Do We Need More Ph.D.s, or Is Fewer Really Better?

An idol-smashing economist thinks expansion of the research ranks has bred a decline in quality. Fewer scientists, she thinks, could be an improvement

MANY BASEBALL FANS FIRMLY BELIEVE THE quality of play declined dramatically when the major leagues expanded in the 1960s. There just aren't enough major league quality players to fill 26 big-league teams, they say, and in the expansion a lot of teams padded their rosters with players who have minor league skills. You don't usually hear that argument advanced in relation to science. On the contrary, many scientific bigwigs, pointing to shortages in the 1990s, are calling for more and more Ph.D.s.

But one economist doesn't agree. Paula Stephan of Georgia State University, who offered her iconoclastic views at the AAAS annual meeting last month in Washington, D.C., thinks that science, like the major leagues, has declined in quality because of dilution—the result of a "loss of selectivity" in the 1970s that opened the gates to young scientists who just aren't as creative as those of previous generations.

Furthermore, she argues, the unhealthy competitive atmosphere bred by the enormous increase in the number of Ph.D.s has created a profession overcrowded with risk-avoiders worried more about their next grant than about intellectual creativity. The projected "shortfalls" scientists see in the coming decade could actually be good for science, Stephan claims, spurring productivity and drawing the best and brightest back.

Predictably, Stephan's ideas raise hackles among science advocates such as Richard Atkinson, chancellor of the University of California at San Diego, and physicist Leon Lederman. They are much more worried about shortfalls than about dilution—and they think Stephan is way off base. But others can't deny that at least some elements of her argument hold water.

Stephan bases her case on evidence that "the younger scientific community we have today is not as productive as younger scientists 20 or 30 years ago." In studies of productivity in physics, earth sciences, and biochemistry, she and her colleague, Sharon G. Levin of the University of Missouri, found that, contrary to what one might expect, the most recently fledged scientists are not the most productive. For example, in the 1970s recent Ph.D.s in particle physics were writing an average of 9 fewer articles over a 2-year period than were comparable ccohorts in the 1950s. Her conclusion: "The average quality of people going into science in the '70s and early '80s was not as high as in the '50s and '60s in terms of motivation, ability, and interest in science."

Stephan says her research shows that an "enormously important" factor in the quality of an individual's work is being "at the right place at the right time"—having good resources, stimulating colleagues, and adequate recognition. The two environments that stimulate productivity the most are top-level research institutions and national laboratories. But there has been "unequal access" to these resources over time, especially in physical science. In 1963 a physicist had a 50% chance of being in one of the "right places." By 1973, because of the increase in the Ph.D. supply, that likelihood had dropped sharply—to 17%.

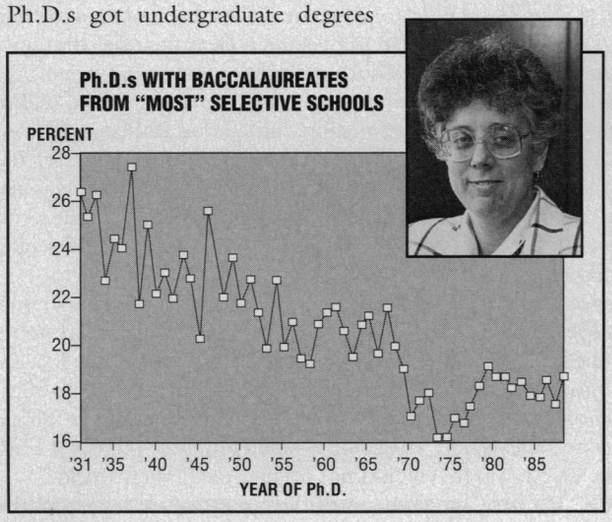
Underlying this trend is a huge growth in the number of Ph.D.s. In 1940, reports Stephan, there were 320 doctoral scientists and engineers for every 1 million people over the age of 22. In 1966 the number had risen to 778. By 1970 it had shot up to 1587, and it now stands at 2000. And as the number has grown, the proportion of researchers coming from the best schools has fallen. Stephan cites data from the National Research Council's Doctoral Records File showing that in the 1930s, '40s, and '50s, 30% of U.S.–trained Ph.D.s got undergraduate degrees from top schools. By the '60s that figure was 17%. The reason, says Stephan, is "dramatic leaps in enrollment in medium-selective schools."

And as the pool of Ph.D.s has grown, it has fostered an intensely competitive atmosphere in which researchers not only devote huge amounts of time to chasing grants, but, to optimize their chances, they are increasingly choosing "risk-averse research agendas."

Contributing to the quality decline, Stephan claims, is the "brain drain" effect. Starting in the early '70s, scientific careers, especially in the physical sciences, "became less attractive to very intelligent people," she says. Increasing numbers of the brightest students sought lucrative work in law, medicine, and business. For example, the proportion of Harvard students graduating summa cum laude who went on to graduate school in the arts and sciences fell from 77% in 1964 to 32% in 1987. Other data invoked by Stephan suggest a similar trend.

All these negative trends might be ameliorated by a tightening of the Ph.D. supply, contends Stephan. By the end of the century, there will be less competition as more jobs open up for younger scientists; academic salaries will improve, and scientists will feel free to take more risk. Far from being the disaster people like Atkinson and Lederman claim, Stephan feels scarcities in the next decade may offer a "window of opportunity" to "rethink how we're doing some things."

