Feature

How Tokyo's Subways Inspired the Paris RER
(Interconnection with SNCF Suburban Lines)

Louis Sato and Philippe Essig

Introduction

Each time a new idea prevails, the initial difficulties are forgotten fairly quickly. In town planning and transportation, it is always difficult to design and execute a project that alters long-established practices. However, during the last 30 years, many metropolises worldwide have seen revolutions in the fields of transportation and urban traffic.

This article recalls the situation 30 years ago when a study of the Tokyo subway guided the design of the central station of the Paris RER.

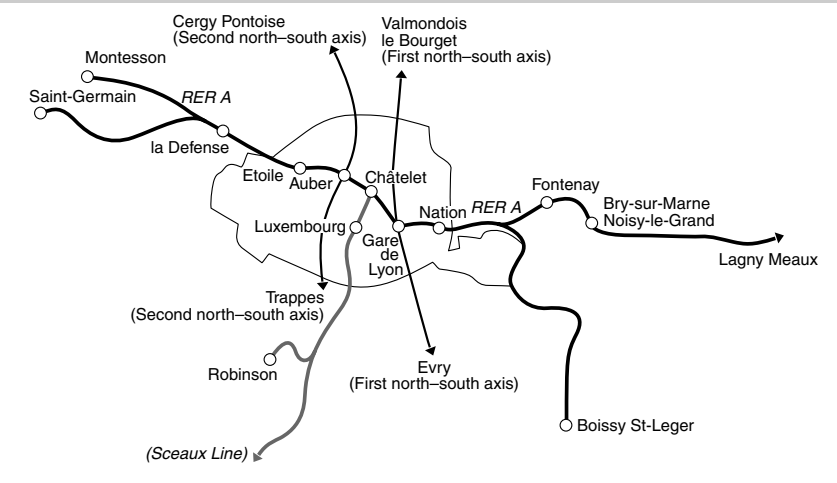
Paris Urban Network in Early 70s

In 1970, the Paris urban railway network was based on principles dating back to the turn of the century when the Paris metro was built. Commuter trains of French National Railways (SNCF) terminated at the Paris stations of Saint-Lazare, Montparnasse, Austerlitz, Lyon, Est and Nord and there was no line crossing Paris. The same situation applied to the Régie Autonome des Transports Parisiens (RATP) Sceaux commuter line serving the southern suburbs, which stopped at Luxembourg Station. The RATP Paris metro was mainly serving Paris and its suburban extensions were limited.

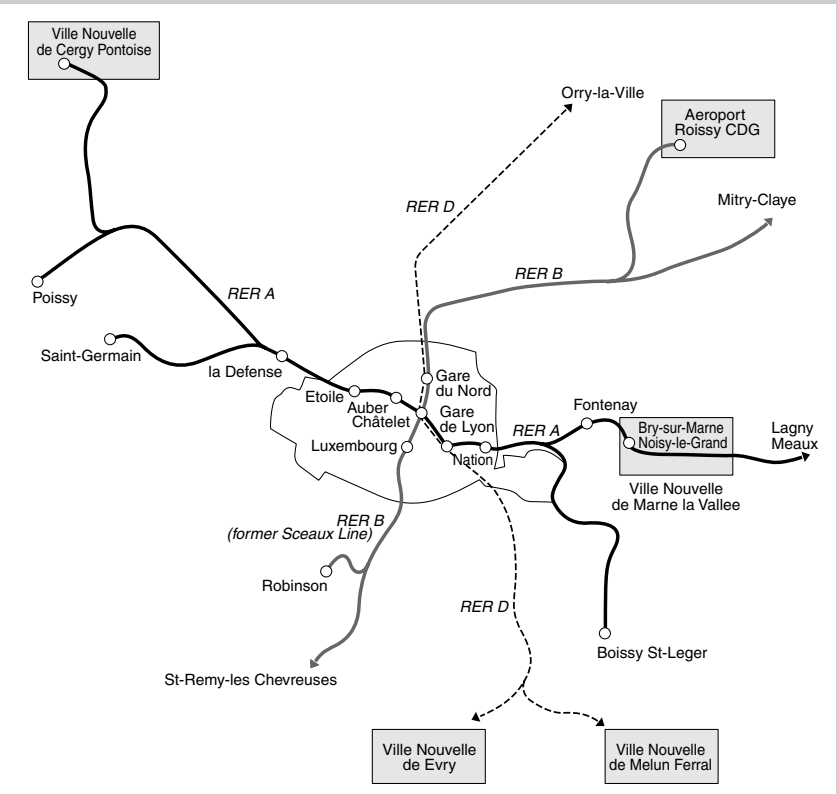
Moreover, SNCF and RATP were two distinctive public operators, running incompatible rolling stock on different gauges and standards; in practice, they were divided according to territory.

