Is the US Losing Its Edge? An Engineering Design Challenge

Maglev train in Japan. (Image Courtesy of Yosemite, GNU Free Documentation License.)

Maglev trains have long been the holy grail of ground transportation. Levitating above steel rails, Maglev trains need no wheels and have no friction with the track, resulting in an ultra-fast and ultra-quiet ride. So far they're also very expensive. Counting an additional planned Tokyo-to-Osaka leg, the project is expected to cost upwards of $100 billion. If that sounds prohibitive, consider that the United States spends significantly more than that on highways in a single year. And while a highway might get you from Los Angeles to San Francisco in six hours if you're lucky, a Maglev train like the one Japan's building could theoretically do it in an hour and 15 minutes. In fact, California has been trying to build a Los Angeles-to-San Francisco high-speed rail line for some 30 years, but the fight for funding has been tooth-and-nail. The state is now slated to have a 220-mph train up and running by 2028—but that's just a conventional bullet train, the kind Japan has had for decades. There were once plans for a California-Nevada maglev train, but they never left the station, and the money for planning them ended up being reallocated to a highway project. (Future Tense, November 30, 2012¹)

Although it’s true that the US is falling behind other countries in technological accomplishments, a renewed focus on engineering as a part of science education could make a difference, at least in the next generation (which is why the new standards are called the Next Generation Science Standards\(^2\).) Watch the 13-minute video about fourth graders building a Maglev train on the Engineering is Elementary website: http://www.eie.org/eie-curriculum/resources/designing-maglev-system-grade-4-medford-ma. If fourth graders can do it, you can too, right? If you do decide to build a model Maglev train, you will need to purchase a few more materials. Notice that the students in the video use long narrow boxes to guide their “train,” so the train does not fall off its tracks. You will also need to purchase long magnetic strips. Whether or not you choose to build a Maglev train, your model of magnetism can help you build a mental model of how you would do so. For example, here’s an initial problem:

You go into a store that sells a wide variety of magnets. You are looking for strips of magnetic material that you can lay along the bottom of the box. The sales person gives you two choices. Which do you choose and why? (Apply ideas from Unit M Lesson 2: Exploring Magnetic Effects.)

\[\text{a. Strips that are magnetized so the top surface is one pole and the bottom surface is a different pole. (Below is a side view.)}\]

\[\begin{array}{c}
N \quad (\text{Top}) \\
\end{array}\]

\[\begin{array}{c}
S \quad (\text{Bottom}) \\
\end{array}\]

\[\text{OR}\]

\[\text{b. Strips that are magnetized so that one end is one pole and the other end is a different pole. (Below is a side view.)}\]

\[\begin{array}{c}
\end{array}\]

2. Create a sketch showing how you would arrange the magnetic strips to build your model Maglev train. Label the sketch, and explain how it works.

3. Imagine that you’ve gone to Japan and you’ve been invited to ride in the control room of a Maglev train. You’re traveling at 300 miles per hour and one of the engineers reads a gauge that says one of the magnets under the train has cracked. Should you worry? Why or why not? (Apply ideas from Unit M Lesson 3: Developing a Model for Magnetism.)

4. A radio call reports that catastrophe was narrowly averted when a fire on the line 50 miles ahead was put out. The crew laughs about it and assures you not to worry, that you will make it to Osaka on time. What do you say to them? (Apply ideas from Unit M Lesson 5: Explaining Phenomena Involving Magnetism.)
Background

Engineering in the *Next Generation Science Standards* involves more than robotics competitions and building model bridges. Students are expected to be able to apply the science they have learned to understand how technologies work and use their knowledge to solve practical problems.