THE JOB CRUNCH

Is It Time to Begin Ph.D. Population Control?

Population control has attracted a good deal of scientific interest over the years—but never more than today, when the population being discussed is the one made up of scientists themselves. Some are saying, in no uncertain terms, that it's time to apply the brakes to production of new Ph.D.s.

"U.S. institutions appear to be producing more doctorates than the market will bear," states a report* issued earlier this year by William F. Massy of Stanford University and Charles A. Goldman of RAND Corp. They claim the "natural production rate" of science doctorates exceeds the demand from all sources by about 22%. The American Chemical Society (ACS) has chimed in with its own analysis, concluding that chemistry doctorates are being overproduced by at least 12% a year.

In the labs, people don't need reports to persuade them that times are tough. Biochemist Jerard Hurwitz, who runs the Sloan Kettering side of the Cornell–Sloan Kettering Medical College Ph.D. programs in the medical sciences, says that in his lab "we're keeping on some people [postdocs] just because they can't find jobs." Another prominent scientist, who asked for anonymity, says: "I have produced 20-odd Ph.D.s, and now I'm beginning to feel a little like a Catholic mother who has just woken up to the population problem."

These views represent a dramatic turnaround from a few years ago. In the late 1980s the National Science Foundation (NSF) triggered alarms about a Ph.D. "shortfall" predicted for the early 2000s, despite the fact that Ph.D. production was growing, from about 19,000 a year between 1976 and 1986 to 25,000 in 1993. Today many still contend that Ph.D.s are facing a bright future—although that future isn't necessarily in academic research. Mathematician Phillip Griffiths of the Princeton Institute for Advanced Study steered a National Academy of Sciences (NAS) report on graduate education (see p. 121) which concluded earlier this year "that the growth in nonresearch and applied research and development positions is large enough to absorb most graduates."

But a growing number of scientists argue that a combination of circumstances—chiefly flat federal funding for universities and science agencies, which limits the creation of new jobs in science and sets the stage for cutbacks—have changed the Ph.D. picture for the worse. And the remedy being proposed by many is to restrict the pipeline. Last November, for instance, University of Colorado cell biologist Richard McIntosh, then president of the American Society for Cell Biology, published an essay in the ASCB newsletter in which he described the situation as a "Malthusian crisis" and called for the training of fewer graduate students.

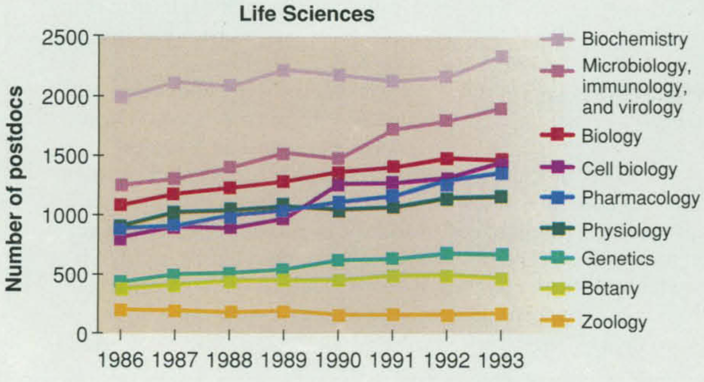
This debate—and which side people take in it—turns on a number of factors. One of the largest is whether you think Ph.D.s should work only in the type of intense research they were trained in, or if you look on the degree as an all-purpose fine-tuning of the intellect, good for jobs from Main Street to Wall Street.

