

Employable physicists

As an “industrial strength” quantum mechanic I must take issue with the claim of Ed Sickafus (“What makes an employable physicist?” June) that quantum mechanics, statistical mechanics, nuclear physics, and atomic physics are of no use to an industrial physicist. It should be noted that quantum mechanics, with some help from relativity, includes statistical mechanics, nuclear physics, and atomic physics (as well as chemistry). I have been greatly successful in using quantum mechanics to solve industrial problems, especially in those areas where “everyone knows that it cannot be done.” Here are some examples from my work in industry. I list the “everybody knows” and then the number of my patent in which I teach how to do it:

- The alloying of aluminum to n-type silicon cannot form an ohmic contact; U.S. 2,984,775 (this technology was the key to making the integrated circuit possible).
- Diamond films cannot be grown in vacuum; U.S. 3,543,394.
- The rate of a chemical reaction cannot be increased without increasing the kinetic energy of the molecules; U.S. 5,328,556 (other researchers seem to have ignored the fact that the “mating” of two molecules has to overcome a quantum mechanical repulsion as well as the well-known coulombic repulsion).

A bit of advice to quantum mechanics who want to succeed in industry—don’t think “particles” and “waves,” think “eigenfunctions.”

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It was with great interest that I read the article by Ed Sickafus in your June issue. I have been an employed physicist in an engineer-

ing world for more than 20 years. Before that, I taught college physics to potential physicists. Based on that experience I offer the following comments.

Core competence and good communication skills would be at the top of my list of important attributes as well. However, what sets physicists aside from many engineers is conceptual thinking. The application of the fundamental laws of nature to the real world is vital to anyone pursuing new areas of research or product development. The ability to make good decisions based on a minimum of information is a very valuable asset. A huge void in my background was project management. I did develop good problem-solving techniques, which have been applied, successfully I hope, to my project management methods.

Physicists (and engineers) tend to get caught up in working on projects rather than producing a finished product. Much of our physics “training” stressed the process for solving problems. Success in the real world demands results. We test a lot of products at Wilson Sporting Goods Co. People who perceive their job as product testers are of limited value. Those who use test results to add value to our products are very valuable.

I’m more than satisfied with how my physics background has prepared me for the “real” world. Looking forward to more articles on this topic.

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Microfabrication

Your March 1996 issue contained an interesting article, “The microfabrication boom,” by Jennifer Ouellette (p. 10), dwelling on the demand, growth, new factories, and job opportunities for physicists. In

the spirit of expanding your readers' perspective, let me recommend another article on the same subject, “Moore’s second law,” by Philip Ross (Forbes, March 25, 1996, pages 116-7). Ross goes beyond the usual discussion of increasing chip densities/falling unit costs. He points to a primal shift occurring in the submicron world where next-generation fabrication plants are projected to cost \$10 billion each. These tenfold increases over the costs of today’s factories are bet-your-company investments and drivers of industrial consolidation. Such economic constraints translate into the end to 30 years of ever-decreasing chip costs.

There is an important message in the Ross article for *The Industrial Physicist*. We physicists need to think beyond incremental steps and include more such nontechnical factors into our considerations. As physicists our task is to create entirely new ways to produce electronic devices—a challenge like that of replacing the heavy, power-consuming, unreliable workhorse vacuum tubes of the 1940s with solid semiconductor devices.

Martin J. Cooper
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Science MBAs

I am currently a graduate student in chemical physics and business at The Ohio State University. Our society is undergoing rapid changes in corporate culture. Traditional command-and-control companies will soon become dinosaurs in a more heavily technology-based economy. This creates great opportunities for technological experts who can direct themselves while making connections to other corporate arenas. Industrial physicists will make important contributions if they can position themselves well. My personal experience is that getting an MBA is a great enrichment. I found many of the concepts we use in science very applicable to business issues. In fact, I believe scientists have a natural talent to study market forces, supply-and-demand equilibria, accounting (conservation of money), etc. It is encouraging to see that some schools offer special MBA tracks for scientists. I would like to bring to the readers' attention that The



Ohio State University, for instance, offers a two-year part-time MBA program with night classes twice a week. Other schools may have similar programs. This way, one can earn a business degree without leaving work for a year. While it is time-consuming to take night classes in addition to full-time research, I found it interesting and stimulating to see a much bigger picture of the business world. I am convinced that additional business training helps physicists “do anything”!

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GPS

I happened to pick up the December 1995 issue of *The Industrial Physicist* while I was waiting in the Nippon Telegraph and Telephone Research Center in Tokyo. The article by Jennifer Ouellette (“GPS industry poised for explosive growth,” page 8) caught my eye. During my second year at the University of California at Los Angeles Graduate School of Management I participated in a 5-month marketing survey for the company (Amex International) that was then manufacturing GPS receivers for the military. The company had been given permission to sell the receivers commercially and were anxious to find out if there was much interest in them. We focused our attention on sea-going applications, particularly commercial shipping and private boating. We figured that GPS was a natural step up from using Loran C and other conventional position-determination methods. However, we found very little interest. Most of the people we talked to, including the captains of oil tankers, didn’t see much need for the improved accuracy. Well, in hindsight, we were all pretty shortsighted.

I must question the dates you give in your article. We did our survey in 1977 and at that time the system was already in use by the military, so the first “operational prototype satellite” must have been launched long before 1978. And I’m skep-

tical when you say that the “first GPS receiver for civilian use... required two men to carry it.” The units Amex was producing in 1977 were a bit heavy, but not so large that one man couldn’t carry one. GPS receivers are very popular here in Japan and seem to be manufactured by a number of Japanese companies. A couple of years ago I saw one made by Sony that is small enough to fit on bicycle handlebars (the price then was about \$700).

Arnold Fisher
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[Ed. Three of our sources remembered the year of the first operational prototype satellite as being in 1978. However, Charles Trimble, CEO of Trimble Navigation Ltd., remembers it as being 1976, so you are probably right. According to Sergei Gourevitch, chief scientist for Ashtech Inc., the first GPS receiver for civilian use, available in 1984, fitted on a rack that could be carried by one person, but when surveyors took it out in the field, there would be two of them carrying the parts and batteries. Trimble told us that it was 1988-89 before we got to the point where a GPS survey set weighed less than 20 pounds and you could start using it in a portable fashion.] 

Corrections

June, page 28—The equation to calculate the stimulated current in high resistance samples should read: $[I_1 - 3(I_2) + 3(I_3) - I_4]/8$, and the associated equation with values substituted in should read: $[(-0.552) - 3(-3.094) + 3(0.301) - (-2.677)]/8 = 1.593\text{pA}$

June, page 37—The telephone number listed for the Semiconductor Research Corporation should read 919-941-9400.

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