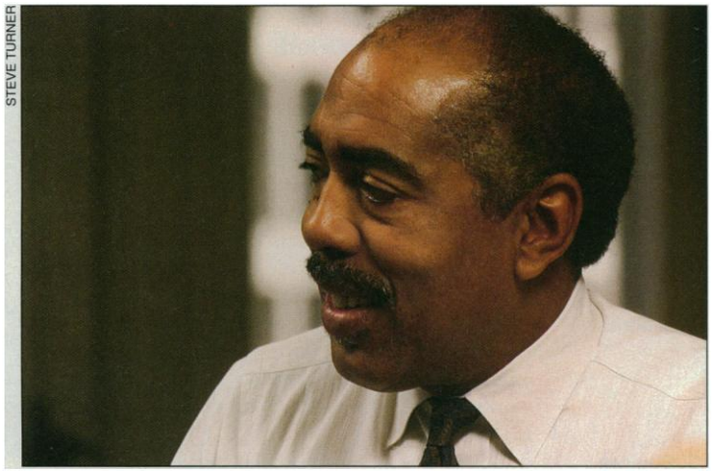

STEVE TURNER

"Few blacks in America achieve this kind of success in science and engineering despite 20 years of effort."

PAST IMPERFECT I

A Success Story Amid Decades of Disappointment

by Walter E. Massey

For a couple of decades now, many good people have been puzzling over how to increase the flow of minorities into the scientific pipeline in the United States. Indeed, a host of programs have been conceptualized, touted, and funded—and largely, they have not made much of a difference. The result is that in 1992 the numbers remain so depressing and the policy prescriptions for change so mind-numbing, that I thought one scientist's real life story might better focus our attention on what will have to be done to change the composition of our beloved professions.

Back in the 1950s, a 16-year-old student from a predominantly black high school in Hattiesburg, Mississippi, was considered promising enough to be sent off to college—Morehouse, a historically black college in Atlanta, Georgia—2 years ahead of his peers. He wasn't planning to become a scientist: He had never heard of physics nor had he taken a high school course in chemistry or trigonometry, much less advanced algebra. As a matter of fact, although he came from a supportive family and had good and dedicated teachers, he was unprepared academically for college and greatly lacking in confidence. He probably would have flunked out of Morehouse long before graduation—had it not been for a physics teacher there who took the youngster under his wing, guided him, challenged him, and wouldn't leave him alone until he graduated...in physics!

But in those days—as perhaps today—getting a science degree from a small college was no passport to future scientific success. After 2 years of teaching undergraduates, first at Morehouse and then at Howard University, the 22-year-old graduate confidently arrived at the doctoral program in physics at Washington University in St. Louis. He was in for another severe shock. He took his first mathematics exam and found it remarkably easy; he even finished ahead of most of the other new graduate students and left the room early. When the grades were posted, he discovered he'd gotten a 9—not on a scale of 10 but 9 correct out of 100.

His subsequent experiences weren't that bad in every course, but they were bad enough to make the young man want to quit that first year. Once again, however, a mentor appeared out of nowhere—in this case an older Ph.D. student who not only worked closely with the younger student those first semesters, but also supported him throughout the next several years, teaching him self-discipline and perseverance as well as math and physics. Even so, that older graduate student could not help this young man much when it came time to produce his Ph.D. thesis. In his fourth year of graduate school, he became so disconsolate at his prospects for completing the thesis process that he went to his adviser, crying, and said he wanted to quit. For a third time, a mentor appeared and preserved that student's career, so that he was able to become a researcher at the University of Illinois and then at Brown University. Later, he joined Argonne National Laboratory where he was chosen to be director, and then he went to the National Science Foundation (NSF) where he was recently entrusted with the leadership role.

As you probably have guessed, this is my story. And without Dr. Hans Christiansen, Henry (Woody) Jackson, and Dr. Eugene Feenberg, I would not only have missed this signal honor, I would not have been a scientist. As a matter of interest, all three of my mentors were white; there were not many black youths so fortunate.

Which brings me to the very difficult problem before us as a society. Few minority students can count on encounters with such giving individuals, black or white. Too often, faculty members look at boys and girls with backgrounds like mine and assume they are inadequate, mistaking lack of confidence and/or poor preparation for lack of intelligence. Too many discount the minority student's potential for growth; too few have time even to determine if the potential is there. And perhaps more important, too many look for signs of future success with a set of standards that they may not