Despite this state of affairs, a major new project called RER (Réseau Express Régional) had been launched some years before with the aim of building commuter lines crossing the centre of Paris. The Master Plan approved in 1965 also included a northbound extension of the Sceaux Line to a new terminal with a transfer to Châtelet (Les Halles) new RER

Original Master Plan in 1965 for RER A and Sceaux Line Extended to Châtelet (Les Halles) Station



1972 New RER Concept



Central Station. The projects included in this scheme were granted major funding with the setting up of the new Ile-de-France regional authority. Construction of the east–west line through the centre of Paris (RER A) was proceeding quickly and there was an urgent need to decide the concept of the Châtelet (Les Halles) Central Station transfer between RER A and the extended Sceaux Line. However, two questions were delaying the project:

- Was it possible to conceive of cross-platform transfers between the RER A and RER B (extended Sceaux) lines?
- Might trains of RATP and SNCF one day use the same tunnel and would it be feasible to interconnect their networks?

These issues raised questions about well-established management practices and safety dating from the building of the first subway. However, solving these issues offered the potential of more economic design and more efficient services for users.

The second half of this article on the RER project (p. 38) by Mr Philippe Essig, who was in charge of these works at RATP, explains the importance of the issues and how they were resolved.

This first half explains the principles facing officials in charge of transport policies and urban planning.

Cross-Platform Transfer

In 1970, access to the Paris metro platforms was controlled by automatic gates that closed when a subway train entered the station. The gates could also be controlled in the case of unexpected events to prevent large crowds building up on platforms. In this case, passengers were held back in the subway approach corridors.

Despite the huge size of the RER project at Châtelet (Les Halles) Station (where a 17-m wide platform was planned), there were fears that a sudden surge of passengers onto the platform could not be managed and that safety would be a problem.

RATP–SNCF Interconnection

There was no precedent in Europe for a subway interconnection between different companies. Problems arising from rolling stock interoperability, safety, operating standards, rules, revenue and cost sharing, etc., were issues that no-one in Paris had experienced.

Steering Committee and Tokyo as Reference City

Today, the answer to these questions seems obvious and cross-platform transfers with 200-m long platforms and full-capacity trains have been in place for more than 20 years ever since the first SNCF–RATP interconnection with the opening of the RER D line in 1995. However, at that time, the solution did not seem obvious to anybody.

Mr Gerondeau, Adviser to the Prime Minister, established a steering committee bringing together the directors of the relevant public services, especially, Mr Laure, Prefect (governor) and Director of Equipment for the Ile-de-France Region, Mr Giraudet, the new Chairman of RATP, and Mr Stern, Vice-Chairman of SNCF.

Among the various studies launched by the committee, the search for a reference city was entrusted to a consulting firm where I was in charge of the town planning and transport department. We soon realized that the Tokyo subways represented the most relevant reference for Paris.

Of course, Tokyo is very different from Paris, not least because its population is markedly larger. Moreover, the behaviour of Tokyoites on public transport is different from that of Parisians. Finally, the structure and organization of the railway network in Tokyo is very unlike that in Paris.