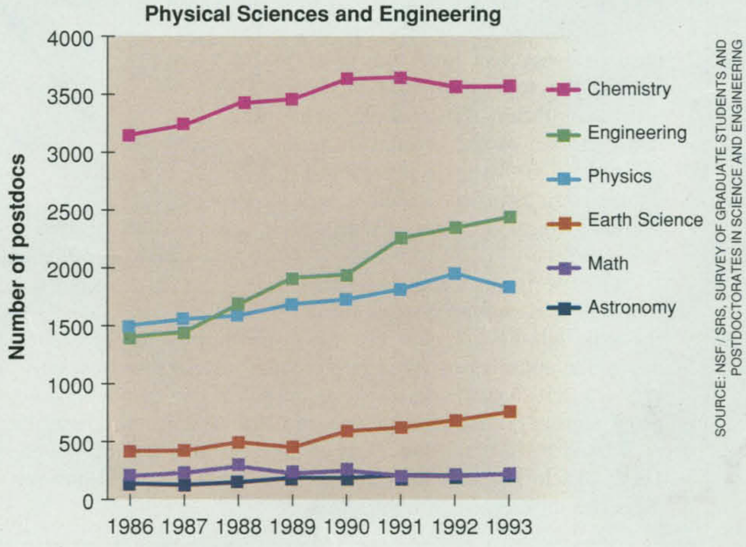
Problem or perception? To some, there's no question that the United States is training too many Ph.D.s. "What better indication ... than the growing postdoc population and the declining grant approval rate?" says former House Science Committee staffer John Holmfeld. Indeed, while the number of graduate students in science and engineering increased by 26.7% between 1982 and 1992, the number of people in postdocs at universities went up almost 64% during that same period, from 14,672 to 24,024, according to the NSF. The postdoc increase means thousands of people are spending years in what's often referred to these days as the postdoc "holding pattern," waiting for a permanent job opening. Such a thing was "unheard of a decade ago," says chemist Glenn Crosby of Washington State University in Pullman.

And those openings sometimes seem to be as scarce as hen's teeth. Overall, the proportion of science and engineering doctorates landing jobs in colleges and universities declined from 51% to 43% between 1977 and 1991, according to the NAS report, from the Committee on Science, Engineering, and Public Policy (COSEPUP). Although the report noted that the proportion going to industry rose from about 25% to 35%,

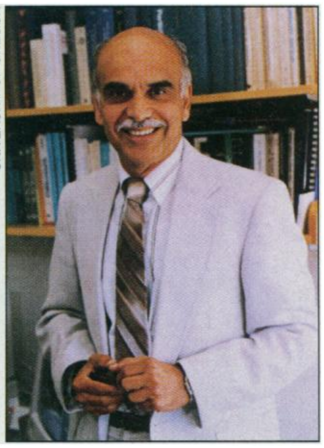
For more info on this topic, see *Science*'s Next Wave World Wide Web site: **http://sci.aaas.org/nextwave/**

* "The Production and Utilization of Science and Engineering Doctorates in the United States," April 1995.





Holding pattern. The number of Ph.D.s holding postdoctoral positions has risen since 1986.



UNIVERSITY OF OREGON

"[The Ph.D. is] a degree that allows you to think for yourself and do what you want to."
—Nilendra Deshpande

when the ACS took a close look at chemists, that didn't appear to be enough to make up the difference. The society polled faculty members at 190 Ph.D. programs on the fate of graduates who got their degrees in 1987 and 1988. With a response rate of over 60%, 17% were still unemployed or in temporary jobs 5 or more years out—which, concluded ACS, means that "suitable permanent employment opportunities are not available in a timely fashion for about 200 to 300 Ph.D. graduates in chemistry annually."

To others, however, the "overabundance" of Ph.D.s is not nearly so apparent. The overall unemployment rate for scientists hovers around 2%, a figure that the COSEPUP report used in arguing against the need for reducing Ph.D. production. Griffiths and other critics have countered that Massy and Goldman's pessimistic analysis fails to adequately take into account job opportunities in the private sector or field-switching.

Massy, however, counters that the committee "didn't say what the employed people are doing." Not only are many of those people in temporary positions, but lots are working at jobs that don't require such an advanced level of training, says Massy. "The main question is not whether or not they were employed, but whether or not it was worth investing the money that got invested in their training," he says.

What's a Ph.D. for, anyway? The issue for these combatants becomes one of defining appropriate work for a Ph.D. If it is seen as a passport to a broad range of jobs, it's hard to spot un- or underemployment. But more narrowly defined, as Massy implies, as a degree suitable for pursuing the research one trained in, overabundance becomes more plausible.

