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Views & Comments

Coming Back from a Trip on High-Speed Trains in the 2040s

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When a new high-speed railway (HSR) is planned, one of the most important elements to consider in decision making is the economic and social balance of the system. For this purpose, the life cycle cost (LCC) of the principal components is essential. Obviously, the extension of the life cycle for each element is a clear indicator of the total LCC and, in the case of rolling stock, this extension depends on many different factors: type of trains, type of components, type of operation, infrastructure, kind of maintenance and its cost, technology evolution, and so forth.

In Europe, the life cycle for HSR rolling stock has traditionally been considered to be 30 years (probably due to an economic perspective, or as a tradition extrapolated from other types of rolling stock), while in Japan, it is considered to be only 17 years. This large difference in life cycle is based on fatigue of the train's body shell: The tunnel cross-section for HSR lines (Shinkansen) in Japan is very narrow; consequently, each time a train passes through a gallery, significant compression and decompression is produced. This effect is similar to what occurs in airplanes and requires the pressure inside an airplane cabin to be reduced. The repetition of this cycle hundreds of times a day makes a careful analysis of the fatigue phenomenon necessary in Shinkansen trains, and generally leads to a regular renewal of the fleet.

This continual renewal of the fleet permits an almost continuous incorporation of new technologies, as any possible innovation can be easily incorporated. In addition, it imposes important conditions on the maintenance policy (and consequently on the maintenance cost), such as the general avoidance of large maintenance operations, and so forth. It also requires an accurate investment plan—other than a recycling materials plan, because recycling high-speed (HS) trains for other purposes or for other countries does not yet occur.

In Europe, the main characteristics of the infrastructure and the operation conditions permit a longer life cycle; consequently, rolling stock requires "lifting," or a thorough overhaul around the middle of its life cycle. As the first HS trains started in Europe in 1981, a significant percentage of the present fleet of European trains is becoming too old. In some cases, such as that of the French railway system, an operation to provide these trains with a complementary life extension is planned, probably to enable them to reach a life cycle of 40 years or even more. In any case, the problem remains of how to face the renewal of the fleet of roughly 100 trains that started operation in 1981, and 110 more trains that started operation in 1989.

Ratios can provide a general idea of the magnitudes involved in this problem. A European manufacturer can supply around 1 or 2 (and, exceptionally, sometimes more) trains per month to a certain operator, including the test and homologation processes. The cost of a typical HS train (200 m, 350–400 seats, 300–330 km·h^{-1}) in Europe represents €30 million–32 million EUR (20 years ago, the cost of a similar train was €22 million EUR). The maintenance cost for one such train operating under typical conditions (roughly 500 000 km per year) can be €1 million–1.2 million EUR per year.

Clearly, some European operators will find that facing the renewal of a significant part of their fleet, while simultaneously previewing an extension of the HS network and HS services, represents an important handicap, especially at a time when competition with other transport modes is increasingly important.

Now consider China's impressive evolution of HS lines, trains, services, and stations. Chinese railway system actors (operators, industry, and authorities) spent some 15–20 years developing their own concept for HSR and getting their own technology ready. By learning from their own experiences and by benchmarking the experience gained from other HS systems around the world, they created new technologies, new products, and a new concept of the HSR system. Everything was ready when operations began in August of 2008. Today, less than eight years later, more than 21 000 km of new HS lines are in operation at speeds from 200 km·h^{-1} to 300 km·h^{-1}, and more than 10 000 km of HS lines are under construction.

One of the characteristics of HS rolling stock, compared with other market vehicles, is the relatively low quantity of units that are built in each material series. In comparison, automobile factories produce hundreds of thousands of units, while aircraft manufacturers produce thousands. However, for HSR, a hundred trains represents an enormous quantity of production. Thus, the low quantity of units imposes important restrictions on the design, manufacture, and cost by a different application of the economy of scale.

Chinese railways operate more than 1600 HS train sets, all less than eight years old. Considering what is happening now under similar conditions in Europe (albeit on a different scale), what will happen 30 years from now? HSR lines will be longer, traffic will be significantly greater, and the rolling stock fleet will be much bigger and more solicited—but it will have an age limit. China Railway will then be obliged to renew a 1600 HS train fleet, without the galvanizing euphoria of the "early days."

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The answer to this problem should rest on the main principles of HSR. A focus on service to customers (and society) and on the identification and anticipation of necessities for future performance will be the key elements to take into consideration for planning railway operations. At this point, identifying the actual necessities of equipment, stations, infrastructure, and rolling stock should be the starting point for planning long-term investments.

The technology evolution will play an essential role in this entire process. The Chinese railway sector is in an excellent position to carry out new and impressive developments coming from railway companies, universities, research institutes, and the industry. The carefully planned renewal of this enormous fleet will be an excellent opportunity to incorporate further advancements, update the competitiveness of HSR, and ensure both its survival and its important role in the future transport passengers market.