The circular Yamanote Line running around the heart of Tokyo has no parallel in Paris. In the late 1950s, all the radiating private commuter lines like the Odakyu, Keio and Tobu ended at the Yamanote Line.

But the Tokyo subways saw an interesting revolution during the 1960s. Just like Paris, the early Tokyo subways had been built inside the administrative boundaries of Tokyo, and with a few exceptions, the lines terminated on the Yamanote Line.

However, the difficulties of making connections on the Yamanote Line coupled with the huge tidal surges of commuters, lead the Japanese Ministry of Transport to ensure that each new subway built in the centre of Tokyo had good interconnections with other railway lines serving the suburbs.

As a result, the Tokyo Metropolitan Government's (TMG) Asakusa subway line was connected with Keisei Electric Railway at Oshiage Station in 1960, and with Keihin Electric Express Railway at Sengakuji Station in 1968. The Teito Rapid Transit Authority's (TRTA) Hibiya subway line was also connected with Tobu Railway at Kita Senju in 1962, and with Tokyu Corporation's Toyoko Line at Naka Meguro in 1964. In each case, the central (mostly underground) section between the two connections is served alternately by trains of the subway operator (TMG or TRTA) and each of the two connected private operators. Similarly, the suburban sections on the outer sides are served alternately by trains of the subway and the private operators. The train crews usually change at the connecting stations. Sometimes, trains are terminated at the connection stations, but in such a case, cross-platform transfer is used to facilitate a quick change.

Similarly, Akasaka Mitsuke Station in the centre of Tokyo has cross-platform connections to the TRTA Ginza and Marunouchi subway lines, both of which have frequencies and traffic comparable to the busiest subway lines in Paris.

In view of this information, Messrs Giraudet, Laure, Gerondeau, and Stern of the steering committee decided to visit Tokyo to observe these operations and meet the people running these lines.

The Tokyo Visit

The steering committee visited the Tokyo subway in 1971 and saw the morning rush hour, the connection stations on the Hibiya Line and the cross-platform change at Akasaka Mitsuke Station. The committee was also fascinated by the operation of the JNR Chuo Line terminal at Tokyo Station. At that time, the Chuo Line was carrying more than 100,000 passengers per hour at an extraordinary load factor. The Tokyo Station terminus consisted of a single 10-m wide platform where 200-m trains controlled by entry switching arrived and left alternately. The headway between trains was about 120 seconds and 3000 passengers were getting off each train onto the single platform.

How Different from Paris

The first thing that the French mission noted was the different carriage layout. The cars had more doors that were all automatic and side bench seats, leaving more standing room. The passengers were more disciplined on the platform than in Paris, but moved with greater swiftness—they seemed more 'easy to handle'.

But despite these differences, the French mission found what it was looking for—a concrete example of how connections worked in a subway network with a similar design to Paris and separating the suburbs and the centre of the urban area.

Enormous difficulties had been overcome in Tokyo. The rolling stock sizes and standards, track gauge, power supply and sometimes even current type were different between the subway and commuter lines. Interconnection meant revising the standards and renovating lines while they were in operation.

However, each operator kept its identity and administration because the connection had been negotiated with well-defined rules. TRTA kept the operation concession for the tunnel in the central section, while the railway operators kept their domain in the suburbs. Although all trains ran through the central subway tunnel, the drivers changed at the connection stations and only TRTA drivers were authorized to drive trains through the central tunnel. Revenue and cost sharing were also agreed in a similarly simple manner.

At last, the reference frame for interconnections in Paris was set.

Cross-Platform Connections at Akasaka Mitsuke Station

Observation of Akasaka Mitsuke Station also made an important contribution. This old station was built before WWII for today's TRTA Ginza Line with curved two-storey platforms of varying width (about 11m max.). In 1959, the TRTA Marunouchi Line was opened and cross-platform transfer of passengers started between the two lines.

