A Short History of "High-Speed" Railway in France Before the TGV

Jean Bouley

The race for speed started at the birth of railways even before the first line had been completed. The Rocket of Robert Stephenson won the race at Rainhill (UK) in 1829. The race has never stopped and speed is still the principal criteria as shown by the recent decision in Korea. Going faster is inherent in railway transportation, as in all transportation. But is speed required by passengers or engineers? Both no doubt, because as Roman Guardini said "In general, man does not know where he is going, but he wants to go there as fast as possible". Obviously, without the ingenuity and the passion of engineers, the train would have long been an obsolete means of transportation. But the history of its development shows that it is not.

An important date representing a milestone in the race is 1 October 1964, the day when Japan inaugurated the first high-speed commercial service in the world—and what service—at more than 200 km/h. This service was inaugurated on new infrastructure, so historians distinguish between the pre-1964 period (or the first century) when all-purpose lines constructed from the start of rail were used, and the post-1964 period, the second period when new lines dedicated to high speeds appeared. People of my generation lived through both these periods. I will limit my remembrances to the first period, which, when viewed solely from the high-speed point of view, could be called pre-history.

I am talking particularly about France, my native country, as well as about the situation in various analogous West-European railroad networks.

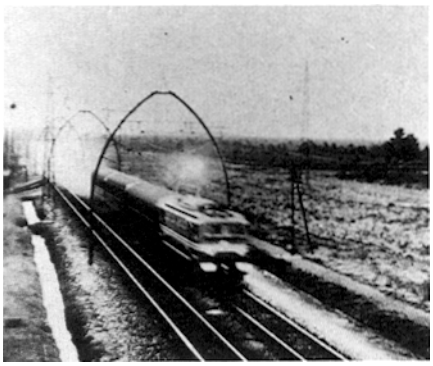
Between the two World Wars, the five private French networks were out of breath, having been battered by the 1914-1918 war and caught in the deficit spiral of the 1929 crisis. They had only one obsession, to make American-style savings and electrification of the type developed in 1920, using the outdated DC technology of General Electric. The railways were nationalised in 1938 and then war came, destroying 40% of the rolling stock. The post-war reconstruction had only one objective, to recover capacity by massive purchases of steam locomotives from the USA. The electrification programmes, particularly of the Paris-Lyons "royal artery" were resumed on a large scale. I am recalling this situation around 1950, to show that the passenger policy of SNCF regarding major lines was, as in the case of freight traffic—which provided two-thirds of earnings—that of heavy slow trains. The "heavy" electrification at 1,500 Volts DC served this policy admirably. For passengers, the 2D2 locomotives, a Swiss model from the 1930s limited to 120 and then 140 km/h, were already faster than steam locomotives and much more economical. During this period, the technical choices came to France from abroad and were already obsolete. Speed was neither demanded nor possible, and had not taken its place.

Against this background, three pre-eminent engineers: Louis Armand, general manager from 1949, Marcel Garreau and Fernand Nouvion, the head of the Electric Locomotive Development Division, arrived at key posts in the company and set about the task of escaping from the "Dependence Path"—a term coined by the American economist Paul David.

They wanted to give the young SNCF the image and the means to rediscover its ambitions, i.e., to affirm the presence of the railways in the growing transport competition.

Armand was a visionary and a man of action. From 1944, in the midst of the "Battle of the Railways", which he directed to resist the German occupation, he recommended the use of monophase current at mains frequency so as to be able "...to connect the locomotives directly to the national network". However, earlier tests had not been favorable. In Germany, tests started in 1936 on the Höllental mountain line (gradients of 2% to 5.8%) were abandoned in 1944, being judged unsatisfactory. During this period, the German government planned to re-electrify France, Belgium and the Netherlands with its monophase 15-kV system at the special frequency of 16.66! Subsequently, the Black Forest line in the French Occupation Zone, was successfully energised by the French in 1948 with the same equipment concluding that it was worthwhile expanding testing to France itself. The mountain line from Aix-les-Bain to La Roche sur Foron in Savoy, became the real mains current traction laboratory from 1949 to 1952.

