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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 Enhanced color image of Central Valles Marineris, Mars, where the suspected recent volcanism occurred. The photograph is a composite of high-resolution images in black and white and low-resolution images in color. Some of the dark material covering the Valles Marineris floor in the image is the material that may have come from volcanic vents and was dispersed by the wind. See page 565. [Alfred S. McEwen, U.S. Geological Survey, Flagstaff, AZ 86001]

Book Reviews

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Lifelong Learning

At one time, a single stint of university education was sufficient to provide the structural framework for lifelong learning. It was then possible for scientists or engineers to maintain a good level of awareness about progress in much of science or engineering. But the body of knowledge is expanding rapidly, and many new specialties have arisen. In some disciplines, several hundred thousand pages in journal articles appear each year. The usual response of the individual to the flood of knowledge is to become an expert devoted to learning more and more about less and less.

Most engineers are employed in industry; there, life is increasingly turbulent as some technologies become outdated and foreign competition destroys many jobs. Even in healthy companies, older engineers find themselves obsolescent as new technologies become applicable that did not exist when they were in school. This country trains fewer engineers per capita than do our leading competitors. Both for competitive and humanitarian reasons, we cannot afford to consign older engineers to oblivion. On the basis of individual effort, it is not feasible for an engineer in mid-career to change fields or to update himself or herself extensively without some kind of structured support. Thus there is a national need to organize effective continuing education for engineers. This need has been recognized by a number of organizations, including the American Society for Engineering Education, which presents a discussion of the problem in a report on Engineering Education.*

The activities of engineers are relevant to the scientific community for several reasons. First, a large fraction of the basis for support of academic research is the assumption that practical applications will result. If there are to help better our competitive positions, our engineers must function effectively. A second reason is that if the engineers evolve good mechanisms for fostering lifelong learning, these will be applicable to scientists.

Engineers working in industry are not alone in becoming obsolescent. At equal hazard are faculties at universities, including scientists and engineers. A striking example and a useful remedy were experienced at Massachusetts Institute of Technology. In common with many other schools teaching engineering, MIT in the early 1980s received a large number of applications from high-quality students wishing to study engineering. After being admitted and on campus, many wanted to major in electrical engineering and computer science. More than half of the students wished to take a sophomore course entitled, "Structure and Interpretation of Computer Programs." This included newly developed cutting-edge material with which only a tiny fraction of the faculty was familiar. Senior faculty were faced with the indignities of knowing less about an important subject than the sophomores and being unable to do their share of teaching it. The crisis was met by a special course for faculty conducted during the January break in 1984. The course, given 8 hours a day for a week, with laboratory and homework, enabled some of the faculty to understand better a textbook on the topic and later to teach it. Other sections of the course were conducted employing a 2-week period of total immersion in the subject at a secluded spot off campus. Freed from the innumerable interruptions and distractions that occur on campus, the professors enjoyed a tremendous learning experience. Experience at MIT with courses designed especially for faculty has been satisfactory and has led to similar courses in other fields.

Some leading companies, including AT&T, GE, and IBM, are active in continuing education. They, too, use isolated campuses with total immersion for a week and more. At least one company conducts a written examination at the conclusion of the course.

Most universities have no structured program for faculty education. Individuals are expected to create their own programs, which may involve sabbaticals, attendance at professional meetings, and other traditional activities. These, though useful, are not sufficient for many professors. A national need exists to foster lifelong learning. This need demands attention and support from universities, industry, professional organizations, private foundations, and the government.—PHILIP H. ABELSON

*American Society for Engineering Education, *The Quality of Engineering Education* (Washington, DC, 1986).