By 1971, the explosion of railway urban passenger traffic in Tokyo had reached a critical level. Subway trains were overcrowded, station staff packed people into carriages, passenger queues and flows were organized by lines on platforms, and movement was controlled by audible alarms. It was obvious that saturation had been reached. It was also clear that the passengers' situation was safer and less unpleasant when simply crossing platforms rather than going through passages and up and down stairs. Moreover, the famous Parisian subway gate clearly could not cope with the massive flows generated by a mass transit system.

Obviously, not every technique was transposable between Tokyo and Paris but we all knew that the questions faced in Paris could be answered by intelligent observation of this old saturated station in Tokyo.

Design of Paris RER Central Project

Tokyo proved that cross-platform interconnection was feasible and swept away all objections to its use in Paris.

Moreover, it stimulated our imaginations and allowed us to suddenly see the possibility of the RER central project in Paris and its interconnection.

The RER station at Châtelet (Les Halles) and the interconnection with the RER D line finally became realities.

The RER Project

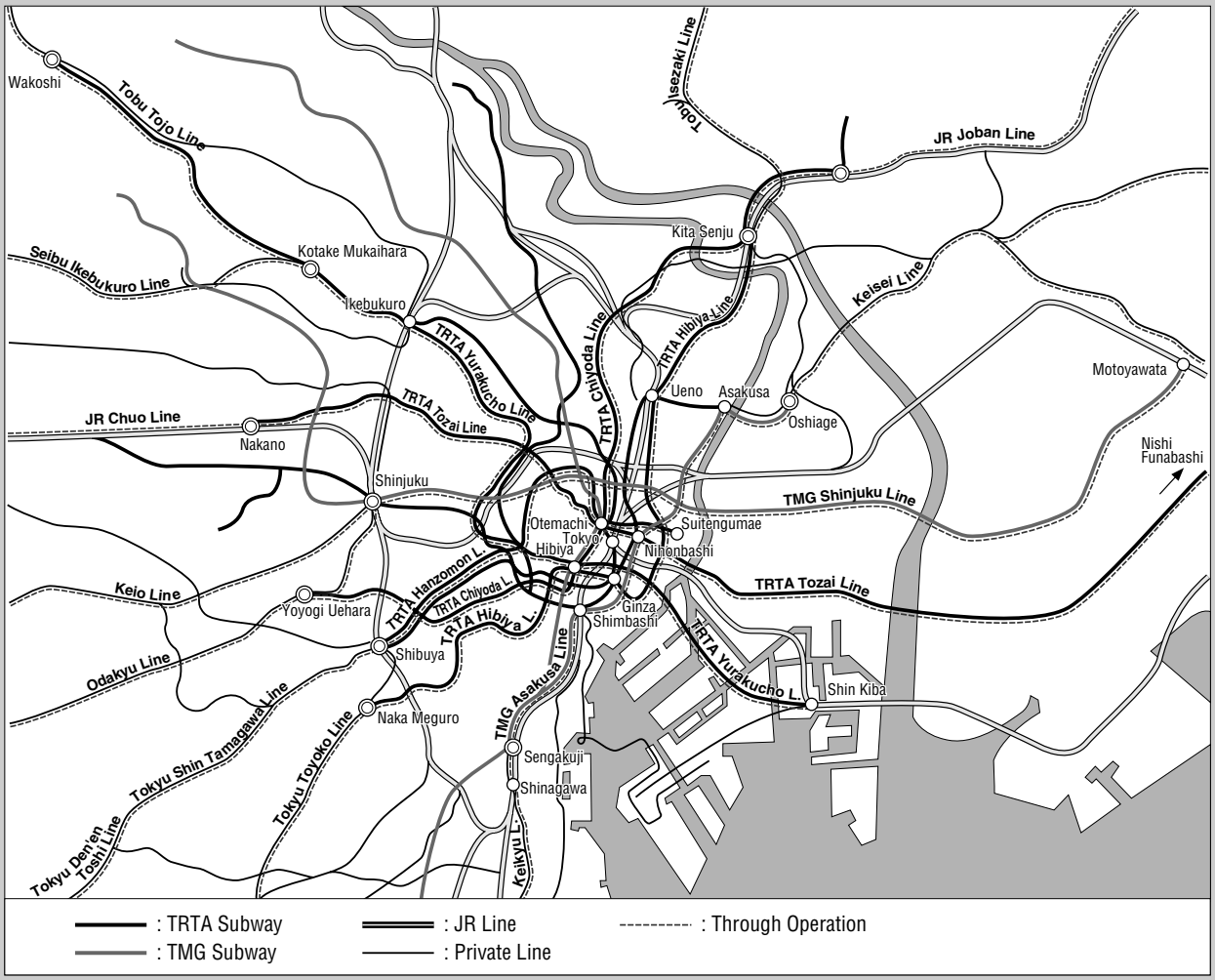
Construction of the east–west RER A line was approved by General de Gaulle, then President of the Republic and started in the early 1960s under RATP, the organization responsible for public transport in Paris. It started with the two branches out of Paris from Nation to Boissy St Leger to the east, and from Auber to St Germain en Laye to the west passing through the newly developed la Defense business district.

