars, electric cars, and electric trains shows that each differs greatly in its impact on the environment. (This comparison examines electric cars and electric trains drawing their energy from a power station that uses the same carbon-based fossil fuel as that burned by a conventional car.) The power station emits H₂O, which is harmless, and CO₂, which is the main culprit in global warming. The more energy produced by the power station, the greater the emission of both H₂O and CO₂. The power station also generates other harmful waste products such as carbon (sooty smoke), sulphur oxides (the main cause of acid rain), and nitrogen oxides, but they are almost entirely removed from the stack gases by scrubbers. While scrubbing is effective in large power stations, it cannot be used to remove these gases from a conventional car exhaust, due to the car's small size. Consequently, there is a limit to the amount of carbon and nitrogen and sulphur oxides that can be removed from car exhaust.

When we compare an electric train with an electric car where both draw electricity from the same fossil-fuel power station, we see a significant difference in their impact on the environment. Steel wheels on steel rails encounter far less friction than rubber tyres on asphalt, and therefore use less energy. In addition, about 30% of the energy required by an electric car is lost in charging and discharging its batteries.

However, there are pitfalls in simple comparison between electric trains and electric motor vehicles, because they are used for different purposes. In particular, studies in Japan show that CO₂ emissions per passenger-km from an electric car are still about four times greater than those from an electric train when both are operated under average conditions for their respective uses.

Time To Make Rail Travel More Popular

There is a growing worldwide interest in railways as the main answer to the problems created by automobiles. And because Japan is the world's largest user of rail transport, one would think that Japan is the logical choice to develop the ideal railway system. However, many Japanese passengers avoid taking the train if they can. Some employees of railway companies have been assaulted, and in extreme cases passengers have come close to rioting because of delayed trains. Britons have been embarrassed by similar incidents in recent years because trains are running further behind schedule.

What would be the best way to improve rail travel and achieve more friendly relations between railways and their passengers? To answer this question, perhaps we should look at Switzerland, a country with the heaviest use of railways in Europe. The Swiss have spent much more effort building and improving their railways than they have on roads and facilities for automobiles. The track length per km² and per person is 1.7 and 3.3 times greater, respectively, in Switzerland than in Japan. Since 1982, public transportation schedules for the entire country have been greatly upgraded and ridership is steadily increasing as a result.

However, Switzerland, like other European countries, has also built an extensive expressway network with a length per person of about 4 times that in Japan.

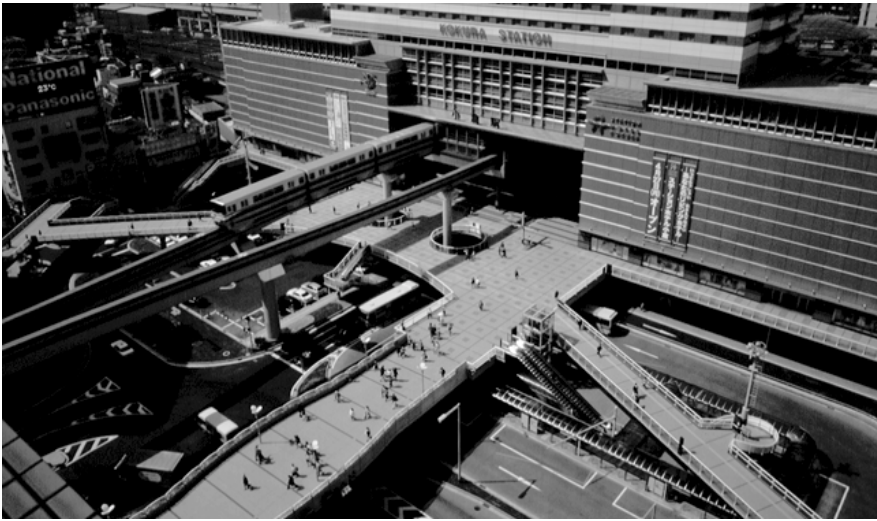
Switzerland is situated between Germany and Italy and is a central hub in Europe's north-south international transport routes. However, the Swiss government policy of favouring rail transport has led to strict regulation of heavy lorry traffic, causing much international criticism—for example, 40-tonne lorries are permitted in other European countries while the Swiss limit is 28 tonnes. To deflect this criticism, Switzerland has proposed greatly increasing rail transport capacity on the 100-year-old St. Gotthard route while protecting the environment by digging a new 57-km St. Gotthard Base railway tunnel deep under the existing tunnel to carry heavy lorries on trains. If built, it would be the longest tunnel in the world, surpassing even the undersea Seikan Tunnel between Honshu and Hokkaido in Japan and the Channel Tunnel between England and France. The Swiss held a referendum to determine whether the people would approve the huge national investment for the tunnel construction. It was assumed that only a small majority of the population would approve, but a large majority did. This approval was the first concrete (and very welcome) indication that the Swiss people agree with the government's many years of effort to improve the public transportation systems and services with especially strong emphasis on railways. As I mentioned earlier, the relationship between some Japanese railway companies and their passengers has started to deteriorate. However, the relationship is still good in some other regional examples. For example, during the JNR period, the Kansai district experienced a steady drop in passengers, but the new JR West quickly brought back these lost passengers by speeding up trains, increasing seating ratios, and making train travel more comfortable. Late in the JNR days, Osaka Station on the Tokaido main line lost the status of being the most heavily used station in the Kansai district to Umeda Station on the private Hankyu Line. After JR West was

inaugurated, the company made every effort to improve rail services and Osaka Station soon regained the top position. The train schedules for quadruple-track sections have made comfort levels so high that they are a world model.

