SHRINKING WORLD I

Foreign Nationals Change the Face Of U.S. Science

Variations on John Wiley's recent experience may become so common they won't even merit a chuckle. Wiley, dean of graduate engineering at the University of Wisconsin, Madison, had a meeting last year with a half-dozen representatives from electronics firms that were sponsoring an on-campus research project. During the discussion, he remembers, "they asked me, 'What are you doing to assure that none of this technology is accessed by foreign students?'" Wiley says he looked around the table, smiled, and said: "Does anyone see anything ironic in this question?" Every one of the corporate representatives was either Indian or Chinese.

The tidal wave of foreign researchers sweeping over U.S. engineering throughout the 1980s has now broadened and is crashing over mathematics, computer sciences, and many aspects of the physical sciences. Although the pattern has been for foreigners to rush in where U.S. students no longer cared to tread, they are now swelling the ranks of biology as well. Says Mary Beth Hatten, a developmental neurobiologist at Rockefeller University: "I think it's everyone's experience that the number of foreign students in Ph.D. programs is pretty close to overwhelming."

Every one agrees that U.S. science couldn't do without foreigners. But with a slowed-down economy, the question arises: Are they taking slots in graduate schools and jobs that Americans would otherwise get? The answer is yes and no. In top schools and in areas where there is a large demand from U.S. students, few graduate school slots are being occupied by foreign students. But that means they tend to end up at large, second-tier institutions, and since there are so many who are both hard-working and well-prepared, they are indeed providing stiff competition for the natives. As for jobs, employers prefer citizens, all other things being equal, if only to avoid the paperwork hassle of hiring a noncitizen. And citizens have a leg up particularly in academia, where strong language skills and familiarity with the culture are part of job requirements. At the same time, observers acknowledge that there's no question but that Americans with only passable qualifications are being aced out of jobs by highly qualified foreigners.

And there's no let-up in the numbers of those foreigners. In 1989, 6.3% of the country's doctoral-level workforce was made up of foreign nationals, most hoping to follow in the footsteps of the 7.3% of that workforce who are now naturalized citizens. There are well over 100,000 foreign students in U.S. graduate schools, the majority of them studying science and engineering. Most of them will try to find employment in the U.S. when they graduate.

What does all this portend for U.S. science, especially now, when one academic Ph.D. opening can draw several hundred applicants? "It seems to be the signals are hopelessly mixed at the moment," says Harvard chemist George Whitesides. After all, only a year or so ago, scientific sages were extolling the availability of a "flexible pool" of foreign manpower to fill the gaps left by U.S. students (specifically white males, who were deserting science to go into business), to buy time for the United States to get its precollege education act together and move more students (especially females and minorities) into the science "pipeline."

Shrinking shortfall

Suddenly, it seems, the gaps have been filled and are beginning to overflow. Ph.D. surpluses have materialized in many areas of science—especially in the highly quantitative areas where Asians tend to specialize: engineering, math, computer science, and areas of the physical sciences. And there are plenty more Ph.D.s—mainly from China and India, followed by Taiwan, Korea, and developing nations on the Pacific Rim—in the making.

In 1991, according to the National Science Foundation (NSF), non-U.S. citizens made up more than 25% of the 415,000 enrolled in U.S graduate schools. And the higher you go, the larger their presence looms. While there are still a lot of Americans getting bachelor's degrees in engineering and math, 60% of engineering Ph.D.s and 50% of math Ph.D.s go to foreigners. Foreign nationals make up fewer than one-third of grad students in computer sciences, but 45% of the doctorates. And though they get fewer than one-third of the doctorates in the life sciences, they get almost half the postdoctoral appointments (see chart). At some schools, departments of chemical, mechanical, civil, structural, and electrical engineering are almost entirely foreign. "Our mechanical engineering department [which turns out about five Ph.D.s a year] hasn't had an American Ph.D. for some years now," relates industrial engineer Donald Frey of Northwestern University.