The project soon ran into enormous difficulties linked to the geology of the area; the solution required new construction methods at difficult sites, causing a considerable increase in costs. Finally, the east branch entered service in December 1969 while the west branch was opened in stages from January 1970 to September 1972. But traffic on these two external branches, like SNCF's suburban lines, remained limited because the overall work could not demonstrate its true potential until completion of the missing-link section between Auber and Nation through Gare de Lyon, the terminus for suburban lines of the SNCF southeast network.

Unfortunately, the cost overruns were so huge that the government was questioning the appropriateness of the investment and two debates started:

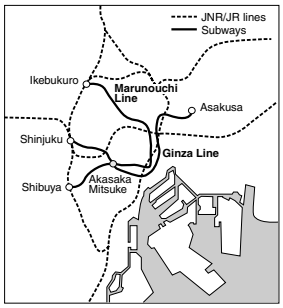
- The first concerned the project for the future Châtelet-les Halles Station where

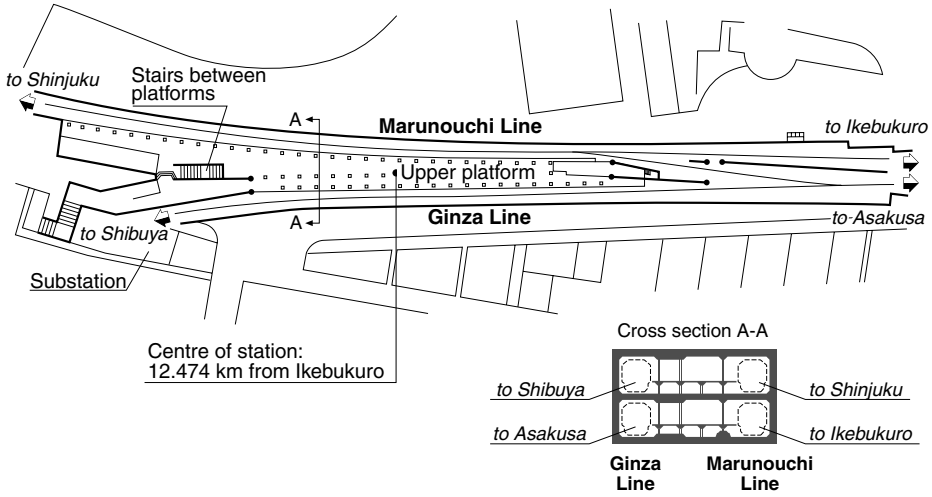
Tokyo Railway and Subway Network with Through Operations in 2000



(Adapted from JR Timetable)