In another development, immediately after Kobe was struck by the Great Hanshin Earthquake on 17 January 1995, experts from the Railway Technical Research Institute (RTRI) were sent in a helicopter chartered from JR Central to the city to draw up reconstruction plans. This swift reaction was so effective that the JR lines were quickly reopened before the private railways running parallel to them and JR West now enjoys an even greater share of the travelling public than it did before the earthquake.

This is not to say that passenger traffic on other private railways in the Kansai district has declined. These private railways have moved ahead of railways in the Tokyo region by introducing the *Surutto KANSAI Card*, which passengers can use on most lines of different regional companies. Furthermore, season ticket holders between Himeji and Umeda can choose to travel on either the Hankyu or Hanshin Line for the section between Kobe and Umeda. These and other examples illustrate how the railways are competing and cooperating with each other to offer better services and improve the general position of railways.

Another excellent example can be seen in Kokura (northern Kyushu) where a monorail was constructed. The original plan, conceived during the JNR days, called for the line to terminate in the open space in front of Kokura Station. This was a standard planning approach for the time, partly because almost every railway in Japan did not like the idea of another company's innovative transportation system being constructed directly over their platforms. Consequently, although it was obvious that every passenger would prefer having the monorail terminate



Convenient link between Kita Kyushu Urban Monorail and JR Kyushu Kokura Station

(JR Kyusyu)

inside Kokura Station, JNR would never agree to such an idea, explaining why the plan was to terminate the monorail in front of the station.

However, local merchants opposed the monorail terminus in front of the station to such an extent that it was finally constructed even further from the station, on the far side of a major road intersection. Many transportation experts knew this was a foolish step and the unpopular and difficult change of mode soon led the monorail into the red.

After the JNR privatization, the newly formed (and visionary) JR Kyushu gave the monorail company the green light to not only build over the train tracks but to extend the monorail very close to the shinkansen tracks, making it very easy to transfer from one mode to the other. Passengers arriving in Kokura Station by conventional (non-shinkansen) train need only walk up one level to the monorail wickets. For a system that requires travellers to buy and show tickets for another rail service, this arrangement is almost as convenient as it could be.

As might be expected, the monorail's financial situation improved dramatically and it now operates in the black. There is every reason to assume that the JR Kyushu passenger numbers have also increased. The entire public transportation system in the area has improved through the cooperation of the two companies.

JR Kyushu's innovative management decisions have also improved rail transport in another part of Kyushu when the company started running express trains every 20 minutes between Hakata and Kumamoto. This is the only non-shinkansen part of the network where express trains run as often as three trains each hour.

There is still room for railways to improve and other innovative ideas would be greatly appreciated by passengers. I can only view the common trend of railways to put cost-cutting at the top of their priorities with consternation. This money-pinching approach is natural for companies that favour stockholders over passengers, but the repercussions from this short-sightedness can be seen in Britain, where railway staff now tend to avoid contact with passengers. The unfortunate result is that the position of public transportation deteriorates, leading to other, more serious results—greater global environmental degradation and more road

casualties.

In Japan, although demand for rail passenger services is so great that crowded trains are a common occurrence in some areas, railway companies are generally reluctant to invest money in ways to reduce overcrowding. They justify their lack of action by saying that the falling birthrate will soon result in less overcrowding. (Demographers forecast that the population will halve to 60 million in 50 years.) Also, if there is no competitive stimulus within a specific company, the tendency is to do nothing to improve the situation that customers face. In any event, one could hardly say the railways are doing their best to attract new passengers.

At this point in time, it is also questionable whether Japan can live up to its commitments made at the Third Conference of the Parties to the Convention on Climate Change (COP3, Kyoto 1997). To properly meet its international obligations, Japan will have to boost rail travel considerably by making important changes in the transportation sector.

In any event, more than the minimum required level of support is necessary from Japanese travellers to create a rail system that could serve as a model for other Asian nations. But if rail travel becomes the preferred transportation mode in Asia, the threat of acid rain to Japan's agriculture from China will fade! ■



Satoru Sone

Dr Sone is a professor of electrical engineering at the University of Tokyo specializing in transport system engineering and power electronics. He has long been interested in railways and is a noted authority and advisor on Japanese government transport policies.