Vice-President's Address in Scandinavia

Information Processing and Control in Railway Systems*

Thank you, Mr. Chairman. Ladies and Gentlemen. I am happy to have the opportunity of being here today. This is my first trip to Stockholm, Bergen, Copenhagen and already I find this city to be a delightful place. The theme of my talk is information processing and control in railway systems—a field in which I have been deeply involved for the last 30 years with the Japanese National Railways, better known as JNR.

I come from Tokyo, a city of eleven million people, where there is a train and subway system covering the whole city. JNR is a public corporation managed by the government. In most other countries the railways are managed by the state and local public authorities, but unfortunately they are all in the red. Japan's JNR is not-an exception.

It is interesting that at one time in Japan the railway was thought to be a declining industry—but this notion changed with the debut of the "Bullet Train" in 1964, the year the Olympic Games were held in Tokyo. In Japan the "Bullet Train" is called "Shinkansen" which literally means "new trunk line".

I imagine some of you have been to Japan and have ridden on the Shinkansen from Tokyo to Kyoto or Osaka. If you had thought that it would be faster to travel between these cities by plane, you might have been surprized to find out that the total traveling time was about the same. The maximum speed of the Shinkansen is two hundred and ten kilometers an hour—so of course airplanes are faster, but taking into account the time to and from the airport, the total time is not much different. Besides, Tokyo Central Station is conveniently located, and there are the added benefits of frequent train service, greater availability of seats, and lower costs. Osaka, the second largest city in Japan, is five hundred kilometers away from Tokyo. It takes only three hours and ten minutes to get there by train.

The first Shinkansen train of the day leaves Tokyo Central Station at 6 a.m. and the last train comes in at midnight. In one day, about two hundred trains are operated, and they transport about four hundred thousand passengers, which is equal to the population of a rather large city in Japan. When you think about the operation of the Shinkansen from the standpoint of safety, it is noteworthy that since the beginning of its operation in 1964, it has carried more than thirteen hundred million passengers, without a single casualty.

The technology used for the Shinkansen was first designed more than 2 decades ago and it is constantly being updated. I would now like to take up the main part of my talk today on computer information processing and control systems in JNR including the Shinkansen.

I wish to begin with a general discussion of the strong and weak points of the railway.

Among the many features of the railway, the most important is that it has its own exclusive route, unlike other means of land transportation. While this feature is a merit of the railway, it does have its demerits.

First, the merits. Since a train runs on a one-dimensional track, the mode of train operation is very simple. That is to say, the operation consists of only accelerating, coasting, and braking . . . no steering, of course. In addition from the viewpoint of space utilization a railway is also a highly efficient means of transportation.

Next, the demerits. For safety and efficiency, trains must be operated under a single rigid schedule called "train diagram". Unlike automobile traffic, the amount of railway traffic can be predetermined because it is operated under a scheduled train diagram. Whereas automobiles run on public roads, the railway operates on its own exclusive track; therefore the ratio of fixed assets is high. This impels us to make the greatest use of the facilities according to an efficient diagram. But, on the other hand, an efficient schedule lacks in flexibility especially when the schedule has to be changed in the event of a failure. It normally takes quite some time to reschedule the traffic.

Since there is an imbalance between efficiency and flexibility, the main task of the future railway is to increase both efficiency and flexibility. The high efficiency merit has been achieved by the system of signaling. So, I will touch upon it first. Then, I will explain how to overcome the lack of flexibility demerit.

A train operates by position control and speed control along its own route. Two trains running on the same track have to be separated by more than the braking distance, in order to avoid collision. For this purpose, the concept of blocking was introduced at the beginning of railway history. The track is divided up into units of a certain distance with each unit called a "block". Only a single train is permitted to enter one

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block. This concept of blocking was also adopted for the "Shinkansen" system.

I would like to give a brief history of the signaling system in Japan. The oldest method which was adopted on a single track line is a very simple one. Only one block exists between two adjacent stations. That is to say, only one train is permitted to run between one station and the next. The tool for this signaling system is called "tablet", but this "tablet blocking system" is not a highly efficient way nor is it a safe one since, it is manually operated.

After that, the automatic signaling system which utilizes electricity was developed. Electric current is transmitted through a pair of rails for each block. When a train enters a block, the pair of rails in that block is short-circuited by the train axles, and an electric signal current is transmitted. The existence of that train in the block can be recognized by the electric current. The driver can operate the train by watching the wayside signal lamps. Thus, a safer and more efficient train operation became possible through the automatic signaling system.

A more advanced signaling system is called "ATC", which stands for "Automatic Train Control System". The Shinkansen adopted this "ATC". As I have said, the Shinkansen runs at the speed of more than two hundred kilometers per hour. This makes it very difficult for the driver to acknowledge the wayside signal. Therefore, we developed cab signals which work by receiving information from the electric signal current running through the rail. In addition, the brake works automatically according to the indication of the cab signal. We can say this is an automatic speed control system.