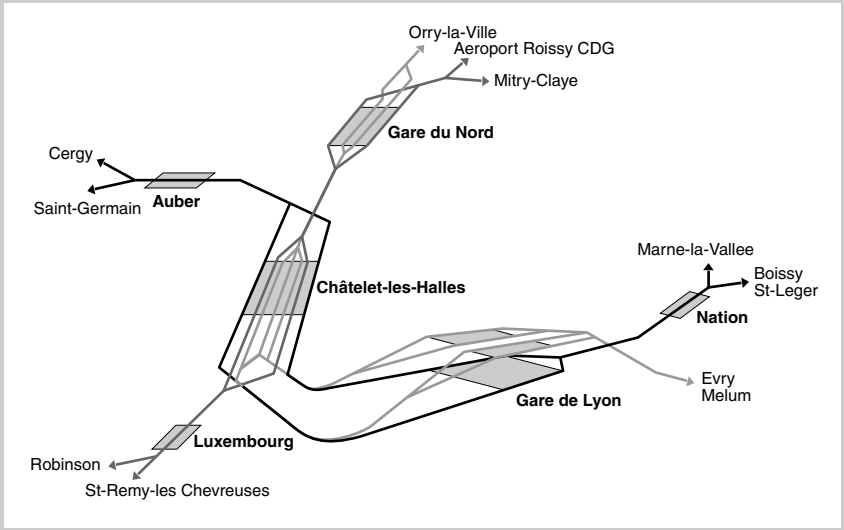
Cross-Platform Connection between TRTA Marunouchi and Ginza Lines at Akasaka Mitsuke Station





(Adapted from TRTA's Marunouchi construction records)

SNCF–RATP Interconnection Project in 1972



the Sceaux Line was to be extended to meet the RER A line; would cross-platform exchange between the two lines be possible?

- The second was implementation of the RER A line. The government was thinking that construction of the Auber–Nation section could not be justified unless it permitted circulation of some SNCF trains of the southeast suburban lines to pass through the Gare de Lyon and run on new track to la Defense.

The principal problem was whether operators as different as RATP and SNCF could run mixed traffic, coupled with important technical problems, such as different signalling, platform heights, arrangement of conductor's cab, operation regulations, and fares.

As Louis Sato mentions in his first part of this article about the influence of Tokyo's subway on the concept of the Paris RER, a committee visited Japan in 1971 to confirm the feasibility of station cross-platform connections on the one hand, and the feasibility of through operations by different operators in the same tunnels.

In parallel, at that time, I was working on the question of interconnection of networks to analyze their limits and constraints. Departing from the Tokyo example, with the fact that the capacity of a metro line is not limited by traffic inside the tunnels but is instead limited by train standing time at stations, it quickly became obvious that by doubling the tracks in the future Châtelet Station, it would be possible to greatly increase the number of trains moving in the tunnel between Gare de Lyon and Châtelet.

But then what to do with those trains beyond Châtelet Station? We couldn't dispatch them any further on the RER A line because the Auber and Charles de Gaulle Etoile stations only had one track with a platform in each direction according to the classical model of metro stations.

Suddenly, a new idea appeared—extending the Sceaux Line north beyond Châtelet and linking it to the SNCF north network lines. A new underground station was conceived, one which could serve two tracks with a platform in each direction.

When the mission returned from Tokyo, the synthesis of these ideas helped formulate the concept of the new RER network project. The two north–south lines of the 1965 Master Plan (see maps on p. 36) were replaced by only one north–south line formed by the Sceaux Line extended north to airport Roissy CDG.

On the other hand, thanks to the interconnection, a third RER line could be created joining the SNCF lines of the southeast suburbs to those of the northwest suburbs using the same lines as the east–south RER A line and the north–south RER B line between Gare de Lyon, Châtelet, and Gare du Nord.

The project was presented to SNCF and the government in early 1972 and approved with enthusiasm in July 1972.

Implementing Interconnection

From 1972, the work of constructing the central Auber–Nation section of the RER A line and the extension of the Sceaux Line from Luxembourg to Châtelet and then from Châtelet to Gare du Nord went busily ahead. Openings followed one after another from early 1977 until 1983 when the north–south RER B line was finished. However, completion of this line was made in stages due to delays in delivery of rolling stock designed for interconnections.

