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Physics and quality

I have just received the April/May issue of TIP and was delighted to read the article by Mark Annett, "The Physicist as Quality Engineer." Physicists would take even more note of this potential career path if they realized that the founder of modern statistical quality control, Walter A. Shewhart, and its greatest advocate, W. Edwards Deming, were both trained as physicists.

Shewhart had a Ph.D. in physics (Berkeley, 1917) and Deming had a Ph.D. in mathematical physics (Yale, 1928). Deming was extremely influential in postwar Japan and later in the U.S. for advocating a scientifically based quality management philosophy. So physicists have been playing major roles in quality engineering from its birth, a fact that does not seem to be well known in the physics community.

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Good prep

I can't tell you how invaluable *The Industrial Physicist* is to our science program at Tri-City Prep High School. Each issue is read and re-read by both staff and students alike. It seems you are reading our minds, since your articles help lead us into a discussion of what we are studying in physics, chemistry, and biology, as well as aerospace science. Many of our recently submitted student projects at the Northern Arizona Science and Engineering Fair have been the result of articles students have read in your magazine. Thank you for producing such a magazine. You can be sure the future scientists we produce at TCP will fondly remember your magazine and the significant differences you have made in their lives as they searched for new ideas and approaches in science.

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Maglev redux

I greatly enjoyed your article in the last issue of *The Industrial Physicist* ("The evolution of transport," April/May, pp. 20–24) and have long been interested in transportation matters. Several years ago, in my dissertation, I was researching mobile robots that learned to locomote and, as part of that work, I studied the metrics of motion and transport. I found a number of interesting references and metrics, but the one I used was one of the simplest—specific resistance, the product of power and velocity divided by the weight. It is a dimensionless metric that has a number of nice features. It is a measure of the efficacy of locomotion (Gabrielli, G., and von Karman, T. What price speed?: Specific power required for propulsion of vehicles *Mechanical Engineering* 1950 72, 775–781). The authors graphed a large

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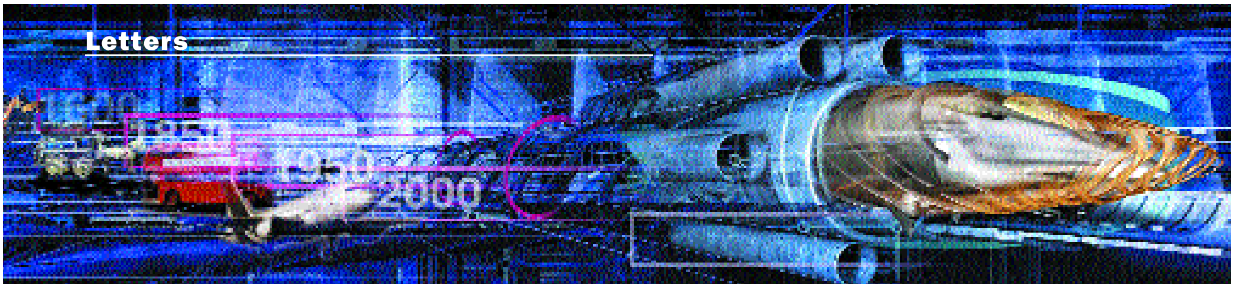

number of transportation modes.

Another piece I found interesting was "The centrality of the horse in the nineteenth century American city," by McShane and Tarr in *The Making of Urban America* by Mohl. Horses were susceptible to things like disease (e.g., the great epizootic of the 1870s in Boston, where every horse was sick or dead. This contributed to the fire that devastated the city in 1872 because there were no animals to pull the fire wagons!). Joel Tarr, a history professor at Carnegie Mellon University, looked at the incredible amount of infrastructure required for horses, in addition to the "effluent" issue you mentioned. He also pointed out that the horsedrawn omnibuses of yesteryear did not increase speed or range for city folks. Most people did not commute on horse either—what do you do with the horse once you get there? And you arrive smelling and sweating like one!

I'm looking forward to high-speed, clean, fast maglevs as well!

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[*Authors reply*: The articles you cite are top-notch. Gabrielli, director of engineering for Fiat, and von Karman, a pioneering aeronautical engineer, understood profoundly the price of air and wave resistance, and eddy formation. They recognized the advantages of operating at low pressure and would surely join us in encouraging the emergence of constant acceleration (and deceleration) maglevs operating in evacuated tunnels. Only linear motors permit this feature, as they can operate with constant traction, independent of speed.