Chemist Herbert Kaesz of the University of California, Los Angeles, is one who sees the Ph.D. as an all-purpose "cultural" degree. People who agree with him—including government officials like NSF head Neal Lane—say, in effect: A Ph.D. will enhance your contribution in any number of professions, and you can't have too much of a good thing. Nilendra Deshpande, physics chair at the University of Oregon, for example, wastes no tears over unemployed or underutilized Ph.D.s: "Ever since I got my Ph.D. 30 years back, they've always complained of overproduction of Ph.D.s. You should not consider a Ph.D. in physics as a vocational degree. It's a degree that allows you to think for yourself and do what you want to."

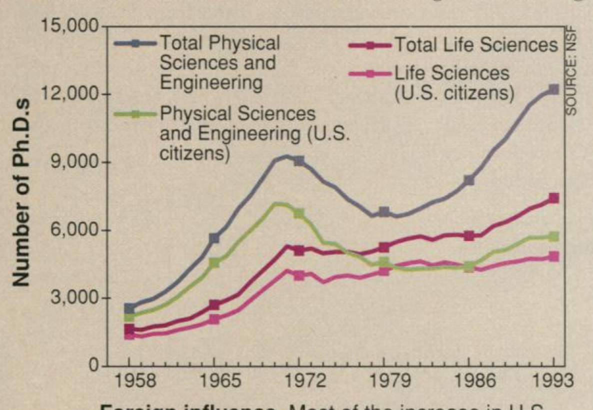
Others cherish a more purist vision, one of the Ph.D. as an elite and hard-won credential that is wasted if not used for research. Says Hurwitz of Sloan Kettering: "It takes a heck of a lot of energy, dedication, and focused effort ... working 18-hour days 6 or 7 days a week" to become a researcher. "Not being able to do what you're trained to do is the worst possible outcome." He doesn't even buy the idea that Ph.D.s should make themselves more attractive by diversify-

Foreign Competition

The increase in the number of Ph.D.s churned out by U.S. universities over the past decade is mostly attributable to a sharp increase in the number of science and engineering graduate students from foreign countries, according to the Committee on Science, Engineering, and Public Policy (COSEPUP) report, which states that they made up one third of graduate students in 1992, up from one fourth a decade earlier. National Science Foundation statistics indicate that the number of U.S. citizens attaining the degree has stayed relatively unchanged.

Foreign nationals have to be taken into account in any overview of the current (presumed) glut of Ph.D.s in the United States. But in a sense, they're the wild card—it's hard to gauge just how they're affecting the system when there are no authoritative statistics on how many remain in the United States after their training is completed. The current ballpark estimate, says William Massy of Stanford University, is 50%.

A few years ago, foreign scientists were being hailed as saviors, filling the void left by U.S. citizens who were failing to get higher degrees in engineering and the physical sciences. But now non-U.S. citizens—particularly those from China—have become prominent even in fields, namely biology, that are also heavily populated by U.S. natives. And changes in immigration law in 1992, which raised occupational quotas, have led to substantial increases in scientific immigration.



Foreign influence. Most of the increase in U.S. Ph.D.s is due to noncitizens.

Scientists now acknowledge more readily than they did a few years ago that foreigners are making it harder for U.S. citizens to get jobs (*Science*, 24 September 1993, p. 1769). Nonetheless there is little sentiment in favor of curbing their presence either in graduate schools or in the job market. As physicist Nilendra Deshpande of the University of Oregon points out, employers "want the best."

But foreigners aren't getting preferential treatment—on the contrary, employers don't like the paperwork involved in hiring a noncitizen, and citizens have an edge when it comes to admission to graduate school. Physics chair Austin Gleeson of the University of Texas, Austin, says that his department tries to keep the domestic-foreign ratio about 50–50, but admitting students purely on academic merit would yield a vastly different ratio. "If we let the thing run loose," says Gleeson, "it would be 80% foreign."

Some people believe the enormous foreign presence may already have peaked. The COSEPUP report, for instance, argues that the influx stems from a highly unusual combination of circumstances—the Iron Curtain, after all, doesn't fall every day, nor are Tiananmen Square massacres commonplace. And, the report suggests, the picture could shift as students from developing nations, such as Taiwan and South Korea, find opportunities in growing economies back home.

