# A train without the daily grind

**Magnets are used to elevate vehicle**

By Bruce V. Bigelow, San Diego Union Tribune Staff writer, August 3, 2004, (619) 293-1314; <bruce.bigelow@uniontrib.com>

DAN TREVAN / Union-Tribune

Sam Gurol, manager for the magnetic levitation transit program at General Atomics, inspected the bar magnets that levitate a passenger car chassis.

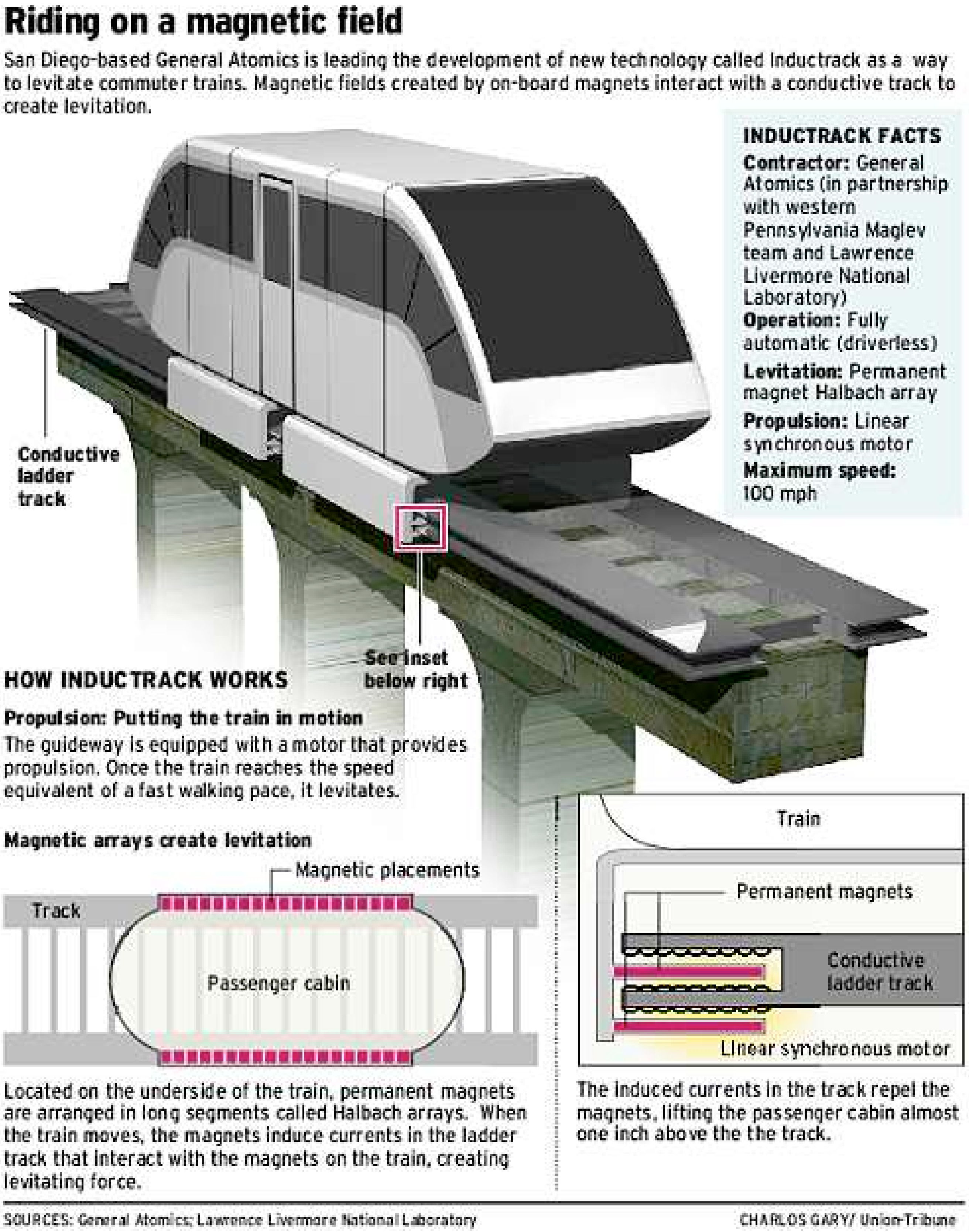
Behind General Atomics' Building 37, at the west end of Sorrento Valley, Sam Gurol is overseeing construction of a train to nowhere. Someday, though, it may lead to a new kind of magic carpet ride for the 21st century.

By this fall, Gurol plans to be operating a full-scale prototype of an urban transit system that adopts recent innovations in magnetic levitation technology.

Costing almost $22 million, the "urban maglev" project includes a 40-foot chassis for a mass transit vehicle that is designed to levitate almost an inch as it glides silently along a 394-foot track.

"When it's all assembled, the vehicle is going to be like a box on an invisible conveyor belt," said Gurol, the company's program manager.

Because magnetic levitation is so quiet, Gurol said elevated systems can run through dense urban areas to alleviate traffic congestion without the metal screeching usually associated with light-rail systems.




"The main advantage over a wheeled vehicle is low noise," said John Harding, chief scientist for the Federal Railroad Administration's maglev program. "Needless to say, it's going to be more expensive than a wheeled system."

