

Omedetō gozaimasu! (Congratulations!)

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Good news from Japan has been rare for years but today's anniversary merits both admiration and congratulations: the age of modern high-speed rail travel began 40 years ago. On October 1, 1964 the new trunk line (*shinkansen*) between Tōkyō and Ōsaka opened for the regular scheduled service with 60 daily trains running with maximum speed of 210 km/h.



Japan's pioneering role in successfully realizing this rapid rail link was remarkable for at least four reasons. First was the magnitude of the vision as the development of *shinkansen* began when the country barely emerged from the enormous destruction of WWII. In May 1956, when the Japanese National Railways (JNR), launched the feasibility study it was just two years since the country's GNP finally surpassed its pre-WWII peak level of 1939, and when the average disposable income was only a small fraction of not only of the US rate but also of the British or French values. Funding was a challenge. The World Bank's loan of \$80 million was less than 15% of the original budget that JNR set on the low side, at ¥ 194.8 billion (or \$541 million in 1958 monies), in order to ensure the government's funding approval. As the cost overruns continued (the final total was nearly double the projected sum, ¥ 380 billion) both Hideo Shima (1901-1998), JNR's Vice President for Engineering, and Shinji Sogo (1884-1981), the company's President who promoted the project and insisted on its standard gauge, took responsibility and resigned in 1963. But in retrospect there is no doubt that *shinkansen* has been an impressive engineering success, an enormous energy-saving and environment-sparing measure.

Second, the commitment to fast trains ran against the prevailing consensus that saw the newly ascendant turbojet-powered flight as the unbeatable choice for rapid travel and railways sliding into inevitable extinction.

Third, although the project's initial phase, the *Tokaidō shinkansen* connecting Tōkyō with Ōsaka, had to solve a number of unprecedented technical and management problems it was completed so successfully -- in just 5 years and 5 months after the construction began in April 1959, just in time for the Olympics -- that it became the model for all subsequent projects abroad.

And, perhaps most remarkably, none of the *shinkansen* trains had

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derailed or collided during the 40 years of operation and so by the end of the year 2004 the system will have carried nearly 6 billion people, almost the equivalent of the planet's entire population, without a single fatality.

Steady extensions of new lines, introduction of new trains, gradual increase in top operating speeds and in the train frequency continued for the rest of the 20th century. A new law enacted in 1970 called for the extension of *shinkansen* throughout the country. In 1987 JNR, deeply in debt, was privatized and divided into six regional companies. In the spring of 1990 Japan's bubble economy began to burst, by the end of 1990 Nikkei index was 40% below its peak and by the end of the century it stood at less than a third of its December 1989 record. But throughout the 1990s *shinkansen* high standards were maintained and its progress continued.

Nozomi trains, distinguished by their 15-m long aerodynamic noses and wing-shaped pantographs, run at up to 300 km/h. In October 1997 the Hokuriku line connected Nagano in the Japanese Alps, and by the year 2000 extensions were underway in Kyūshū and in the northernmost Honshū. Frequency of trains on the *Tokaidō* line was increased to 285 by the year 2000. That line alone carries annually about 132 million people, slightly more than Japan's total population, and all lines are boarded by nearly 300 million people a year. Its social and economic benefits have been far reaching and its environmental benefits are indubitable: riding the *shinkansen* needs only about a fifth of energy per passenger-kilometer than driving and it generates less than 20% of CO₂.

Shinkansen is a perfect example of transformative technical advances that were so skillfully executed by post-WWII Japan. None of the system's key ingredients was a new invention. Steel wheel on steel rail -- the arrangement that gives the advantage of firm contact, good guidance, low friction and ability to move massive loads with low energy expenditures -- was present at the very beginning of commercial railways during the 1830s. Electric motors, the most suitable prime movers for such trains, were powering trains already before the end of the 19th century: what took place after WWII was a critical shift from DC to AC supply but by that time that, too, did not require any fundamentally new inventions. Pantographs to lead electricity from the suspended copper wires, light aluminum car bodies, their aerodynamic styling, regenerative brakes to slow down the trains from speeds above 200 km/h -- all of these key components had to be improved and tested and redesigned but none of them had to be invented. And the first *shinkansen* ran on ballasted track as did all previous generations of trains (reinforced concrete slab track came later).

But when these ingredients were combined in a new system the railway travel was transformed. No wonder that when JNR sought the World Bank loan for *shinkansen* the bank's bureaucrats saw it as an experimental project and hence ineligible for the funding. But Hideo Shima, Japan's leading railway engineer who traveled to Washington in 1960 to secure the loan, knew what he was

talking about when he convinced them that *shinkansen* included no experimental ingredients but integrated proven advances with safety concerns.

I logged more rail travel by the time I was 25 than most people do in a lifetime. But when I stood for the first time at a platform of Tōkyo's central station and saw the sleek *shinkansen* trains come and go at what seemed to be incredibly short intervals I was awed. And those were still the first, 0 series, trains with their bullet noses that now look distinctly old-fashioned and slow. Since that time I have traveled in the comfort of the first class Green cars as well as standing in packed compartments at the end of *obon* holidays, catching the first train from the capital as well as arriving just before the services end by midnight. All of these trips have one thing in common: this is travel as an event because even when the rapidly receding scenery is hidden, even when standing in a nonreserved crowded carriage you know that on the same track and just three minutes and 45 seconds behind you is another sleek assembly of 16 cars with 64 asynchronous motors moving in the same direction at 300 km/h -- and that when you arrive after a journey of hundreds of kilometers the most likely delay will be 24 seconds!

Vaclav Smil does interdisciplinary research on many aspects of energy and the environment. Some of his latest books are "The Earth's Biosphere" and "Energy at the Crossroads" (both with the MIT Press). He wrote an article on the hydrogen economy, "No Alternative to Reality" in summer of 2003.

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