Scientific manpower shortfall: Is it real? What can be done?

by Mark Wilsey

A couple of years ago, the alarm was sounded by various groups that U.S. competitiveness was in jeopardy due to a projected shortage of scientists and engineers by the turn of the century. The source cited was the National Science Foundation (NSF). A case, based upon the NSF projection, was built for more science education funding. Now, the NSF is being accused of crying wolf over this potential shortfall in scientific manpower, and is coming under fire from Capitol Hill and other quarters.

The reported projection of the NSF was that the United States will be short 700,000 scientists and engineers by the year 2010. This was expressed as a cumulative shortfall in science and engineering bachelor degrees below the rates of the mid-1980s. The problem NSF faces is in defending numbers which came from an NSF analysis paper that, though widely circulated, was never published as an official NSF report.

Criticism of the NSF comes from those whose job is also to monitor manpower needs and who fail to see an imminent crisis. It is argued that by "twinking" the data on the demand side of the equation, the shortage on the supply side can be smoothed out. The trends toward shrinking budgets, defense cutbacks, and corporate down-sizing tends to shrink demand, critics argue.

Some critics argue the free market approach, that wage scales will balance out supply and demand. If there is a shortage, then rising wages will attract more scientific manpower; an oversupply of scientists and engineers will drive wages down and people from the market.

Professional associations, whose members are feeling the effects of a weakening economy, felt that such projections did not correspond to current realities. Such reports may only serve to flood more scientists and engineers into an already tight job market. It is also pointed out that there is a pool of technical talent in the labor force which is not employed in the scientific field, and this could be tapped if needed.

Last July, Rep. Howard Wolpe (D-Mich.), chairman of the oversight subcommittee of the House Science, Space, and Technology Committee, called for an investigation of NSF to see if this analysis had undergone sufficient review and to determine if it was politically motivated.

So far, investigations of NSF methodology of analysis and the quality of its data have shown that, like most government agencies, it could be better. But what is clear is that the mere suggestion of a possible shortage of scientists and engineers strikes a raw nerve. The question remains, what can be said about the future needs for scientific manpower in the United States?

The shortfall

The NSF projection is based upon the future demographics of the U.S. college-age population, along with a decline in the college enrollment of freshmen in science and engineering. According to the U.S. Census Bureau, between 1980 and the year 2000, the 18- to 24-year-old population is expected to decline 19%, while the overall population is expected to increase by 18%. In real terms, the number of 22-year-olds is expected to drop from 4.4 million in 1983 to 3.3 million by 1996.

U.S. freshman enrollment in science and engineering has been slipping steadily since 1982. The result has been a 10% drop in the number of undergraduate science and engineering degrees awarded from 1986 to 1988, a loss of more than 20,000 degrees.

Given that fewer students are seeking science and engineering degrees from our educational institutions, and that more of our current technical work force is nearing retirement, coupled with a modest 2% projected annual growth rate in engineering employment demand, there could be a significant shortfall of technical manpower by as early as the mid-1990s. For certain engineering specialties in emerging technologies, such as advanced materials or enhanced microchips, positions are becoming harder to fill.

The National Research Council (NRC) has studied the manpower prospective in the specific fields of mathematical sciences, biomedical research, and nuclear engineering, and has issued their findings in various reports.

Despite increased federal support and recent accomplishments in mathematics research, the NRC finds that "the numbers of supported senior investigators, graduate researchers assistants, and postdoctoral researchers are still seriously out of balance with the numbers supported in other sciences of comparable size," as well as that "the rate at which young people enter the mathematical sciences remains inadequate to renew the field."

For biomedical scientists, the NRC notes that since the early 1980s, demand has been growing relative to supply. A 1989 survey of biotechnology companies found shortages, defined as unfilled vacancies for 90 days or longer, amounting to 5.5% of total scientists employed. "Industrial employment growth is over twice the rate of academic employment growth." Unless demand falls or enrollments increase, the NRC projects "an undersupply of biomedical PhDs [doctoral degrees] into the next century," particularly in the R&D segment. However, the NRC fails to note that a drop in "demand" is just as bad as an "undersupply" to the health of our nation.

Although the collapse of nuclear engineering education in the United States is not surprising, the picture that the NRC presents is stark nonetheless. The undergraduate enrollment in nuclear engineering has gone from 1,150 students in 1978, to 650 in 1988. University nuclear engineering departments have dropped from 80 in 1975, to 39 in 1987. There were only 27 on-campus nuclear reactors in use for training, compared with 76 in 1970.