In the meantime, the promise offered by interconnecting the SNCF and RATP networks had persuaded the government and others responsible for Ile-de-France of its merit and they asked for other extensions of this concept, particularly west of Paris to serve the new city of Cergy Pontoise and the industrial developments in the Seine valley downstream of Paris towards Poissy. Thus, the government finally gave priority to development of the interconnection west of Paris before starting the third RER D line between the southeast and northeast suburbs.

The west interconnection entered service in 1987, and 1995 saw the whole RER D line accomplished. In the meantime, an important intermediary stage was marked by the extension of SNCF trains to the northern suburbs to Châtelet in 1987.

Today, Paris has an exceptional regional network fully meeting the needs of the region. However, this network has been a victim of its own success. The traffic on the RER A line was so heavy that from early

RER A train running in Paris western suburb (Yoshihiko Sato)

RER B train at Charles de Gaulle Airport (EJRCF)

1990, the government decided to create a new east–west RER E line. The preliminary phase connecting the SNCF east suburban lines with two new metro stations inside Paris at Gare du Nord and Gare de l'Est, and the other with the Gare St Lazare entered service on 14 July 1999.
The entire new east–west line is expected to be completed during the next decade.

Technical, Commercial, Social and Operational Problems

The network was completed through the outstanding collaboration between the RATP and SNCF teams to make the trains compatible with the two networks, to adopt common signalling and control, and to settle difficult commercial and social problems concerning the working conditions of the conductors and personnel.
These issues were not inconsequential and involved real problems. But the will to succeed, the Tokyo reference model, and the progress of technology, made it happen. The most difficult problems were:

- Differences in power supply
  The RATP trains and some SNCF trains were powered by 1500 V DC while the other SNCF lines were powered by 25 KV AC. It was necessary to be able to swap from one system to the other without stopping the train and without passengers knowing it—electrical engineers found the solution with electronic devices using Gate Turn-Off thyristor (GTO) components.
- Differences in platform height
  SNCF platforms varied in height from 0.60 to 0.90 m while RATP platforms were 1.10 m. The problem was resolved by using carriages with variable step height—in this case, mechanics won the game.
- Finances
  First, it was necessary to unify the fare structure, tickets, and ticket gates, some of which were automatic and some manual. This was facilitated by the creation of the popular *carte orange* used by most Ile-de-France commuters. Next, it was necessary to decide how to share the takings from the joint traffic and service levels on each network. Finally, it was necessary to settle very complex administrative problems, some of them with fiscal impact.
- Commercial problems
  RATP and SNCF quickly came to an agreement on the concept of a common RER, but it was not easy to obtain a consensus on implementing this concept, because each company was looking to get the glory for itself.
- Driving customs
  RATP drivers generally sat while at SNCF at that time, they preferred standing. On RATP trains, the brake handle is to the right of the driver while on the SNCF, the brake handle is to the left. One may laugh, but it was not a small task to adapt the geometry of the driver's seat or to use a double brake handle.

There were many other details I don't want to explain at length in this article, but what is important is that without the Japanese reference model as a start, there would never have been interconnection of the RATP and SNCF networks in Paris. ■

Louis Sato

Mr Sato is a graduate of the Ecole Polytechnique and the Ecole Nationale des Ponts et Chausées. He is Chairman of Sato et Associés, consulting engineers in Paris for strategic planning and project management. He has been involved in transportation and urban development projects in Paris and major French cities as well as in the Beirut Reconstruction Master Plan, the Channel Tunnel Transmanche consortium and other tunnel projects in Paris, Lisbon and Lille.

Philippe Essig

Mr Essig graduated from the Ecole Polytechnique and the Ecole National des Ponts et Chaussées. After working 10 years in Africa, he joined RATP and served as Managing Director from 1981 to 1985. He was president of SNCF from 1985 to 1988 and then State Secretary for Housing in the first government of Prime Minister M. Rocard. He later became president of TransManche Link, the business consortium that built the Channel Tunnel.