Notice: This material may be protected by Copyright Law (Title 17 U.S. Code)
HIGH-SPEED RAIL POISED FOR RUN ON FAST TRACK

Chris Thompson

Chris Thompson researches high-speed rail at the Robert M. LaFollette Institute for Public Affairs at the University of Wisconsin in Madison and teaches in the Department of Urban Planning at the University of Wisconsin in Milwaukee. He also heads TGL International, Inc., an international consulting firm specializing in economic development.

When Americans think of trains, one of two images comes to mind. The first is a romantic vision of the 19th-century "iron horse" racing across the open plains. The second is a grim portrait of an Amtrak diesel locomotive amid the gray congestion of the Northeast.1

In the next few years, however, both of these images may be supplanted by a more futuristic vision known as "high-speed rail." High-speed rail is rail transportation moving at 100 miles per hour (mph) or more between major cities, along rights-of-way isolated from highway traffic and pedestrian crossings.

The design innovations of new high-speed trains may surprise Americans, who are familiar only with oversized locomotives billowing black smoke. In fact, if high-speed rail becomes a reality in the United States, it likely will be based either on conventional high-speed trains, "bullet" trains, or "super-speed" magnetically levitated trains.

TRAIN TECHNOLOGY

Conventional Trains. Conventional high-speed rail technology involves increasing the speed of traditional electric or diesel trains on existing tracks. It has been set in motion by Britain, Sweden, Spain, and Italy. The United States began its own conventional high-speed service in 1976 by upgrading Amtrak's Northeast Corridor Metroliner service between Washington, D.C., and Boston. The train now runs nearly 130 mph.

An innovation that has allowed the use of existing track for some faster conventional trains is the tilt-body suspension system. Flexible axles, combined with a cabin whose angle of tilt shifts, allow the vehicle to lean into curves, thus reducing the passengers' sense of lateral acceleration, which can make them queasy. Tilting also enables the train to take curves at a higher speed.
The Swedish X-2000 tilting train, used on the Stockholm-to-Gothenburg line has a top speed of only 124 mph, but it can take curves at speeds 40 percent faster than a non-tilting train and can accelerate more quickly after exiting a curve.

Tilting cars, however, require extra control mechanisms and maintenance and larger gaps between parallel tracks. Furthermore, some passengers experience motion sickness caused by rising and falling visual horizons. Despite these problems, tilting has emerged as the option of choice for increasing speed on existing track.

**Bullet Trains.** The world’s best known examples of “bullet” trains are the Japanese Shinkansen and the French TGV. The Japanese first launched their idea of a 156-mile-per-hour train from Tokyo to Osaka in the late 1950s.

In December 1958, the Japanese government’s economic planning agency decided to build a Shinkansen line. Ground was broken in August 1959; model track and test runs were completed in June 1962; and commercial operation between Tokyo and Osaka City began in October 1964. The 322-mile stretch cost 380 billion yen ($3.7 billion) and cut rail travel from six to three hours.

The next extension, launched in 1967, linked Shin-Osaka to Hakata with 350 miles of additional track. It took another eight years to complete. By 1985, four Shinkansen lines, totaling 1,125 miles and having a maximum speed of 130 mph, were in operation.

Although Shinkansen lines account for only 5.6 percent of the total mileage of the Japanese national railroad system, they carry more than 25 percent of the traffic and account for more than one-third of total passenger revenue.Δ

The Japanese have developed an even faster Shinkansen train, the Nozomi Series 300, which in late February 1991 set a Shinkansen speed record of 202 mph. The Super Hikari is expected to link Tokyo and Osaka in two and a half hours at a top speed of 170 mph.

In 1974, France decided to build a high-speed train between Paris and Lyons.Ω Since then, the country has planned 14 additional TGV lines, with three currently under construction: the TGV North Line, linking London through the Anglo-French Channel Tunnel with Brussels, Amsterdam, Koln, and Frankfurt; an interconnecting line linking the northern and southeastern TGV lines within the Paris metropolitan area; and an extension of the TGV southeast line beyond Lyons.

