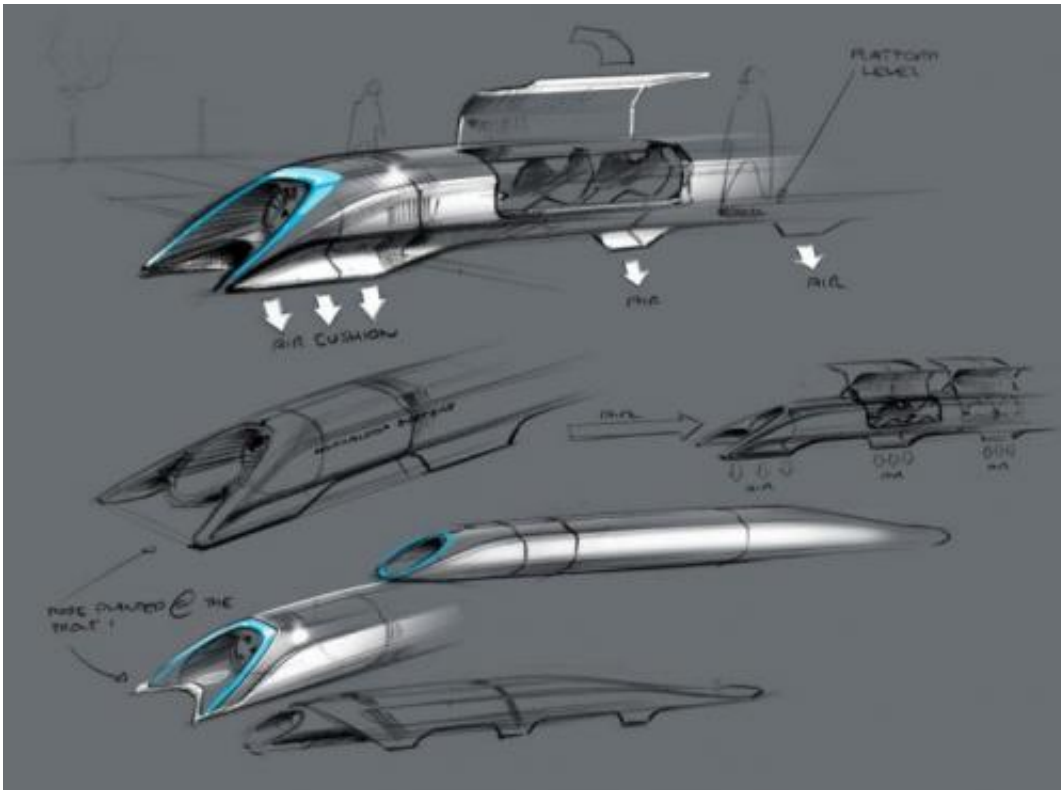


# Elon Musk's Hyperloop hype ignores practical problems

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You've got to hand it to Elon Musk - he certainly dreams big. The entrepreneur loves to take on tough technical challenges and turn them into business opportunities. He revolutionized online payment services with PayPal, built the first successful electric-car company with Tesla Motors and launched one of the first commercial space transportation

companies with SpaceX.

But his proposed [Hyperloop transportation system](#) - which he unveiled Monday as a faster and lower-cost alternative to a high-speed train service between San Francisco and Los Angeles - may prove to be his toughest challenge yet. While the science behind the idea seems sound, turning it into reality would require overcoming a host of [engineering design](#) obstacles, not to mention political and funding hurdles.

"The high-level concept doesn't violate any fundamental [laws of physics](#)," John Hansman, a professor of [aeronautics and astronautics](#) at MIT, said Tuesday in an interview. But he added, "I'm not sure whether the details work."

The Hyperloop would consist of carlike capsules traveling at near the speed of sound through enclosed tubes. The capsules, which would contain about 28 passengers each, would ride on pockets of air, propelled by a linear induction motor. They would travel through a low-pressure air system that would limit resistance and friction without requiring the amount of energy needed to maintain a complete vacuum.

According to Musk, the system would cost just \$6 billion and get passengers from Los Angeles to San Francisco in 35 minutes - less than one-tenth the price of California's proposed high-speed rail system, while moving passengers five times as fast.

At first blush, the concept seems to come from the realm of pulp sci-fi novels. It reminded me of a comic book I had as a kid in which a character traveled from Los Angeles to Tokyo on a high-speed train that traveled through a tunnel deep inside the Earth.

But as fantastic as the Hyperloop concept may appear, experts familiar with the 57-page proposal Musk unveiled Monday say it's theoretically

feasible.

Linear induction motors already are used to propel maglev trains in Japan. Hovercraft have long demonstrated that one can travel on a pocket of air. And the first subway in New York was operated inside a pneumatic tube, which was a larger variation on the systems still used by consumers at drive-up bank windows and pharmacies.

"There's no question we have the technology to get something like this up and running," said James Moore, director of the transportation engineering program at the University of Southern California.

But while Musk has laid out the potential price of building the Hyperloop, he has ignored the development costs, which are likely to dwarf the cost of construction. Moore compared it to a pharmaceutical company exploring a new drug.

"It's not the manufacturing costs worrying them," he said. "The costs they're worried about are the development costs." A big part of that development cost would be to build a prototype that would highlight for engineers things Musk didn't account for or anticipate in his proposal, things that could come out only in real-world tests.

One concern would be how the fast-moving capsules would respond to even a slight misalignment in the tubes, said MIT's Hansman. Another would be the interplay between the low-pressure air in the tube and the air pads on which the capsule will ride, he said.

By laying out his proposal before actually prototyping it, Musk has skipped a crucial step, argued Richard Muller, a physics professor at the UC Berkeley.

"From the science point of view, he's done it the wrong way," Muller

said.

Even if the Hyperloop idea proves sound in prototyping, practical issues would need to be overcome. A big one is how much energy the Hyperloop would require. The linear propulsion system and the air pressure pumps for the tubes would probably need much more energy than would be provided by the solar panels Musk proposes installing on the tubes and the energy recovery system he envisions having at the end of the route, said Roger Goodall, a maglev train expert and a professor of control systems engineering at the United Kingdom's Loughborough University.

Then there are safety concerns. Muller argues that the system, because of its novelty and the vulnerability of its tubes, would make a tempting target for terrorists. But it also could potentially be disrupted by more mundane threats, such as dirt and grime, he said.

And what would happen, Hansman wondered, if the power went out while a capsule was rocketing through the tube or if a capsule got stranded miles from a city?

Engineers would need to determine exactly how the Hyperloop would deal with such contingencies if the system is ever to get up and running.

While such challenges could be overcome, some experts are skeptical that they will be. Because Musk's proposal ignores the expense and risks of developing the Hyperloop, it is for now just "another science-fiction dream," Muller said. "It's completely impractical."

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