And, in increasing numbers, new foreign-born Ph.D.s have been electing to pursue careers in the United States—with the percentage rising from 54% to 68% during the 1980s, according to the NSF. They are going into industry and academia in roughly the same

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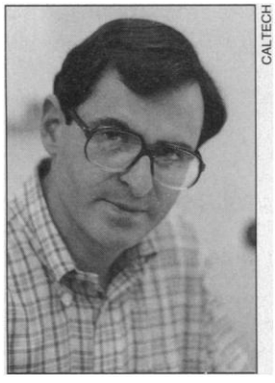
IEEE SPECTRUM

Foreign Ph.D.s in U.S. labs. This engineering group at AT&T Bell Labs includes three foreigners—from Taiwan, Mexico, and India.



CALTECH

With the dropoff in American kids' interest in science, "we no longer had raw material from our own mining operations so we started importing."

—David Goodstein of Caltech

proportions as Americans—that is, slightly over half of new Ph.D.s who have job plans are aiming for academia, according to the National Academy of Sciences. Throughout R&D-based industries, the proportion of foreign-born scientists is substantial: In the pharmaceutical industry, for example, according to the American Chemical Society, about 22% of Ph.D. chemists are either naturalized citizens, permanent residents, or temporary residents.

On campuses all over the country, especially at large state universities, foreign students, who are likely to be the crème de la crème of their countries, offer very stiff competition to the natives. They have a reputation for working very hard, they finish their degrees faster, and are more willing to put up with the hassles of being a graduate student. For instance, physicist James Allen of the University of Michigan in Ann Arbor says that the Chinese and Koreans who make up close to one-third of the 160 graduate students in his department are making their schoolmates sit up straight. "There's maybe a little tension in the first year or two," Allen says, because "the foreigners seem to be a little bit better prepared." Physicist Eugene Stanley of Boston University readily acknowledges that American students don't relish the competition. "Of course, I hear students express their resentment," he says. But "that's natural."

Are they elbowing out Americans? Neurobiologist Hatten says she and her colleagues at Rockefeller University have discussed that issue at some length and have concluded that even in hot fields such as theirs, foreigners aren't taking slots that might otherwise go to qualified Americans. Rather, the feeling is still that "we don't have enough really exceptional American students applying to graduate school."

Home field advantage

Despite the tremendous foreign presence, U.S. citizens still have an edge both in graduate school and in the job market. In the past, says materials scientist Rustum Roy of Pennsylvania State University, "we could take virtually any foreign student that was good. Now we're a little more stringent." For example, James Economy, professor of materials science and engineering at the University of Illinois, reports that although several hundred foreign students applied to his graduate program this year—making about a 3:1 foreign to domestic applicant rate—most of the 20 students that were accepted are American. The foreigners that made the cut either brought their own financial support or were so stellar that the department couldn't turn them down. Molecular biologist Jeremy Thorner of the University of California, Berkeley, says the situation is similar in his department. "We wish we could take more" foreign students, he says, but can't afford to because federal training grants are reserved for U.S. citizens.

In entry-level jobs in academia, foreign-born applicants are swelling an already bloated manpower pool in many fields. Last year, for example, Georgetown University in Washington, D.C., created a new position for an assistant professor for computer sciences. Herbert Meisel, professor of computer science, says there were 550 applications: Of these maybe a dozen came from overseas, and several dozen were from immigrant East Europeans or former USSR citizens. Of the 500 applicants who held U.S. Ph.D.s, about one-third had Asian or Indian names (Georgetown hired an American from Princeton). Scientists point out that U.S. citizens have the advantage over foreigners owing to the need for bureaucratic and political skills. As Rockfeller University's Hatten points out, "you have to have people with peak skills in paper writing and grant writing [as well as] research."

Notable exceptions to this "home field" advantage are the small number of scientists from the former Soviet Union and Eastern Europe who have thrown American academia into a bidding frenzy. Universities are competing for world-renowned figures in math and theoretical physics while hundreds of highly trained natives languish for lack of job opportunities. Newly installed at Pennsylvania State University, for example, is Yuri Zarkin, a renowned number theorist. And the University of Michigan at Ann Arbor has snagged an emininent particle theorist, Valentine Zakharov. But the Russian case is a special one where a limited supply of superstars have just come on the market. At this level, "Buy American" doesn't apply.