These first two categories of high-speed trains—conventional and bullet trains—make use of what engineers call steel-wheels-on-steel-rails technology. This technology encounters problems at higher speeds that do not affect slower-moving trains: wind resistance; potential vehicle instability on the track; axle strain; wheel-rail adhesion; maintainance of smooth contact with an overhead electricity supply; and excessive noise and vibration, which is particularly disturbing to people living near the track.

Some of these problems may be solved with more research and experience. Other problems, if they can be solved at all, may demand more drastic design changes.

**Maglev Trains.** Work has progressed on a revolutionary alternative to steel wheels on steel rails—super-high-speed magnetically levitated (maglev) trains—which avoid the problems caused by physical contact between train and track.

Maglev trains operate above—not on—an elevated guideway. They are suspended in space by magnetic forces, an effect physicists have dubbed “electromagnetic flight.”Ω

Conventional electromagnets have long been known to induce levitation at small clearances, but, until recently, they were incapable of maintaining mag-
netic fields powerful enough to levitate a train. Advancements in superconductivity overcame that limitation. Today, maglev is more than science fiction. Working prototypes exist, and large-scale commercial service seems feasible. Two principal magnetic-levitation systems are under investigation. Germany is developing an electromagnetic-suspension (EMS) system that uses magnetic attraction, and Japan is developing an electrodynamic-suspension (EDS) system that uses magnetic repulsion. In both systems, electromagnets lift the train and propel it above the supporting guideway. Coils in the electromagnets rapidly alternate their polarity, pulling the vehicle ahead and then pushing it from behind.

The Department of Transportation’s Federal Railroad Administration concluded in 1990 that both EMS and EDS are technically suitable for deployment in the United States. Issues that await resolution include:

- Type of guideway to be chosen.
- Train configurations to be used: whether multi-car trains are to serve a limited number of stops or single-car trains are to serve many stations.
- Degree to which existing interstate highway and railroad rights-of-way, whose curves that were designed for slower speed vehicles, can be used.
- Development of the high-speed switching systems.
- Concerns about health effects of magnetic fields inside the cars, particularly for passengers with pacemakers.
- Incorporation of future technological breakthroughs, especially those that may affect superconducting magnets.

As of today, no large-scale, high-speed maglev system is in regular commercial operation anywhere in the world, but several small-scale developments and interesting future plans have been put forward.

In Japan, for example, an unpiloted superconducting maglev test vehicle has achieved a top speed of 320 mph in trial runs. In Germany, government and private investors reportedly have spent more than $1 billion on maglev prototypes that have carried passengers on test runs. The German consortium, Transrapid International, Inc., has a TR-07 maglev train that has operated at 270 mph. It is designed for speeds of up to 310 mph and may soon run on a 50-mile line between the Bonn/Koln and Dusseldorf airports. In Britain, a low-speed maglev shuttle already carries passengers between Birmingham’s airport and main rail station.

Interest in maglevs has been stirring in the United States as well, particularly among companies—for example, General Electric and Grumman—engaged in superconductivity research. In fact, the corporate-sponsored Council on Superconductivity for American Competitiveness has proposed building a full-scale demonstration prototype maglev in the United States by 2000. Another group of companies has formed Maglev USA, also to promote development of the technology.

Within governmental circles, the U.S. departments of transportation and energy, the U.S. Army Corps of Engineers, the Environmental Protection Agency, and other federal agencies are seeking to coordinate U.S. maglev activities in a research effort called the National Maglev Initiative. The Federal Railroad Administration, despite having little money to spend directly, is eager to back research and development of magnetic levitation trains (see accompanying articles by Charles H. Smith and Robert Scott Cox).