While few other observers go all the way with Stephan's upbeat conclusion, there is a widespread feeling—even among scientific insiders—that scientists these days do play safe. "I think the system has really pushed people into a no-risk approach," says former National Science Foundation head Erich Bloch. Assistant NSF director Fred Bernthal says that when he met recently with a group of NSF Presidential Young Investigators, they told him that without these awards, "they would have discounted their ideas ahead of



Weaker tea? *Chart shows fraction of U.S. science Ph.D.s who went to selective universities. Researchers say Ph.D.s who attend good undergraduate schools go on to good graduate schools. (Graduate schools weren't ranked until the late 1960s.) Such data are cited by Paula Stephan* (inset) *to show there has been a dilution in the quality of U.S. researchers. From "Research Productivity Over the Life Cycle: Evidence for American Scientists," in the March 1991* American Economic Review.

time as too speculative and risky because the system is so conventionalized." But whether there has actually been a decline in the quality of those entering science is a question that sharply divides observers of science. Some scientists do agree with Stephan. A Gallup poll commissioned by the Pharmaceutical Manufacturers Association Foundation early this year showed that, of the respondents, 41% of academic researchers and 44% of NIH grant-holders think that the quality of American graduate students entering biomedical research is going down. Only 21% and 15%, respectively, think the quality is on its way up. In a typical comment, Margaret Geller of the Harvard/Smithsonian Astrophysical Observatory told *Science*: "The brightest people aren't being attracted to science...even the best are not what they used to be."

But several big guns emphatically reject Stephan's views. Atkinson says, "The young assistant professors I've seen are more capable and more brilliant than ever in the past." Says Lederman: "My impression is that scientists if anything are publishing more per person than ever before." And Robert Rosenzweig, president of the Association of American Universities, says, "I have never seen evidence that I thought was reliable" indicating that young scientists are not producing at the level of previous generations.

And some in Stephan's own field question her view of the students who go into science. Cornell University economist Ronald Ehrenberg notes that Howard R. Bowen and Jack H. Schuster, in a 1986 book on American unversity faculty, reported from a poll of department chairmen in the humanities, arts, and sciences that graduate students seemed "better" in the mid-'80s than in the late '60s. Another study indicated that top scorers in undergraduate Scholastic Aptitude Tests were *not* increasingly migrating to professional schools rather than doctoral programs. Concludes Ehrenberg: The evidence is "inconclusive."

And even if an economic argument can be made that a shorter supply of Ph.D.s will raise salaries, lure some defectors back from industry, and make academia a more attractive place for potential scientists, would a shortfall in supply really be beneficial? Atkinson, for one, has no doubt that it would not. We need those Ph.D.s, he argues, and if the supply diminishes, the nation will suffer. "We've got to produce a necessary number to maintain the business of society. If we change that mode, then we're just going to change the whole society we're living in....If the economy becomes a totally Third World economy, then we don't need Ph.D.s." ■ CONSTANCE HOLDEN

Europeans Push Computer Plan

Brussels—European physicists, looking enviously across the Atlantic at the $638-million high-speed computing initiative proposed by the Bush Administration, are pushing for an even more ambitious European effort. Last week, a working group of the European Commission, chaired by CERN director Carlo Rubbia, laid out a proposal for a high-speed computer network spanning the continent, and a massive investment in the development of a European supercomputer industry. Total cost: about $1.4 billion a year over the next decade, half from government and half from industry.

"Unacceptable." *Europe needs a supercomputer industry, says Rubbia.*

Europe has a long way to go to rival the United States and Japan in supercomputing, however. Although Europe represents 30% of the $2.6-billion world market for supercomputers, not a single European company manufactures the machines. And that, says Rubbia, is "an unacceptable situation."

It might seem a bit late to play catch-up, but Rubbia argues that Europe has a window of opportunity because high-performance computing is at a watershed. Current machines are capable of several gigaflops. (A flop is essentially one calculation per second.) The next generation will be teraflops machines, capable of 10^{12} flops. That will require completely new approaches to hardware and software, which could be developed in Europe.

The report, drawn up by 18 high-level users of supercomputers, outlines a five-stage program. First would be an effort to encourage the use of existing supercomputers. That's where the new pan-European high-speed network comes in. Existing links are relatively slow and fragmented within individual countries. Rubbia would like to see a multi-megabaud backbone to create what he calls "a European high-performance computing community" and position Europe to build the next generation of gigabaud links. While that is going on, manufacturers should "vigorously" pursue advanced machines, while programmers concentrate on "the inventive development of novel software." Basic research will be needed "to raise the competitive level of European industry." And education and training—even at the high school level—should be stepped up to ensure that Europe's scientists become aware of the potential of high-performance computing.

As for funding, the Rubbia report says spending—currently about $150 million for "advanced architectures and their application"—should increase gradually to about 1 billion European Currency Units a year by 1995. (One ecu is currently worth about $1.4.) But it does not say exactly where that funding should come from. Rubbia took the easy route: "We are scientists and engineers, calling attention to the needs rather than suggesting a clear financial strategy of how to solve these problems."

The working group unveiled its proposal to the European Commission last week, and it got a favorable reception. Fillipo Maria Pandolfi, vice president of the commission, hinted that Rubbia's proposals fit well with future plans of Directorate-General XIII, which is responsible for telecommunications, information industries, and innovation, and which commissioned the report. In 1992 the directorate will reassess priorities under its third Framework program. That will involve concentrating resources in specific areas, Pandolfi said, and supercomputing is likely to be one of them.

Does Europe really need its own supercomputer industry? Rubbia and other members of the working group stressed the benefits that supercomputers bring to science, engineering, and everyday life. But they were less specific on the benefits of building, rather than buying, the capability. "It is just inconceivable to buy everything from abroad," said Rubbia. Pierre Perrier of Dassault Aviation stated baldly that "without a supercomputer industry, Europe would return to the second world. It would not be part of the first world." ■ JEREMY CHERFAS