While it may be initially more expensive, the new approach to maglev technology promises certain cost advantages, Gurol said. Unlike a light-rail system, for example, this maglev system would not require extensive maintenance and repairs of train wheels and brakes.

Privately held General Atomics, with headquarters in San Diego, has been leading an industrial consortium developing the new approach, funded chiefly by the Federal Transit Administration. Most of the other companies are based in western Pennsylvania, where interest in building a downtown maglev system has been relatively strong.

The idea behind the San Diego field test is to perform what engineers call dynamic testing of the team's levitation, propulsion and guidance systems. The urban maglev is designed to operate without a driver, like a horizontal elevator.

Another motive, though, is to demonstrate the feasibility of a safer and more efficient approach to maglev technology – and perhaps to contrast it with the aggravations many commuters now endure in rush-hour traffic.

Just a mile or two east of Gurol's backyard project, commuter traffic can be seen crawling along Interstate 5, just north of where the freeway merges with Interstate 805.

"To put this into highly congested areas like downtown Pittsburgh, we could move 12,000 passengers per hour in each direction," Gurol said.

By his reckoning, moving 3,000 passengers an hour is equivalent to the capacity of a single freeway lane, which means an "urban maglev" system would be roughly the same as building a four-lane freeway.

If only commuters would ride it.

"The question is: In the United States, do we have the willpower, or the driving force to do this?" said Richard F. Post, a senior scientist at the Lawrence Livermore National Laboratory.

Post, 85, a leading researcher in fusion research, conceived of the technical approach to magnetic levitation employed in the San Diego field demonstration.

Post says his approach is passive because it does not require the use of costly, high-powered electromagnets or complex, cryogenically cooled superconducting magnets to levitate passenger cars. So no electric power is required inside the train to generate the levitating magnetic field.

Rather, it uses a new and powerful type of permanent magnet that is made of a neodymium-iron-boron alloy. Gurol says it only became possible in the past five years or so to use the alloy to make magnets powerful enough for use in a maglev system.

The magnets, made in long bars, are mounted in special arrays in the undercarriage of each car. The bars are arranged in a configuration so that the magnetic orientation of the bar is at a right angle to the magnetic orientation of the adjacent bars.

The arrangement, called a Halbach array, generates a very strong magnetic field below the magnets. But above the array, where passengers would be, the magnetic fields cancel each other out. The array was invented by Klaus Halbach of the Lawrence Berkeley National Laboratory.

As the car moves forward, the magnetic field generated by the Halbach array induces an electric current to flow in copper cable embedded in the track in ladder-like rungs. The electric current flowing through the cable then generates its own magnetic field, which repels the field generated by the Halbach array.

The underlying principle is nothing new; it was demonstrated by English physicist Michael Faraday in 1831.

The train is propelled by a separate, electric-powered system that is also embedded in the track. The system, called a linear synchronous motor, offers an important safety advantage: If the power unexpectedly fails, the cars remain levitated until the train slows to roughly 5 mph, then settle on auxiliary wheels as the train comes to a stop.

To Gurol, however, one of the biggest advantages of the new urban maglev technology is that its actual performance can be theoretically simulated with highly accurate computer models.

"You can calculate the fields and the effects, and we've demonstrated the accuracy of those calculations to a high degree," Gurol said.

The next stage would be to build a working system.

A 4.6-mile, single-track system has been proposed to link the main campus of California University of Pennsylvania with a 98-acre auxiliary campus. The state-supported university is about 60 miles south of Pittsburgh.

The terrain, which includes a climb above the Monongahela River, is ideal for a maglev system, Gurol said.

"The beauty of maglev is you don't need to go underground, because it's quiet and can handle sharp turns and steep grades," Gurol said. By one estimate, going underground can add from $200 million to $400 million per mile to the cost of an urban mass transit system.

The proposed site was driven largely by the Pittsburgh-area companies and institutions participating in General Atomics' industrial consortium.

The consortium, which has shared about 20 percent of the cost so far, includes Carnegie Mellon University, Hall Industries, Mackin Engineering Co., PJ Dick, Sargent Electric Co., Union Switch & Signal and the Western Pennsylvania Maglev Development Corp.

The Pittsburgh group asked General Atomics to participate in the effort about four years ago, Gurol said. The company has developed broad experience in various types of magnetic technologies, arising largely from its expertise in using magnets to contain plasma in its fusion reactor.

Now Gurol sees new opportunities for his company to develop new business in urban transportation.

At an estimated cost of about $190 million, though, development of the Pennsylvania system is years away.

Until such a system is built, however, "We don't know how much things are going to cost," said Harding of the Federal Railroad Administration. "We've discovered at this early stage that these early estimates don't mean very much and that these costs escalate."

Like Post, Harding said another question is whether enough Americans would use an urban maglev system to make it financially viable.

"In Amsterdam, there are magnificent trolleys and public transportation systems that are heavily used," Harding said. "But everyone points out that the United States is quite different. Our infrastructure is built around the automobile.

"My feeling is that it's probably worth a try," Harding added. "I wouldn't want to build a system that is 100 miles long. But a system like this has its advantages."