News Focus

White men don’t study?

U.S. students are avoiding science degrees, industry is worried about filling high-tech jobs, and graduate programs are overflowing with foreigners. That’s the accepted wisdom. But how true is it?

Down for the Count?

When 250 scientists descended on Washington, D.C., last month to urge federal legislators to boost funding for the physical sciences and engineering, they also made a pitch for training more scientists. They described “a diminishing number of Americans” entering the profession and an inadequate supply to satisfy demand for their services, an “unhealthy trend” according to the coalition of scientific organizations that sponsored their visits. “If there’s one killer stat, it’s that we’ve produced a declining number of [bachelor’s degree] engineers for the last 10 years,” explains David Peyton, vice president for technology at the National Association of Manufacturers and vice chair of the Alliance for Science and Technology Research in America, which cosponsored the Hill visits.

It wasn’t the first time such arguments had been made. The idea that U.S. students are avoiding science has been repeated so often in recent years, by so many scientific organizations, that it has become accepted wisdom. Most groups also lament the low participation rates of women and minorities in an increasingly diverse society and the country’s over-reliance on foreign talent. And they want the government to do something about it—and fast.

“We face a looming crisis based on the country’s inability to train enough U.S.-born talent,” asserts George Langford, a biologist at Dartmouth College in Hanover, New Hampshire, and head of the education committee of the National Science Board, whose task force on the scientific workforce is finishing up a report that is expected to call for a major boost in government training funds (see sidebar). Shirley Ann Jackson, president of Rensselaer Polytechnic Institute in Troy, New York, and the author of two widely cited reports warning of looming holes in the scientific workforce, sees a “gap [that] represents a shortfall in our national scientific and technical capabilities.”

The message is compelling. But how true is it? Statistics collected by the National Science Foundation (NSF) and other authoritative bodies paint a much more nuanced picture of the emerging U.S. scientific workforce. Some of the numbers and trends about enrollments and degrees are at odds with the conventional wisdom, whereas others show a cyclical pattern with both slumps and spurts. The decline in engineering degrees that Peyton cites, for example, isn’t visible in the statistics collected by the Engineering Workforce Commission of the American Association of Engineering Societies. A report issued in March shows that the number of bachelor’s degrees in engineering stood at 65,001 in 1993 and 68,648 in 2002—and that the number has changed very little over the decade. Moreover, first-year enrollments jumped by 14% between 1999 and 2001, suggesting that the number of degrees is likely to rise in the next few years.

Langford’s “looming crisis” and Jackson’s “gap” are more difficult to pin down. Neither person says when it will hit nor spells out what would be “enough” degrees. The trends upon which their forecasts depend are also far from clear-cut. To pick one broad marker, the number of bachelor’s degrees awarded in science and engineering (S&E) rose by 31% between 1980 and 2000, according to federal data compiled by the Commission on Professionals in Science and Technology (CPST). For the natural sciences (i.e., excluding the social sciences and psychology) and mathematics, it’s up 15%. Even in computer science and engineering the number of degrees awarded is up 38% since 1980, although it’s been on a roller coaster ride during those 20 years (see sidebar, p. 1071). And those students are overwhelmingly U.S. citizens. Moving up the academic ladder, NSF figures analyzed by the RAND Corp. show that the number of doctoral degrees in science, engineering, and health awarded to U.S. citizens has risen by 22% over the same 2 decades, including an 11% rise over the past 10 years.

To be sure, there is consensus that pre-college training for prospective scientists...
and engineers needs to be improved and that African Americans, Hispanics, and Native Americans are seriously underrepresented among those pursuing S&E degrees. And some of the enrollment numbers suggest worrisome shifts in the composition of the scientific workforce being trained by U.S. universities. To cite an extreme example, a new NSF report on graduate enrollments shows that the total pool of U.S. citizens and permanent residents pursuing S&E degrees has dropped by 10% since peaking in 1993, and the number of white U.S. graduate students in S&E has dropped by 20%. The share of graduate students in computer science and engineering with temporary visas has risen by 66% in the past half-dozen years, notes the same report, with foreign-born students now making up almost half the graduate population in those fields.

But are these enduring trends? Moving the baseline back by only 3 years wipes out the decline among all U.S. citizens pursuing graduate degrees and cuts in half the size of the shrinkage among males. And the attractiveness of U.S. higher education to foreign-born graduate students is notoriously volatile, subject to external events—such as Tiananmen Square or 11 September—that have nothing to do with the scientific workforce.