–C.H.

ing, taking courses in management or law, for instance. "If someone has come through one of these programs, yeah, they can do lots of things if they're forced to, but ... it's a big loss for science." Cell biologist Donald Fischman of Cornell Medical School agrees: "I was shocked this year when two of our very best students decided to consider patent law."

Such disappointments are old news to young physicists, hit hard by the death of large projects such as the Superconducting Super Collider. But in biology, the anguish is still fresh. Colorado's McIntosh got close to 100 replies to his ASCB essay last fall—virtually all agreeing with his grim assessment. One response echoes what many professors have said privately: "I continue to wonder how ethical it is to recruit new students into a field with little prospect for survival by 'average' Ph.D. graduates." Others lamented the waste of talent. Wrote one: "I get very depressed each time I serve on a [National Institutes of Health] study section due to the large number of outstanding proposals which we review that I know will not be funded."

Biting the bullet. But even those who believe it's high time to cut back acknowledge that cuts go against fundamental forces driving science in the United States. Schools still need a continuous supply of graduate students to keep the machinery of teaching and research running, McIntosh says. "It is in the best interest of most investigators to maintain the current size of their labs," because it enhances their chances of getting funded.

That makes this bullet a particularly difficult one to bite. This is even true in physics, a discipline whose graduates have been among the first scientists to hit the employment wall. At the University of Texas, Austin, for example, physics chair Austin Gleeson says the department decided 2 years ago to curb the number of new graduate students, reducing last fall's entering crop to about 20, down from the usual 80. But then, says Gleeson, "we started getting complaints from lab managers and problems staffing our classes." So enrollment is rising again—to 46 this fall.

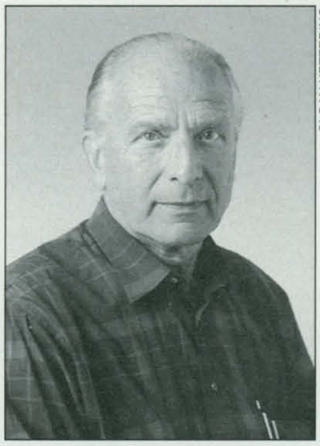
The University of Chicago reports a similar experience. Says assistant to the chair Nobuko McNeill: "We experimented for 2 years [with lower enrollments] because we heard a lot about the difficulties new Ph.D.s were faced with." But, as at Austin, enrollment has partly bounced back in response to the university's domestic needs. Cornell University's physics department now plans to cut back by 25%, citing the bleak job market as the reason. It remains to be seen how long this resolve will last.

In biology, setting absolute caps on enrollment is rare despite all the money worries. "I don't know of any departments reducing the number of students being taken in," says biologist Howard Schachman of the University of California, Berkeley. "All of them are talking about it but not doing it." Schachman and others say the attitude is that if university A cuts back, students who would have gone there will instead go for inferior training at universities B and C.

As for chemistry, the ACS task force is now determining ways to deal with the surplus it has identified. The chair of the committee that produced the report, David Lavallee, provost of the City University of New York, says that some scientists favor straight-out elimination of smaller departments. But Lavallee notes that those really aren't the best ones to kill off, because "our survey demonstrates that the graduates of small programs have been able to find employment." Moreover, the committee worried, closing small chemistry programs would affect quite a few states whose legislators might then decide there's no point in funding any chemistry research.

The tentative answer arrived at by the ACS is to cut the lowest quality programs first. But quality is, of course, a qualitative issue. The society plans to help institutions make such assessments by developing "a set of quality measures," such as a critical mass of graduate students and detailed expertise in certain subfields, says Lavallee. The ACS is also pondering whether to get into the business of certifying graduate programs itself, as it now does for undergraduate programs.