But the majority of former Soviet technical people are suffering at least as much as anyone else. In industry, it's harder for foreigners to land jobs unless they're superstars. Isaac Dvoretsky of Shell Development Co. in Houston says that his company's needs are so reduced that in campus interviews last year, the company didn't even bother to interview foreign nationals with temporary visas. Catherine Connor, director of placement at the University of Illinois' Biotechnology Center, says the story is similar

Non-U.S. Citizen Ph.D. Recipients in Science and Engineering, by Institution

	Institution	1981	1991	% Change
1	Univ. of Illinois-Urbana	91	205	125
2	Univ. of California-Berkeley	130	194	49
3	Univ. of Minnesota	67	187	179
4	Univ. of Texas-Austin	61	177	190
5	Ohio State Univ.	91	175	92
6	Cornell University	95	167	75
7	Univ. of Wisconsin-Madison	87	156	79
8	Univ. of Michigan	50	154	208
9	Stanford University	93	149	60
10	Pennsylvania State Univ.	41	147	258
11	Texas A & M Univ.	40	147	267
12	Purdue Univ.-all campuses	80	146	82
13	Univ. of California -Los Angeles	89	133	49
14	Univ. of Florida	46	127	176
15	Iowa State Univ. of Science and Tech	75	121	61
16	Univ. of California-Davis	63	119	88
17	Univ. of Maryland -College Park	24	112	366
18	Univ. of Arizona	35	108	208
19	Univ. of Pennsylvania	61	106	73
20	Univ. of Washington	41	106	158

Source: NSF/SRS Survey of Graduate Students and Postdoctorates in Science and Engineering

Postdocs in 1991

	Total	Non-U.S. Citizens
Total S&E	**23,018**	**12,116**
Engineering	2237	1630
Astronomy	210	84
Chemistry	3627	2336
Physics	1763	1006
Earth/Atmosphere/Ocean	645	236
Math	206	114
Computer Science	157	47
Agricultural Science	574	247
Biology	12,684	6155
Psychology	503	101
Social Science	425	147

Source: NSF

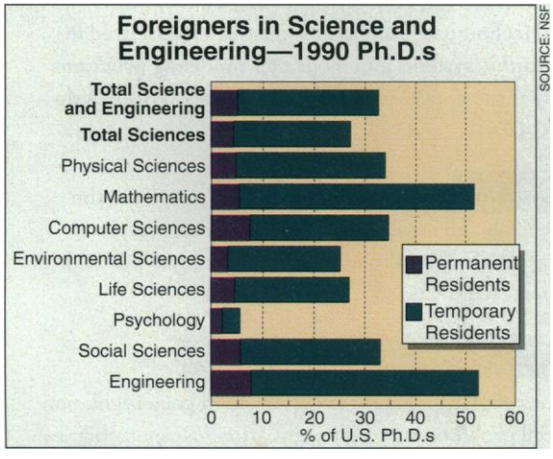
among pharmaceutical, chemical, and consumer products companies. As recently as a year ago, she says, companies were getting more interested in temporary residents, whom they had been reluctant to hire because of all the red tape. But now, Connor says, the attitude, at least until the economy picks up, is "we can't hire foreigners anymore because we've got to save the jobs for Americans."

The big picture

So what does the increased foreign presence in U.S. science really mean? The conventional wisdom over the past few years has been that foreign scientists have been saving our bacon by filling high-tech jobs that would have gone begging for lack of qualified citizens. But some observers nowadays feel that they are also helping institutions of higher education avoid coming to grips with reality: namely the failures of the U.S. precollege education system, and the failure of higher education to tune itself more to the needs of the 21st century.

Caltech physicist David Goodstein, who outlines his views on the alleged U.S. Ph.D. shortage in a recent article in *The American Scholar*, maintains that world production of scientists started slowing around 1970—it had to, as if the trend continued, "every man, woman, and child in the United States would have a Ph.D. in physics by the year 2080." Smart U.S. kids figured out what was going on, he says, and turned to other fields. As a result, he says, "we no longer had raw material from our own mining operations so we started importing"—thereby enabling the Ph.D. mills to keep operating at full capacity. Indeed, Rustum Roy has a ready example: At Penn State's department of mining, he says, 27 of the 28 grad students are foreign. They are "keeping the department alive." Goodstein won't say whether that kind of thing is good or bad. But since foreign students are getting heavily subsidized through tuition waivers and research and teaching assistantships, he says that the U.S. is, in effect, either training foreigners to take jobs that Americans might have had, or "putting our money and our best talent into training our economic competitors." He concludes: "If the U.S. government says educating the world is a foreign policy objective, OK. But I do think we're doing it without a policy decision."