In addition, trends vary by discipline—patterns for the biological sciences differ markedly from those for the physical sciences, mathematics, and engineering—and are easily influenced by business cycles. It is noteworthy that the much-cited data on student enrollment and degrees, the supply side of the equation, say nothing about the demand for scientific talent. Nor do they constitute evidence of a gap between supply and demand, notes John Marburger, the president’s science adviser.

“I’ve been hearing a lot about labor shortages since I came to Washington [in the fall of 2000],” says Marburger. “But I don’t think that there’s a good model that can tell us what’s going on in the workforce and what the government can do to help.” Most of the current debate, he adds, “is based not on data but on anecdotes, or in response to pleading by individual sectors.”

By the numbers
What do we know for certain about the U.S.-born-and-bred workforce? For starters, NSF
figures show that the total number of S&E Ph.D.s awarded to U.S. citizens held fairly steady throughout the 1980s and rose gradually throughout the 1990s before leveling off at the end of the decade. The 2000 figure stood at 16,390, according to an analysis by RAND, compared with 13,438 in 1980.

The data are also encouraging for those concerned about participation rates by underrepresented groups. The number of white women (all U.S. citizens) earning doctoral degrees has almost doubled over that span, and ethnic and racial minorities, a group that consists of African Americans, Hispanics, and Native Americans, have done even better, nearly tripling their presence. Admittedly, the numbers for minorities are still small, only 1540 in the year 2000. But their share of the pot has risen from one in 25 to one in 10. (Including Asian Americans boosts that to one in six.)

The overall story doesn’t change as one moves down the academic food chain. Graduate enrollments in S&E for U.S. citizens and permanent residents have risen by 15% since 1980, according to the latest figures through 2001, just released by NSF. Graduate enrollment in computer sciences, a field of special concern to many industrial leaders, rose for the fifth straight year, standing almost 20% higher than in 1990 and some 130% greater than in 1980. Likewise, the number of bachelor’s degrees in mathematics and computer science has more than doubled since 1980, although the figure has cycled up, down, and back up. And under-graduates aren’t forsaking science for other fields: The overall proportion earning bachelor’s degrees in all S&E fields has held steady, at about 32%, for the past 35 years.

The gender gap is also narrowing. In 2000, women for the first time earned more bachelor’s degrees than men in all fields of S&E. That’s almost true within the natural sciences and mathematics as well, where the female-male ratio is 47:53. However, when engineering is added, the ratio drops to 39:61. The same pattern can be seen at the graduate level: In 2001, women occupied 48% of all graduate slots in the sciences (natural, behavioral, and social sciences), up from a 34% share 2 decades ago. Even within engineering, their presence has grown from less than 9% in 1980 to 20% in 2001. And the absolute number of women engineering grad students is up 50% since 1990 and has nearly quadrupled since 1980.

The data do seem to reinforce the standard wisdom on some points. The increased presence of foreigners in U.S. graduate departments, for example, is real. NSF figures show that noncitizens have increased their share of science, engineering, and health Ph.D.s from 22% to 37% since 1980. And the latest figures on graduate enrollments show a rise of 10% a year for the past 3 years. But that sudden rise comes after a decline for much of the 1990s, leaving the number of Ph.D. degrees awarded noncitizens in 2000 roughly the same as it was in 1991.

It’s also not clear how long these trends might continue. Many observers speculate that the tightened visa procedures in place since September 2001, combined with the recent war in Iraq, could turn off many prospective graduate students from abroad. An abrupt falloff could cause strains within some university departments. On the other hand, some observers believe that such a decline might create opportunities for U.S.-born students.

It is true that the number of Americans pursuing advanced degrees is dropping in some fields. The number of Ph.D.s in the physical sciences—astronomy, chemistry, and physics—has dropped by 14% since 1993. Then again, that’s also true for noncitizens, who experienced a 10% drop over the same period. Some of the statistical gains by women are due to a shrinking male population: The number of white men who earned science, engineering, and health Ph.D.s in 2000 was 15% lower than 20 years ago. The rise in the number of engineering students also masks a slight drop in the proportion of women (but not the absolute numbers) in the classroom, as computer engineering—the fastest growing specialty— Attracts a heavily male enrollment.

So far, however, there is no evidence that these trends have created a shortage of scientific workers, says economist William Butz, the former head of social and behavioral science research at NSF, now at RAND’s Science and Technology Policy Institute.