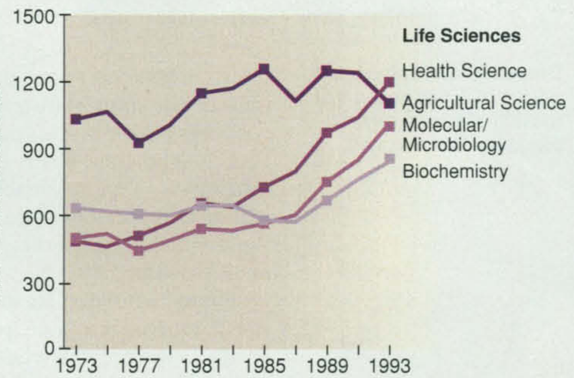
While few graduate programs are deliberately reducing the number of students they train, some are tightening the pipeline by upping entrance requirements—and leaving slots unfilled if there are no qualified applicants. At Northwestern University, Richard Morimoto, who oversees the newly consolidated Ph.D. program in biochemistry, cell biology, and molecular biology, says it "will no longer accept students at the fringe"—just the ones who are really "hungry for the process of discovery." That means entrants will be reduced by about 30% to no more than 10 a year. "We've come to realize [that] if you have a few remarkably talented students you're just much better off at every level," says Morimoto. Similarly, at the Cornell–Sloan Kettering graduate program, Fischman says that entry-level slots will simply go unfilled rather than be given

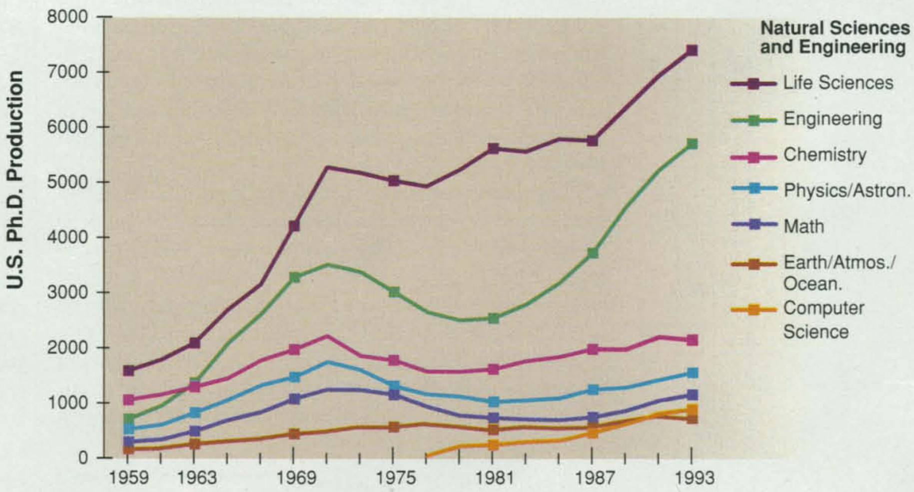


SLOAN KETTERING

"Not being able to do what you're trained to do is the worst possible outcome."
—Jerard Hurwitz

Overproduction? The numbers of doctorates awarded in engineering and the life sciences have shot up since the early '80s.





SOURCE: NRC, SURVEY OF EARNED DOCTORATES to less-than-stellar applicants. And at the University of Michigan, B. A. Taylor, chair of the mathematics department, says, "I think we're using 'birth control' ourselves by being more selective."

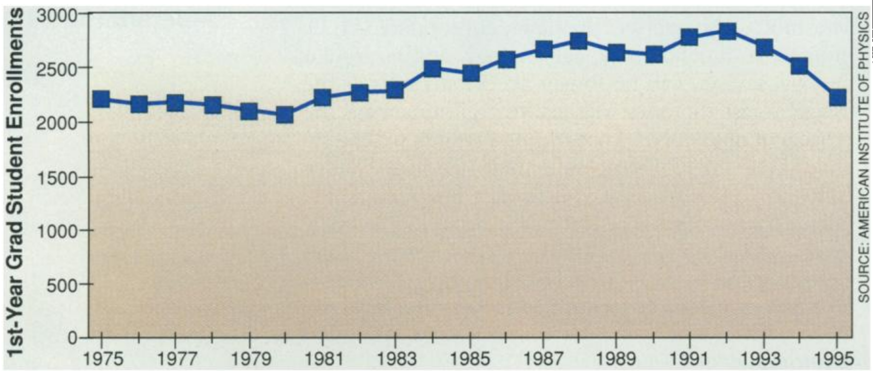
One place where the bullet seems clamped firmly between the teeth is the Board of Regents of the state of Ohio. Several years ago the board decided that the costs of graduate training were getting too high. "We've been very concerned that over the last 5 years the state subsidy for Ph.D. education has gone from 8% to 11% of the total subsidy for all higher education," says Garrison Walters of the Board of Regents. The board has therefore ordered reviews of all state-supported Ph.D. programs over the next couple of years. Ultimately, there will be caps on how many students get trained. Meanwhile state subsidies are frozen at the 11% level until the review—designed to assess the productivity and quality of each program—is completed.