Now, I'd like to speak about the history of another aspect of the signaling system which is how to handle a lot of route switches and how to choose the correct route in the stations and in the marshalling yards. Once the correct route is chosen and all the relevant route switches are handled, the route switches must not be reversed before the train runs through the route. For this purpose the "interlocking system" was developed.

In the beginning, only a mechanical interlocking system existed. But, after the electric automatic signaling system was introduced, an electric interlocking system was developed. Later on, the use of a logical circuit composed of relays improved the interlocking system. The relay interlocking system enabled the operators to handle the complicated route switches more accurately and more rapidly. We adopted the relay interlocking system in large stations and in large marshalling yards.

At first, operators, handled the relay interlocking system at each station. Then, a remote operation was developed by using telecommunication technology. Several operations at different stations were centralized at one place. We call this "Centralized Traffic Control or CTC".

As a result, the computer came to operate this CTC, instead of the operators. Here, the computer appeared in the signaling system for the first time. This system, called PRC, stands for Programmed Route Control System. As to the Shinkansen, we developed a new computer system called COMTRAC. This system, COMTRAC, not only has the function of the PRC but also other functions, namely those of resource management such as train operation planning, and rolling stock utilization planning. Moreover, this Shinkansen computer system also has the function of changing the diagram for recovery from unforeseen disturbances in train schedules.

I have mentioned the history of the signaling system. In the beginning, the task of the signaling system was only to assure safety, whereas, the Shinkansen system became capable of not only assuring safety but also of being able to partially manage product control.

As I have said, the railway lacks flexibility. What should we do to make the railway more flexible? There are two problems. One is demand projection and the other is product control. And also, we have to combine demand projection and product control. I believe that the answer is in the utilization of the computer. In this sense, the Shinkansen computer system, COMTRAC, has entered the field of product control a little.

Now, as for demand projection, I would like to take this up from two sides, that is, the side of passenger traffic and the side of freight traffic.

In transportation, production and consumption generally occur simultaneously. We cannot store the products of transportation. Therefore, accurate demand projection is indispensable for efficient traffic management.

First, passenger traffic. Demand projection for passenger traffic can be divided into two phases, short and long term projections. We can make a basic long term projection from statistical data in regard to the number of passengers carried or the number of tickets issued. Traffic investigations offer useful data for this projection. Computers are useful for gathering and processing this kind of statistical data.

As to short term demand projection, the seat reservation system provides valuable data. We have to change the plans for train operation in accordance with the demand. In case of a full booking, we have to operate one or more special trains. Accurate demand projection will produce profitable trains.

Next, I will explain about freight traffic. Freight traffic is different from passenger traffic, because freight cars are moved at the request of the customer. The station clerk receives the order from the customer, and the clerk reports the order to the freight control center. The central staff finds an empty freight car and gives instructions to move the car to the station. This is the basic flow of freight operation. The computer system of JNR does this job with regard to express freight and container trains.

There is another important job in freight traffic.

It is to transship goods from truck to freight car at the station, and to switch freight cars in the marshalling yard.

Several automatic yard control systems have been developed in JNR. In the future, the total computer system of freight traffic will have to involve freight car allocation and switching.

Now, I would like to touch upon the computer systems in JNR. We planned a total information processing system for the twenty-first century railway. This total system consists of three points: The product control system, the demand projection system for passenger traffic and the demand projection system for freight traffic. Needless to say, the demand projection systems can be combined effectively with the product control system.

Here, let me introduce the passenger seat reservation system, called MARS, which is a sub-system of the demand projection system. MARS was put into regular use when the Shinkansen commenced service. The initial system only issued reservation tickets at the ticket windows of the stations, according to customer requests. Afterwards, we connected MARS to the public telephone network which made it possible for customers to reserve seats directly by calling on push-button telephones. As a result, more customers came to make reservations, and we were able to project demand more precisely.

Although I have said that JNR's total computer system consists of the demand projection system and the product control system, there are indeed other supporting systems which are now being developed, these are the system for maintenance of installations and rolling stock and the system for management of materials, personnel and money. We still need much more time to accomplish a total system and I guess that, perhaps, JNR so far has completed only one tenth of this total system.

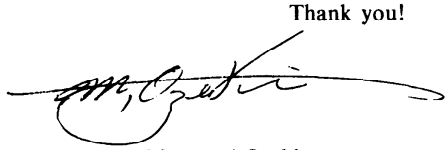
Lastly, before I finish my talk, I would like to speak a little about the relationship between man and the computer.

When there was no telegram or telephone, information was carried by man, namely, the means of transmitting of information was the same as the means transporting people. But the diffusion of the telegram and telephone made it possible to separate the transmitting of information from the transporting of people and letters.

This change brought about big social progress. I believe that the diffusion of the telegram and telephone brought about the first information revolution and now I think we are in the second information revolution which is being brought about by the computer. Although the telephone separated information from the movement of man, the judgment of information was still in human hands. However, now, the computer can partially make decisions in place of humans. The machine has come to partially take over the functions of the human. As a last thought, I would like to emphasize that the user of the computer is always man, and we have to remember that the host is not the computer but man.

Now my time is up. I am looking forward to seeing you again at IFIP'80 in Japan.

Thank you!



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