Only a person of the stature of Armand could, by virtue of his charisma, his conviction and his expertise in inter-personal affairs, come to such a decision. There was much hostility among those who supported using electrical power and the chances of success were judged slim. One expressed a common opinion "Electrification at 50



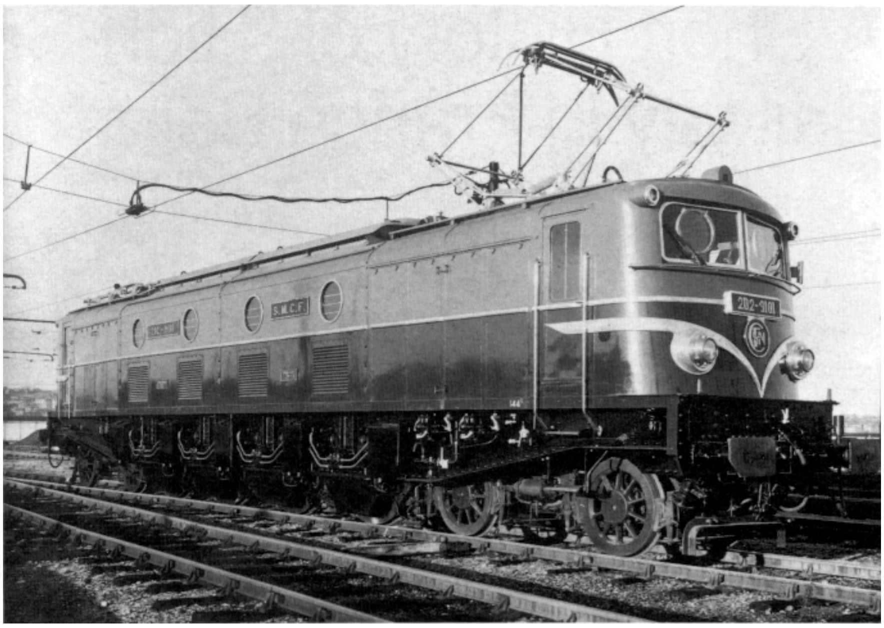
■ SNCF DC Locomotive reaching 331 km/h on 28 March 1955 (La Vie du Rail) cycles is a stupid idea, for reasons which are found in any electricity manual".

The following is known. Electrification since 1954 of the iron and coal line in the north-east from Valenciennes to Thionville, with 150 locomotives, freight trains for the most part, used four different technologies. Electrification at mains frequency, which resulted from development of the 50-Hz DC motor, finally won, but in an unexpected way—conversion into DC on board the locomotives by simple rectifiers! However, it is true that Armand was also of the opinion that use of intermediary power supply systems between the general network and the traction motors would have a simplifying effect. This was to take traction technology out of the prison that it had been locked in, into the "main playground" of industry, where it benefitted from the inevitable and spectacular progress of electrical technology called electronics.