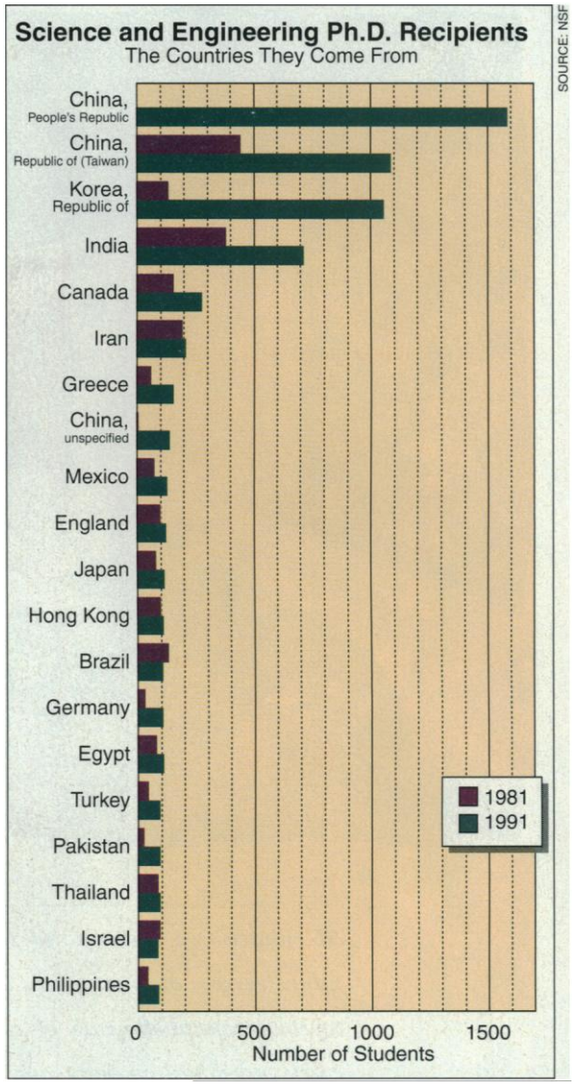
Other observers believe that the large foreign presence may also be helping universities to sustain some second-rate departments, and in doing so are helping delay the strategic realignments that universities are talking about these days. The chairman of a top university biology department (who doesn't want to be quoted) says there are many programs that are kept operating at full capacity by foreign students "the loss of which would not damage the enterprise a great deal." In his opinion it would be more efficient to put some of those programs out of their misery and pour more resources into the better ones.



U.S. training the world? Foreign nationals are cornering the Ph.D.s in heavily quantitative fields.

What's next?

There's no indication that such dilemmas are going to go away. As recently as 2 years ago, some American scientists worried that, as the native economies of Asian scientists started heating up, U.S.-educated foreigners would all be hot-footing it back to jobs at home—as the Japanese do now—leaving the United States to face the dismal reality created by the failure of its education system. But nowadays this doesn't seem likely. Chinese Ph.D.s aren't returning home if they can help it. Gu Xiaocheng, professor of biology at Peking University, reports, for instance, that "much to my regret ...of the 425 students that we sent to the U.S. between 1982-90 none has come back to China so far." Rather, they seem to be happily settled in university professorships and pharmaceutical companies in the United States, Europe, and Asia—everywhere but China. As for Indians, they "stick like velcro here," says Rustum Roy, who was born in India himself. This is particularly true for women researchers who, says Connor of Illinois, are reluctant to return to cultures that don't take them seriously. Connor says that although most Korean students return home on completing their training, the women don't because "they can't get good jobs in Korea."



Asians everywhere. Some are returning home to developing economies; most want to stay in the United States.

Immigration law is also on the side of the would-be immigrant scientist. Changes in the law, effective October 1991, tripled the quota for employer-sponsored immigrants—from 54,000 to 140,000 a year—and made it easier for people of exceptional training to come in without being sponsored.

These days, says Rustum Roy: "No [U.S.] university could run without an intake of foreign faculty." And it doesn't look as though any university will ever have to.

–Constance Holden