Data-gathering. Like Ohio, most institutions are looking for better information before they take action. Says Charlotte Kuh, the new head of NAS's Office of Science and Engineering Professionals: "Biting the bullet when you don't have data is not a very good idea." One of the most glaring voids in any report to date concerns people a few years after they've gotten their Ph.D.s—the time when traditionally they would be settling into a "permanent" position. Such information will be considerably more illuminating of the state of the scientific job market than are simple unemployment figures.

But more projects are in the works. The most extensive is a survey just launched at the University of California, Berkeley, which has a Mellon Foundation grant to do a follow-up survey of 1500 people in five fields who got their Ph.D.s between 1983 and 1985. And smaller initiatives are going on at other schools such as Cornell, where biology department chair Peter Bruns says he's commissioning someone to do "an analysis of where our students end up and what they think of their training."

The definitive answer to the Ph.D. population problem, however, may ultimately be as elusive as the definition of appropriate Ph.D. employment. As Representative Sherwood Boehlert (R–NY) asked at a recent congressional hearing on Ph.D. training, referring to two colleagues with Ph.D.s in engineering and physics: "Are they underemployed because they're members of Congress?" The rhetorical question was posed, ironically, as Boehlert was justifying planned cuts in federal science spending.

–Constance Holden



Breeding fewer physicists. Since 1990, first-year enrollment in graduate physics programs has declined.

CHANGING DOCTORATES

Grad Schools Preview the Shape Of Ph.D.s to Come

When revamping its graduate program hit the top of the agenda at Northwestern University's biochemistry department, based in Evanston, Illinois, in the early 1990s, it did several things that would have been unthinkable a scant 10 years earlier. The department halved its intake of students and told new entrants they were expected to finish their degrees in 5 years, rather than the usual six to seven. And in what seems the ultimate act of self-sacrifice, the department abandoned its own recruitment program in favor of a broad-based effort that draws students to a variety of life and physical science departments.

But these changes are not going to weaken the department, says biochemistry chair Richard I. Morimoto; they will—he hopes—make it a biochemistry hotbed for the 21st century. "It took us a while to realize that we can't train students the way we were doing," says Morimoto, who got his Ph.D. in 1978. "We're in a different era"—an era that can no longer count on the continuous expansion made possible by massive build-ups of federal research money during the Cold War.

The Northwestern exercise is in response to a refrain that is ringing across the country. It's one that calls for shortening the number of years of Ph.D. training, which has crept up to about eight in some fields; for broadening the requirements for a Ph.D. to create a more versatile researcher; and even for changing the way graduate students get funding, to free them from dependence on a single faculty member, who may keep them in the lab longer than necessary. While there's been a lot more talk than action so far, a few schools have begun to reshape their curricula to respond to today's realities.

Changing times. When Morimoto was in graduate school, most doctoral students expected to follow the career paths of their academic advisers and to become tenured professors. Now fewer than half can expect such a course. This situation has spawned a great deal of rhetoric and self-examination by universities and the government agencies that support their research (see p. 135). Mark Wrighton, former provost at the Massachusetts Institute of Technology and now chancellor of Washington University in St. Louis, says the feeling is that doctoral training is too long, too narrow, and not well connected to the concerns of the outside world. "We need to focus more on the needs of students to prepare them for independent careers," he says.

Until recently it was possible for academic Ph.D. scientists to spend their entire careers pursuing one narrowly defined subject. A chemist, for example, could study the structure of compounds using a single technique—such as computer simulation or nuclear magnetic resonance or x-ray crystallography—while barely being familiar with the other two. Now, however, it's become clear that the best structural chemists must be comfortable with all available techniques.