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■ The American Association for the Advancement of Science was founded in 1848 and incorporated in 1874. Its objects are to further the work of scientists, to facilitate cooperation among them, to foster scientific freedom and responsibility, to improve the effectiveness of science in the promotion of human welfare, and to increase public understanding and appreciation of the importance and promise of the methods of science in human progress.

COVER A wave of increased cytosolic calcium concentration propagates from cell to cell through a confluent culture of hippocampal astrocytes. The wave, induced by glutamate and measured with fluo-3, is evident from the spatial progression of color overlay areas (in a spectral sequence from violet to red). Each color indicates an area of calcium elevation at one of seven successive 4-second intervals. See p. 474. [Digital fluorescence micrograph courtesy of Ann H. Cornell-Bell, Steven M. Finkbeiner, Mark S. Cooper, and Stephen J. Smith]

Book Reviews

Products & Materials

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Engineering's Silent Crisis

Signs of trouble in American engineering are getting little more than a shrug from government and industry, even though both have much to lose. A serious shortage of engineers is a distinct possibility by the year 2000, caused by falling numbers of engineering graduates (down by 9350, or 12%, since 1986) and the retirement of the large cohort of engineers who entered the profession after World War II.

To the shortage add a sense of shortcomings: *Made in America*,* a recent report on industrial productivity from the Massachusetts Institute of Technology, indicts engineering as a factor in the nation's lagging competitiveness and declares flatly that the education of engineers "must be transformed." The report recommends increased emphasis on real-world projects by teams of students, a highly effective approach but an expensive one.

Engineering schools have a clear responsibility to confront these problems head on, but they need help. One reason is that the deficiencies of engineering education pale in significance before the prospect of millions of youngsters entering the work force without basic language and math skills. Another is the general assumption that engineers from other countries can be drawn to the United States or that engineering projects can be exported. America's engineering schools have been depending increasingly on foreign manpower, but heavy reliance on citizens of other nations to meet our country's engineering needs is problematic. Many engineering positions in government agencies or defense-related industries, for example, require American citizens. Department of Energy Secretary James Watkins recently acknowledged that his department has "serious problems finding qualified people." So far, that help has been elusive. NASA and other agencies have expressed similar concerns.

None of this is to suggest that American engineering should close its door to foreign nationals; on the contrary, the education of engineers in all advanced countries will more and more include a period of study abroad. But seeking exposure to foreign cultures is a far cry from dependence born of failure to educate our own engineers. Engineering education is demanding and costly, and new investments in technology and curricular reform will strain engineering school finances to the limit. Industry and government—today concentrating on the precollege part of the educational process—should help at the university level in three ways.

First, they should provide additional engineering scholarships for low-income students. During the 1970s, industry funding resulted in a surge of such scholarships, but the numbers have since dwindled. Studies show that engineering students, on average, come from families of lower socioeconomic status than those of students aspiring to other professions. This means that scholarships are particularly important in engineering and will be more so in the coming decades. Second, industry should work with engineering schools to expand cooperative education and summer employment programs. Beyond the financial help and learning experience these programs provide, they give a tremendous psychological boost, especially to minority students who have just struggled through their freshman year and badly need the reinforcement that comes from early contact with real-world engineering. Yet, industry has been reluctant to involve freshmen and sophomores in such programs.

Third, federal agencies, heavily dependent on American citizens, should institute the equivalent of ROTC—a Reserve Engineering Training Corps (RETC)—in which competitively selected high school students would be awarded scholarship support through the B.S. in engineering, after which they would serve for 5 years with the sponsoring agency. RETC could help pay for itself through its impact on recruitment costs and federal engineering salary scales. Its primary purposes, though, would be to ensure our government services a fresh supply of engineering talent while providing young people with both the incentive and means to pursue an engineering education.

Can we continue to assume that foreign nationals will meet our engineering needs, while American youth moves to the sidelines? The risks involved in a shortage merit more than a shrug of society's shoulders.—WILLIAM R. GROGAN, *Dean of Undergraduate Studies, Worcester Polytechnic Institute, Worcester, MA 01609*

* M. L. Dertouzos, R. L. Lester, R. M. Solow, and the MIT Commission on Industrial Productivity, Eds., *Made in America: Regaining the Productive Edge* (MIT Press, Cambridge, MA, 1989).