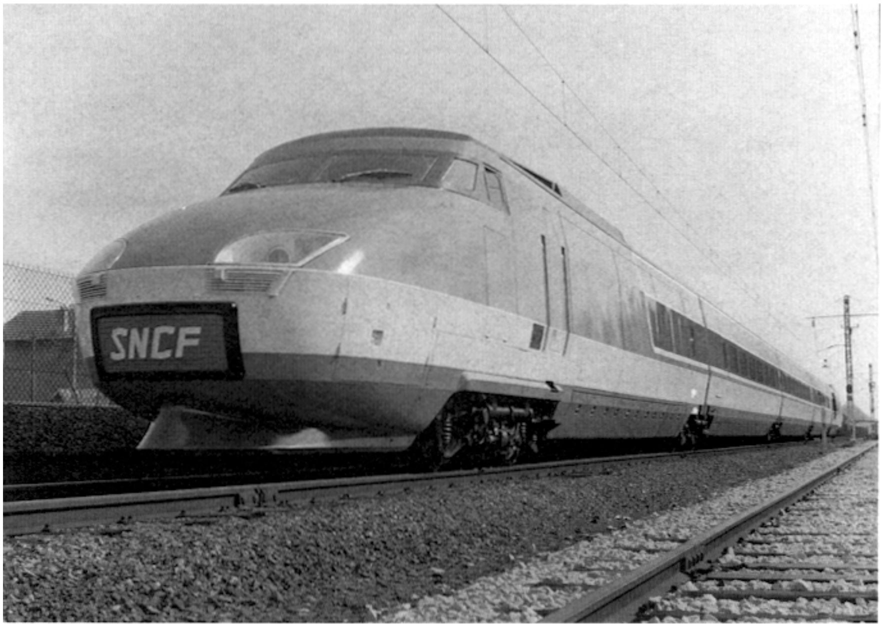
Different conferences and presentations made French monophase technology well known throughout the world—we actually had to explain this to the French authorities—in Annecy in 1951, in London in 1954 and in Lille in 1955. Care was taken to present the monophase system as a light system well suited to mountain lines as well as "light electrification for heavy trains". In France, the monophase system did not replace DC. Instead, it supplemented it, because the 1,500-V choice had already been made on major lines. This was why new bi-current locomotives appeared. The Congress of Lille in 1955 convinced the last of the hesitant disbelievers (except Germany) and served as the kick-off for numerous electrification projects worldwide using mains frequency. It was in this manner that Japan, which had already prepared the shinkansen, caught the ball on the rebound and, after having developed its own philosophy on the experimental Hokuriku line and on the metric gauge network, took the decisive step to power the new lines at the frequency of the national power network.

Thus, the first bridge was built between AC and the new infrastructure. We knew the boomerang would eventually come back to France. However, in France, the "very high speed" dimension of 50 Hz was still not foreseen in the 1950s. A very modest step was taken in 1966 in the form of the electrification of the Paris-Lille line; the BB16,000s travelled at 160 km/h, which then became the standard for the entire network (as well as elsewhere for the major European trains of the Trans-Europe-Express network). In fact, things started moving from the DC side. At the same time as the monophase system was launched, Garreau and Nouvion attempted to push the DC system to its limits. The key was the total track grip of the locomotives. Here I would like to digress a little. Every profession has its legends, goblins, and bad spirits—miners do not allow women to the floor of the mine, sailors fear the song of sirens. Steam-locomotive engineers fear the whims track grip. A little grease, dead leaves, a sloping curve and "whoops", the wheels are set to slipping, ruining in a few rotations, the costly efforts of the traction team. What was it with high speeds? The engineers themselves were divided, but the commonly-accepted idea was that track grip fell to zero with speed. The 1,500-V electrical engineers thus constructed the principle that since the wheels were no longer connected to the track, it was necessary to give the locomotive the maximum weight and power. The 2D2 was developed as a consequence. The Electrical Traction Engineering Division endeavoured to construct two locomotives with total track grip: the CoCo (1949) followed by four types of BoBo (1951). They were much lighter, but with speed, their technology required a good mastery of the transmission and movement of the bogies where the motors were housed. Two series of tests were organised to verify this. In February 1954, the speed of 243 km/h was reached using unmodified equipment and beating the "old" steam locomotive record of the Mallard set in 1938. On 28 March 1955 in the Landes region, both the BB and the CC reached 331 km/h smashing the preceding record. For good measure, the locomotives and three towed cars had been modified (gear ratio, aerodynamics, pantograph) and the voltage was increased to 1,800/2,000 V. This caused amazement in France, the amazement starting with the SNCF itself. The Director of Rolling Stock, Ange Parmentier, who was in the driver's cab for the test, immediately telephoned Louis Armand in Paris. The telephone line was bad and Armand could not really hear the speed reached.