On a regional scale, Carnegie-Mellon University in Pittsburgh, in cooperation with Maglev, Inc., a consortium of local corporations, plans a 20-mile,
high-speed maglev link between Greater Pittsburgh International Airport and Downtown Station Square. In January 1991, Pittsburgh's Urban Redevelopment Authority appropriated $80,000 toward the cost of planning the $500-million demonstration project.

The main differences among the three types of high-speed rail technologies—the tilting, bullet, and maglev trains—lie in their respective speeds, costs, and potentials for integration into existing infrastructure.

Using tilting trains to upgrade existing Amtrak routes offers only an incremental increase, not a quantum leap, in speed. Therefore, they are unlikely to be an appealing alternative to air commuting, except for travelers in the Northeast. Nevertheless, the tilting trains' comparatively low construction costs and their ability to use existing track make them the easiest and cheapest option to implement.

High-speed bullet trains, by contrast, likely would require considerable new track and straighter routes. The Shinkansen- and TGV-type trains represent truly high-speed rail, with a proven technology that still has not reached its potential speed limit. But this option also comes with a larger price tag than tilting trains.

The super-speed maglev option is the most exciting, but it would veer most dramatically from existing facilities and cost the most to develop and implement. Unlike the other two options, maglev is an unproven technology in terms of long-term system performance, and it would require new, separate, and exclusively dedicated rights-of-way and technologies systems.

FAST FORWARD

By late 1990, no fewer than 14 serious high-speed rail proposals—mostly for tilting and bullet trains—were under discussion in 17 U.S. states and two Canadian provinces. The U.S. Senate also held hearings on the issue, and by the early 1990s, Congress was considering seven bills related to high-speed rail. Progress is monitored by the High-Speed Rail/Maglev Association, formed in 1983 to promote high-speed rail. The association now holds an annual international convention for its 2,250 members, publishes a newsletter monitoring progress in 35 potential high-speed corridors, and generally extols the virtues of high-speed rail.

Although none of the proposals has been implemented in the United States, the nation's first franchise to build and operate a high-speed rail system was awarded in Texas in 1991. This 50-year deal went to the Texas High-Speed Rail Corporation, a consortium that includes the Boise-based Morrison-Knudsen Corporation and GEC-Alsthom, the Anglo-French maker of the TGV. The planned $5.7-billion, 620-mile steel-wheel system eventually will connect Houston, Dallas, and San Antonio; the first segment, from Dallas to Houston, is planned for completion in 1998 at a projected cost of $2.1 billion. This trip would take 90 minutes and cost 20 percent less than a similar trip by air. Today's travel time is 55 minutes by air and four hours by car.

Other positive moves for U.S. high-speed rail in 1991 included a $4-million appropriation by Amtrak's board of directors to bring a Swedish X-2000 tilting trainset to the United States for test operation along the Northeast corridor between Boston and Washington, D.C.

Plans for the nation's first commercial maglev service are on track in Florida, where Maglev Transit, Inc., a consortium dominated by Japanese banks, will embark on a 14-mile, $600-million maglev system. In October 1994, the system...
will begin transporting passengers from Orlando International Airport to Walt Disney World. There are long-range plans to extend the route another 33 miles, from the airport eastward to the cruise ship harbor of Port Canaveral at a cost of $920 million.\textsuperscript{16}

CONGRESS ON BOARD

In 1991, Congress considered four potentially significant bills concerning high-speed rail.

The first, the proposed High Speed Rail Transportation Policy and Development Act, would require the Federal Railroad Administration to complete an economic and technical study of existing high-speed technologies and to determine ways to develop high-speed rail systems in the United States. It also would give the administration six months after the proposed report’s release to establish a national high-speed rail policy.

The second and third proposed bills sought to lift 25 percent of the value of tax-exempt bonds for high-speed rail projects from state limits on bond issues. Because many states are at or near their bonding caps, any significant rail financing likely would be ineligible for federal tax exemptions.