Testifying before the House Subcommittee on Energy last March, Dr. Marcus H. Voth, associate professor of nuclear engineering at Pennsylvania State University, compared U.S. research reactors to those in the Third World. He stated that "most of the university reactor facilities in the U.S. have been in service since the 1950s and '60s," and that "to remain technologically competitive, the aging U.S. facilities now require equipment replacements, modernization, and upgrade. . . . Without new sources of funds for upgrades U.S. URRs [university research reactors] suffer in comparison with newer or upgraded similar installations in Europe, Japan, the U.S.S.R., and even in emerging countries such as India."

The NRC report concludes that "even if there is no demand growth in the future, supply will not satisfy expected demand if present trends in nuclear engineering education continue." However, if there is a resurgence of nuclear power, the best estimate is "that the annual demand for nuclear engineers would increase at least 200 and possibly 300% between 2000 and 2010."

The report notes that while the undergraduate course work focuses on power reactor science and technology, less than 20% of funded research concerns power reactors. Therefore, the NRC calls for expanded funding for power reactor research, "to ensure that faculty retain the skills and enthusiasm necessary for the undergraduate curriculum."

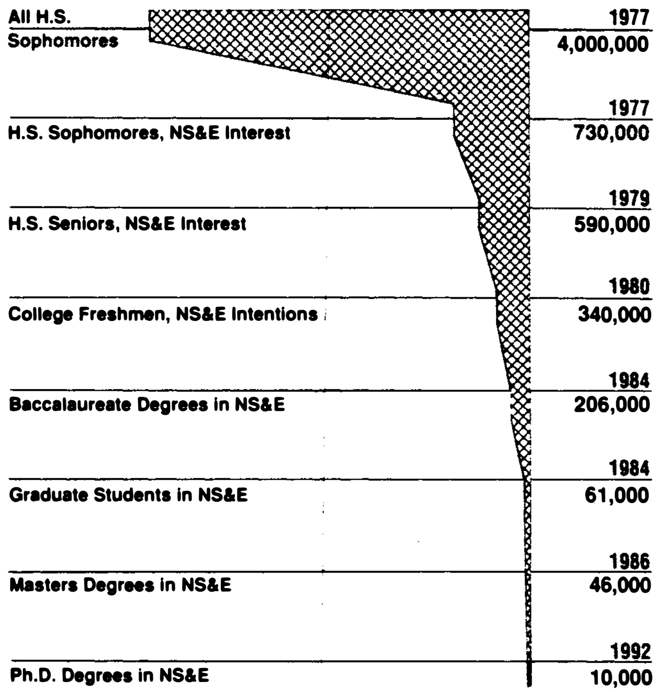
The pipeline

A snapshot of U.S. scientific manpower is as follows: There are about 4 million scientists and engineers in the United States, making up about 4% of the labor force. The ratio of scientists to engineers is about 3:4. About one in four works in research and development.

To keep this technical work force replenished, many different agencies have begun initiating programs designed to encourage students, particularly women and minorities, to stay in what NSF describes as the science education "pipeline." The rationale is that a minor change in the percentage of high school students who go on to technical careers would alleviate future shortfalls, but also to reach beyond the traditional pool of white 18-year-old males, which demographics show is shrinking.

Persistence of natural science and engineering interest from high school through Ph.D degree

(The pipeline)



Source: National Science Foundation.

This is how NSF lays out the "pipeline": From a total 10th-grade population of 4 million students in 1977, NSF estimates that 730,000 expressed an interest in science and engineering careers. By their senior year of high school, that had dropped to 590,000, dropping again to 340,000 among college freshmen. By 1984, however, only 206,000 bachelor's degrees in science and engineering were awarded. Less than one-third of these went on to seek advanced degrees, and of those, 15,000 dropped out during graduate school, leaving 46,000 science and engineering masters degrees awarded in 1986 (see **Figure 1**). NSF projects that at the doctoral level, less than 10,000, or only 0.24% of the original pool, will earn their PhDs.

This gives rise to a more fundamental issue. In these times when education budgets are being squeezed ever tighter, how can our science "pipeline" handle an increased volume of students? Also, it seems that our students are poorly prepared to pursue those science and engineering careers. So the "pipeline" is in need of upgrading both quantitatively and qualitatively.