Jesse Ausubel and Cesare Marchetti]

I read your paper and found it a useful framework for discussing this problem. You conclude that all votes favor maglev as the ultimate ground transportation technology of the future. I invite you to consider some of the other contenders that you may not know about. I do not consider the intercity travel problem to be as important as the intracity travel problem at this time, even though the air transportation system is currently having substantial difficulties. I think that intercity problems pale in comparison to the millions who get stuck in traffic each day in our large metropolitan areas. It does not seem to me that a slower urban maglev technology is likely to be as cost-effective as a higher speed, intracity maglev system. What are the alternatives to more and more autos, congestion, and pollution in our large cities (where most of us live)?

If you are interested in this question, I invite you to visit my ITT Web site (http://faculty.washington.edu/jbs/itrans) and see what people who are working on the intraurban problem are doing. It includes descriptions of more that 50 transit technologies from around the world. Some are operational, some are under development, and some are still conceptual. All are trying to become competitive with the use of autos in urban areas. I hope you will include some of these ideas in your future work.

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[*Authors reply*: We had fun browsing. Your site collects ingenious transport systems that may finally fail in the field because inventors do not place in the center the number one request of the traveler—speed with appropriate cost. City dwellers want low-cost speed, like everyone else. For a "mass transit" system to prevail, it must beat the 40-km/h door-to-door speed that car owners enjoy in metro areas. Because the maglev system is a set of magnetic bubbles moving around under the control of a central computer, what we put inside is immaterial. It could be a personal or small collective vehicle, starting as an elevator in a skyscraper, becoming a taxi in the maglev network, and again becoming an elevator in another skyscraper. The entire bazaar could be run as a videogame whereby shuffling and rerouting would lead the vehicle to its destination in the shortest time, following the model of the Internet. In fact, in the end, we see a maglev system as a common carrier or highway, meaning "private" as well as "mass" vehicles can be shot through it.

Jesse Ausubel and Cesare Marchetti]

Just a note to let you know how much I enjoyed reading the article you co-authored with Cesare Marchetti. It was extremely interesting and obviously backed by a great deal of human transportation data. Do you see any economic factors, resulting from the masses of lower-income city inhabitants in coming years, speeding up or slowing down the evolution to fuel-cell cars, hydrogen-powered planes, and maglev mass transit? I am looking forward to future articles and other publications of your research.

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[*Authors reply*: Rising incomes mean rising speed at all social levels. The rich, of course, accelerate more than the poor. While poor means slow, even the slow today speed compared to Queen Victoria or Montezuma. In industrial countries, a poor man has a car and the mobility of an ancient nobleman. When new travel modes are introduced, such as hypersonics or maglevs, initially they will be the province of the rich. Maglevs, however, lend themselves to mass transit and can benefit the poor. While fuel cells are clean and efficient, these new generators do not enhance speed. They may diffuse first in buses and trucks and generally in a "democratic" fashion, that is, in vehicles with a high utilization factor. Some increase in the speed of cars may come from intelligent transport systems, that is, total computerization of the vehicle and its context.

Jesse Ausubel and Cesare Marchetti]

ERRATA

[These corrections have all been made to TIP online.]

1. On the contents page of the April/May issue, under Corporate Associates, page 39, the name of the author Dan Hays was incorrectly spelled Hayes.

2. In the "Molybdenum as nanoconductor" item (April/May, p. 14), the correct reference is *Science* **2000**, *290*, 2120, the coauthor is Michael P. Zach, and the institution is the University of California, Irvine.

3. In the article "Quantum cascade lasers turn commercial" (April/May, p. 12), we erroneously identified a gas species as "nitrous oxide (N_20)" instead of "nitric oxide (NO)." The relevant text should read: "Ford Motor Co. expects sensors based on QC lasers to quantify the concentration of nitric oxide (NO) in vehicle exhaust gases. Although the QC laser is not yet sensitive enough to measure concentrations of emitted NO at less than 1 part per million in real time—the Holy Grail for the automotive industry—Ford expects them to find short-term use in vehicle-certification testing.

"Under federal regulations, all new vehicles must be certified to meet specific standards for unburned hydrocarbons, most notably carbon monoxide and nitrogen oxides, which are measured in grams per mile after the vehicle has gone through a specified driving cycle. Bag samples are collected for later off-line measurements, some of which have NO concentrations of tens of parts per billion, which is comparable to those found in ambient air and too low to be measured accurately by current sensors. However, "the vehicle-certification facility is an ideal environment to implement a QC laser measuring system, which has more than adequate capability to measure minute concentrations of nitric oxide in bag samples," says Willes H. Weber, a senior staff technical specialist at Ford.