These two proposals became part of President Clinton’s omnibus tax bill package of 1992. As approved by Congress, Clinton’s tax bill contained provisions for tax-exempt bond issues for high-speed rail projects. Thus, high-speed rail investment has now been put on the same competitive playing field as airport and seaport financing, which have always enjoyed tax exemptions.

The fourth, and probably most significant, piece of legislation is the $151-billion Intermodal Surface Transportation Efficiency Act (ISTEA) signed by President Bush in December 1991. The act pledges federal government support for construction of high-speed rail systems by allowing the systems rights-of-way alongside interstates at no charge. The act also budgets $725 million over six years to develop a U.S. maglev train.\textsuperscript{17}

In addition, the act requires the Department of Transportation to designate five corridors, which will receive a total of $30 million in federal matching funds for studies of high-speed rail technologies over the next four years. The corridors are: (1) Chicago-Milwaukee; Chicago-St. Louis; and Chicago-Detroit; (2) Miami-Orlando-Tampa; (3) Washington, D.C.-Richmond-Charlotte; (4) San Diego-Los Angeles-Sacramento; and (5) Eugene-Portland-Seattle-Vancouver.

ISTEA is regarded as landmark legislation for two other reasons. First, it may encourage defense contractors to shift their engineering talent from military to civilian technologies. Government contracts for early research and development under ISTE A call for “collaborative competition” among private contractors. Four systems concept/design contracts have been awarded to teams headed by Bechtel, Foster-Miller, Magneplane International, and Grumman Corporation, all with considerable aerospace and university participation.\textsuperscript{18}

Second, in examining the potential for domestic maglev capability, ISTE A encourages alternative maglev designs to those being explored in Japan and Germany. It thus gives U.S. maglev producers a chance to become innovators, not just importers and assemblers of foreign designs and kits. One such U.S. innovation is the proposed “magneplane.” Likened to a magnetic surfboard, the magneplane rides the forward slope of a traveling magnetic wave whose speed and height are constantly adjusted to keep the surfboard in smooth motion.
Magneplanes may be the ultimate in high-speed development: a vehicle that blurs the distinction between train and plane.

THE THIRD RAIL

Whichever of the three main high-speed rail technologies the government chooses to pursue, some experts have suggested that high-speed rail will be as significant in the 21st century as steam trains were in the 19th century and autos in the 20th century. Such a dramatic change is unlikely to come overnight, or without significant economic and social change. As one high-speed rail advocate puts it:

...high-speed rail systems [will]...affect virtually every social and economic activity in every community involved...Consequently, such projects are inevitably targets for conflicting political and social pressures.19

Predicting what high-speed rail systems might mean for the U.S. economy in the 21st century is a challenging task. Yet, that is exactly what must be done to help citizens ask the right questions of their policy makers, politicians, and transportation planners.

History provides a valuable cautionary note. Rail transport’s heyday in the late 19th century did not always bring universal growth and development. For all the winners, there were losers as well: communities that failed to receive a rail station, immigrant rail workers poorly paid and poorly treated, Native Americans whose lives were disrupted by the iron horse, and pristine landscapes overlain by an intricate network of tracks designed to promote progress.

Placed in the stilted language of modern planning, we could say that 19th-century rail development in the United States was accompanied by a disregard for the rights of the non-enfranchised, uneven access to the opportunities the technology afforded, and lack of consideration for alternatives and long-term consequences.

When Americans of the late 21st century look back in the same way on the 1990s, they are not likely to judge the current debate over high-speed rail on how fast the trains travel. Rather, judgment will be rendered on how well new rail technologies served the nation’s efforts to build a more prosperous and just society. That is what the debate over high-speed rail should focus on, and that is how we should track our ultimate success or failure.

NOTES

1. This article is an abbreviated version of a more detailed analysis of high-speed rail that is available on request from the author.


6. See Johnson, "Putting Maglev on Track."