In a talk last fall entitled “Is There a Shortage of Scientists and Engineers? How Would We Know?” Butz applied five definitions of “low” production of a commodity and found that only one—when production doesn’t satisfy market demand—has a self-correcting mechanism. The mechanism, according to traditional economic theory, is rising wages and declining unemployment rates.

After looking at the available data, Butz concluded that neither phenomenon is occurring in the S&E workforce. “The data at
Report to Argue for More Training Funds

Although many groups have tried to make the case that the supply of scientists is not keeping up with demand (see main text), the members of the National Science Board’s Task Force on National Workforce Policies have taken a different approach to the issue. Indeed, they canceled a study to examine industrial demand for scientists in the course of their 2 1/2-year study. Instead, they have been propelled by a conviction that the country needs more U.S. citizens going into science and engineering because those graduates will benefit the nation in countless ways.

“There aren’t any new data presented, but we have a wealth of anecdotal evidence” pointing to a shortage of domestic scientific talent, says Joseph Miller, Corning’s chief technology officer and chair of the task force, which has held a series of open meetings to discuss a long-awaited report that it plans to present to the board next week. “A healthy scientific enterprise leads to a strong economy,” adds Miller, a polymer engineer who spent 35 years at DuPont before joining Corning 2 years ago. “And a strong science and technology workforce is essential to that enterprise.”

The report is expected to recommend that the federal government offer “substantial new support” to make science and engineering degrees “more attractive to students.” Its suggestions will include more scholarships and higher paying stipends for students and more institutional funding for a range of programs aimed at attracting and retaining U.S.-born-and-bred students. The goal is to produce “more individuals with competencies that industry needs,” says George Langford, a biologist at Dartmouth College in Hanover, New Hampshire, who heads the board’s education committee.

The task force originally planned to commission a study of industrial demand for scientists and engineers. But Miller says the idea was abandoned because “assessing the demand side is always very difficult ... it can change dramatically in a relatively short time.” That left the task force, formed in the fall of 2000, free to focus on what the government should do to lure more U.S. citizens into the field.

-J.D.M.

Bad guess. The late 1980s featured stark warnings of an impending shortage of scientific talent based on a demographically driven formula for calculating the number of science and engineering Ph.D.s in a given cohort of college-age students. But the reality was quite different, noted a 2000 National Academy of Sciences study on the perils of forecasting supply and demand for this highly specialized labor market.

N E W S  F O C U S

News Focus

Cries of a scientific shortage are not new. Sputnik forced U.S. leaders to ask, perhaps for the first time, whether the country had a sufficient supply of technically adept workers. The response, the National Defense Education Act of 1958, launched a generation of scientists who found employment in the baby-boomer–propelled expansion of academic and industrial research of the 1960s and early 1970s. Then came a decade of economic malaise and a tough labor market, which allowed workforce issues to fade to the sidelines.

Former NSF Director Erich Bloch revived the idea of a looming shortage after taking office in 1984. The number of bachelor’s degrees awarded in the physical and biological sciences, math, and engineering was near a peak, driven largely by demographics. Bloch and other influential voices in the community projected a drop in degree production against rising demand and came up with a massive predicted shortfall over the next decade and beyond. They believed that the federal government needed to address it. The conclusion dovetailed with Bloch’s campaign to boost the agency’s budget, then around $1.5 billion.

Although NSF’s budget rose in the late 1980s and early 1990s, the idea that the nation was facing a shortage of scientific talent collapsed after a 1992 congressional inquiry pointed out its weak underpinnings. “The NSF models did not anticipate a deep economic recession [or] the end of the Cold War,” notes a National Academy of Sciences report based on a 1998 workshop on scientific labor forecasting. “They also failed to account for the market mechanisms that operate to bring supply and demand in balance.”

The latest drive to boost the workforce springs from two sources. One is a 1996 report by the Department of Commerce that projected the nation would need 2 million more information technology workers over the next decade than the number of IT graduates coming out of U.S. universities. This report, in turn, reflects concerns raised by the Information Technology Association of America (ITAA) about a pending labor shortage.

But the Commerce Department results have since been largely discounted by workforce analysts. “We got hammered by the General Accounting Office, and rightly so,” says a department official who helped with the report. “Our approach was way too simple.” Demographer Michael Teitelbaum, who oversees several workforce initiatives for the Alfred P. Sloan Foundation, not only criticizes the survey’s methodology but also scolds lobbyists from research universities for climbing aboard the ITAA bandwagon in hopes of winning more federal spending in IT-related fields.