"How many?" he said to Parmentier
"331."
"How many?"
"Three hundred and thirty-one."
"...two hundred miles!"



■ 2D2 1500V DC Locomotive of 1950s (140 km/h max. speed) (La Vie du Rail)



■ TGV001 Gas Turbine Prototype replaced by Electric Traction at25 kV/50Hz (La Vie du Rail)

In fact, the limits of the 1,500-V system had been reached and exceeded. The pantograph was split by melting. (It exceeded 4,000 A!). The track was deformed in zigzag configuration over more than 400 meters.

Although confirming the choice of total track grip, adopted for the new locomotives, the Morcenx tests showed the impassable boundaries of the DC system at high speeds: the stability of the drive bogies and the pickup of current. The engineers understood the lesson—very high speed required that the load per axle and the non-suspended weight be reduced and that few amperes (or none at all) should be picked up.

Thus, it is true that the basic studies (not fundamental since they were applied) were performed in the 1960s on a single-motor bogie, the weight of which was placed in the center, on double-stage reduction, and on an improved pickup at 50 Hz.

However, for all that, the SNCF still did not acquire a speed policy. Consequently, the "pre-historic" period ended in the early 1960s. The French network completed its electrification with DC and monophase current. The speed of 160 km/h became the accepted standard, with no view or desire to increase it, other than using DC to reach 200 km/h with limited investment.

The commercial start of the shinkansen service at 210 km/h on 1 October 1964 came like a bolt of lightning from a clear blue sky. The Germans reacted first by launching the Munich-Augsburg line at 200 km/h in 1965. The 1965 reaction of the SNCF was given incentive by Bertin, the charming prince of the aerotrain; it was time to change policy. Two technical actions of unequal scope were taken: A service at 200 km/h (very partial, but very newsworthy) on the Paris-Toulouse route in October 1967, and development of self-propelling units using a gas turbine. These were tested in 1966 on an autorail body (the ETGs) and put into commercial service at the end of 1969 on the Paris-Caen-Cherbourg route. This "turbine" line became a technical on-board laboratory from a different viewpoint: a second generation (the RTGs) was prepared and the first locomotive (the TGS) designed to explore speeds beyond 200 km/h was born. It gave birth to the TGV001 experimental locomotive, also with a turbine. After having visited Japan, the Economic and Commercial Laboratory of the new Research Division created in 1966, tested and perfected completely new econometric models. The adventure of the Paris-Lyons "CO3" project began bringing us into the second high-speed period.

However, it is intriguing to realise that the policy for high-speed trains took form and found freedom to experiment from the basis of a "self-propelled turbine" train, which was unknown up to that time and was, by all accounts, short lived. The 1974 oil crisis dealt it a serious blow and was sufficient reason to abandon it. In the meantime, SNCF had the solution for electrical self-propelled units with distributed power; the motor was no longer in the bogie, but suspended from the body and connected to the axles by universal joints. Suddenly, 300 km/h was within reach.

SNCF followed this path from the route opened by JNR. From the first appearance of the shinkansen, Mr Fernand Nouvion has never ceased to acknowledge and admire its role. I still remember his dazzling presentation on the "Electrification of Japanese Railways and the Tokaido Line" given to the staff of the Rolling Stock and Traction Department upon returning from Japan in March 1962. The audience, machine gunned with slides, was amazed.

From that, I conclude what Japan borrowed from France, it has returned faithfully through the excellence of its initial choices and by the creative rivalry it inspires. ■

Jean Bouley

Mr Jean Bouley graduated in Engineering from the Ecole Polytechnique and joined SNCF in 1947. His first appointment was to the Motive Power Department and he subsequently specialised in rolling stock maintenance. As Director of the Traction and Rolling Stock Department from 1974 to 1980, he was especially responsible for the TGV train sets ordered in 1976. He was UIC Secretary General from 1981 to 1990. He is an Officier de La L?gion d'Honneur.