There are at least 200 education reform studies vying for the attention of our educators and the public. And although taxpayers cannot be expected to underwrite every new program that comes along, they must insist that the necessary science and math courses be made available.

Science illiteracy

It is important that more students become interested in science, whether they go on to earn advanced degrees or not. As Dr. Bassam Z. Shakhashiri, former head of education at NSF, told *EIR* in an interview that appeared Aug. 17, 1990, "We need an educated citizenry that can distinguish between astronomy and astrology."

There seems to be an unending stream of reports and studies that show how U.S. students stack up against their foreign counterparts. A survey by the Educational Testing Service comparing South Korean, British, Irish, Spanish, Canadian, and U.S. high-school students found that the United States ranked near the bottom in science and mathematics, with Korea at the top. Another report showed that the average Japanese student does better in mathematics than the top 5% of U.S. students. The same study reported that more than 25% of our 13-year-olds cannot handle elementary school arithmetic and only 6% of 17-year-olds can handle algebra.

In the United States, high-school students take an average of 2.5 years of science courses, while Soviet students, on average, take six years of biology, five years of physics, and four years of chemistry.

These reports, often cited to drive home the point that U.S. science education is falling behind the rest of the world, show some of the leaks in our "pipeline." For example, two-thirds of U.S. high schools do not offer enough mathematics courses to enable a graduate to enter an accredited engineering school.

Perhaps what these reports really show is the degree to which we have neglected science education in the United States. We can hardly expect little Susie to become a chemist when her school has no chemistry course. By the same token, we cannot in good faith encourage her to pursue a career in chemistry if we cannot show her the vital role she has to play in society. Indeed, there is no point worrying about the future supply of scientists and engineers if there is no commitment to make use of them.

Economist and statesman Lyndon LaRouche has often stated that 5-10% of the U.S. labor force should be employed in scientific R&D. As shown earlier, scientists and engineers make up about 4% of the labor force and only a fourth of them are engaged in R&D. If breakthroughs are our goal, then more talent must be brought to bear on the challenges facing society.

The goals that a nation sets define the tasks to achieve them. Framed in the effort to put man into space, NASA, during the 1960s, made major contributions to U.S. science education which were felt from the university level down to the elementary school level. Through the Sustaining University program, NASA helped finance postgraduate training, build or upgrade facilities, and fund space science research. There were more than 200 educational institutions in the program, involving 1,500 faculty members and 3,600 students working on space related problems in 30 disciplines. NASA, working with the National Science Teachers Association (NSTA), also sought to improve school science curricula. Through a series of 13 paperback science books for children published by the NSTA, the principles of rocketry and space science became classroom topics. Today, NASA's involvement with the nation's youth is shown in such programs as allowing high-school students to fly experiments on the Space Shuttle.

The fusion engineering act

In 1980, Congress passed the Magnetic Fusion Energy Engineering Act "to provide for an accelerated program of research and development of magnetic fusion energy technologies leading to the construction and successful operation of a magnetic fusion demonstration plant in the United States before the end of the 20th century"—no less worthy a goal than putting a man on the Moon, which had clear implications for strengthening U.S. technical capabilities, spinning off new technologies into the economy, and moving toward securing an abundant energy source for mankind.

The act included provisions addressing manpower requirements. Section 10 mandated that the secretary of Energy "assess the adequacy of the projected U.S. supply of manpower in engineering and scientific disciplines required to achieve the purposes of this act," and to "submit a report to the President and to the Congress setting forth his assessment along with his recommendations regarding the need for increased support for education in such engineering and scientific disciplines."

However, the act was never funded and fusion energy is still an elusive goal. The same can be said for the NASA Moon base—the point being that without a forward-looking commitment to progress at all levels of human endeavor there can only be an erosion of capabilities, and once lost they are difficult to replace.

There is a lesson we can learn from the warning last fall of Yevgeny P. Velikhov, vice president of the Soviet Academy of Sciences. Speaking before the Congress of People's Deputies, he urged support for his nation's scientific institutions and attacked the idea of the former Soviet Union becoming merely a raw materials producer and source of cheap labor. "What distinguishes Third World countries from those in the First World? In the main, Third World countries have resources, they have a work force, too, but they do not have science or expertise. If we destroy science . . . we shall never rebuild it. . . . Then we will have no future."