The second impetus is a very real, and widening, disparity between federal funding for the biological and the physical sciences. This year’s $27 billion budget for the National Institutes of Health (NIH), already the...
biggest kid on the academic-research funding block, signaled the end of a 5-year doubling. Although science groups were glad to see Congress doling out more research dollars to NIH, they argued that because all fields are interdependent, such a growing imbalance is bad for all of science.

To remedy the situation, advocates settled on a common vehicle—a proposal to double NSF’s budget. As pro-science groups joined forces with leading high-tech industrial firms, they broadened their message to include workforce issues as well as funding. “Companies care about federal support for research,” says Peyton, “but from a business standpoint the personnel issue is much more pressing. After all, these are the people you’ll be hiring in the next 1 to 3 years.”

The campaign has been successful—to a point. Late last year, President George W. Bush signed into law a bill that spells out a 5-year doubling path for NSF, but it contains only guidance, not money. And the president’s current budget request for NSF calls for only a 3.5% increase in 2004, a far cry from the 15% annual rises that would be needed to double NSF’s budget by 2008. To keep the issue alive, vigilant lobbyists are peppering meetings, congressional hearings, and other forums with anguished cries about the state of the scientific workforce.

Indeed, workforce initiatives are popping up like spring flowers in Washington science policy circles. A federally funded coalition of companies, government officials, and professional societies called Building Engineering and Science Talent (BEST) last fall warned of a “quiet crisis” based on the fact that “American colleges and universities are not graduating enough scientific and technical talent to step into research labs, software centers, refineries, defense installations, science policy offices, manufacturing shop floors, and high-tech start-ups.” Jackson, the author of the BEST report, issued a similar warning in March under the auspices of the Government-University-Industry Research Roundtable, an unusual hybrid body staffed by the U.S. National Academies. The report, Envisioning a 21st Century Science and Engineering Workforce for the United States, describes “a shrinking workforce [and] an unprecedented labor shortage.”

Over the next several months, top government advisory groups will offer their analyses. A task force of the National Science Board will shortly deliver a report asserting that the U.S. government has the responsibility to ensure an adequate supply of technically trained workers and suggesting several ways to meet that need (see sidebar, p. 1073). And the President’s Council of Advisors on Science and Technology (PCAST) has just established a task force, headed by former Microsoft COO Robert Herbold, to see if sufficient numbers of U.S. students are being trained for scientific careers and if universities have the resources to meet the challenge. The White House Office of Science and Technology Policy has created an interagency group to gather up the numbers.

In the meantime, Teitelbaum doesn’t expect the community to stop beating the drums for increased federal support to reverse the alleged dearth of scientists and engineers. “It’s a hardy Washington perennial,” he says, “even if there’s no credible, quantitative evidence to back it up.”

In the end, its staying power may derive from the fact that the debate rests not so much upon numbers as upon an abiding faith in the value of a robust scientific enterprise. And that faith translates into the need for scientists to be fruitful and multiply regardless of current market conditions. “Doesn’t everybody agree that everybody should be trained as an engineer?” quipped PCAST co-chair Floyd Kvamme at a recent meeting.

Jackson summarized that imperative last month at a 2-day science and technology colloquium sponsored by the American Association for the Advancement of Science (which publishes Science). “This country needs more scientists in the pipeline,” she said. “And we also need to create the right climate to generate that [demand for] scientists.”

—JEFFREY MERVIS

Taiwan-China Collaboration

A Bridge Over Troubled Waters

Researchers from Taiwan and the mainland have hit scientific pay dirt with the first—and so far the only—collaboration between two institutions across the Taiwan Strait

TOKYO—A hot campaign issue in Taiwan’s presidential election in March 1996 was whether the island should drop its long-held objective of reuniting with the mainland and formally declare its independence. As a warning to what it regards as a renegade province, China staged military exercises along the Taiwan Strait and fired test missiles into nearby waters. It was hardly fortuitous timing for physicists planning the first-ever institutional-level scientific collaboration across the strait. But it didn’t deter Chang Chung-Yun, a physicist at the University of Maryland, College Park, then on sabbatical at the Institute of Physics of Taiwan’s Academia Sinica.

“I was scared because the missiles were being launched when I flew from Taipei,” admits Chang, who was born on the mainland but is now a U.S. citizen. It was his idea to get Taiwanese scientists together with researchers at the Chinese Academy of Sciences’ Institute of High Energy Physics (IHEP). That month, the two institutions signed a memorandum of understanding to work together on the Taiwan-China collaboration.

Powerful collaboration. Scientists from Taiwan and mainland China are studying neutrino emissions from this nuclear power plant outside Taipei.