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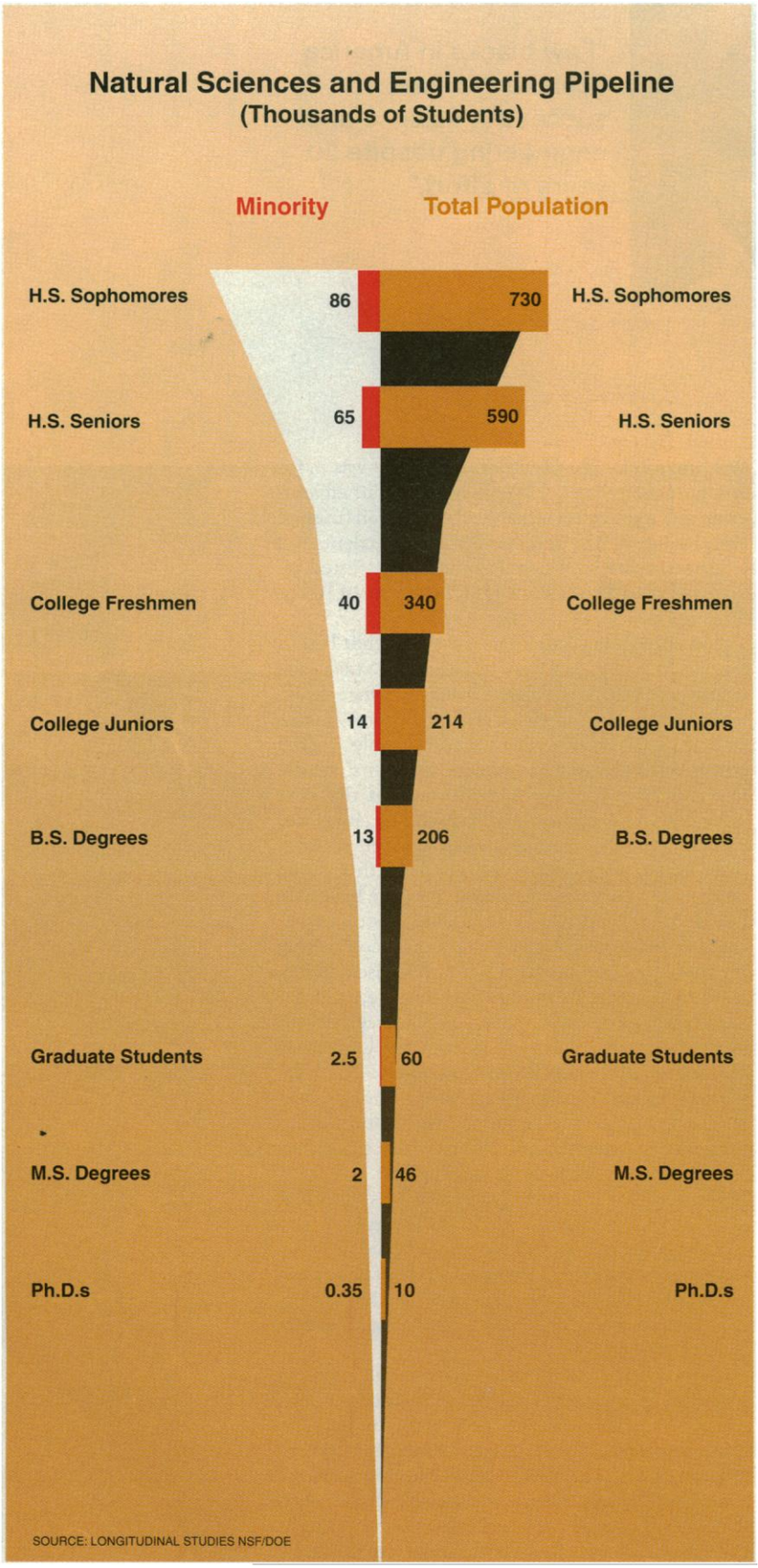


Brain drain. Students of all races filter out of science and engineering so that only a fraction of interested high schoolers—1.4%—earn Ph.D.s. But the minority pipeline, smaller to begin with, constricts even more sharply than that of the total population; only 0.4% of minority students emerge with Ph.D.s in science or engineering.

apply to white students.

This latter point is little discussed. Often "success in science" connotes the careers of those rare individuals who blaze a trail across the firmament of our profession like hot comets in our skies, whose unique insights open entire new areas of thought, discovery, and innovation. Just as crucial, however, is the everyday success achieved by the cadre of scientists and engineers who continuously clarify our understanding of phenomena, improve our technologies, and teach the next generation.

We have many white scientists and engineers of this sort—the hardworking, talented, devoted bench engineers and scientists who make our enterprise world class—but what is strikingly and dismally clear is that few blacks in America achieve this kind of success in science and engineering despite 20 years of effort on the part of our colleges and universities. Consider a few statistics: When I joined the faculty at Brown in 1970, there were 15 black faculty members, including myself; this year there are 17. At the University of Chicago, there were 17 black tenured and tenure-track faculty members in 1972–73. Twenty years later, there are 21 black members on a faculty of 1226. Of the 60,347 full-time faculty in the natural sciences at U.S. 4-year colleges and universities in 1987, only 1% were black; fewer than 200 of the 18,682 full-time engineering faculty were black.[1]

This lack of progress demonstrates that Americans have learned little from our 20 years of experience. One reason for our ignorance, I believe, is that we have considered the underrepresentation of minorities in science and engineering an intractable problem. But it is not.

In order to understand why the American education system has failed in its efforts to educate black scientists and engineers, we need to look more closely at how it has failed. According to a National Longitudinal Survey of the high school class of 1972, 40% of the black graduates who immediately entered college left within a year. The statistics are even worse for the high school class of 1980; half of the black college entrants left before their sophomore year.[2] Among those same black high school graduates intending to major in science or engineering, 16% had completed their bachelor's degrees 4.5 years later compared to 34% of whites.[3]

It doesn't get better as the 1980s pass: In 1983, 9% of full-time freshmen planning to major in science or engineering were black; 6 years later, only 5% of the bachelor's degree recipients in these fields were black.[4] It is no surprise then that at decade's end, African-Americans received only 2% (264) of the more than 13,600 Ph.D.s in science and engineering awarded to U.S. citizens in 1990.[5]

What we as a society began to recognize 20 years ago is that one key reason why African-Americans are underrepresented in science and engineering is that our education system fails to retain black students—at all points in the pipeline, but especially at the undergraduate level, and in the freshman year.

The culture of science and engineering may contribute to this failure. The common concept of "success in science" I mentioned earlier seems to have created an illusion that only "the best and the brightest" can do science. Coursework is viewed by many

faculty as a way to separate the "men" from the "boys." Unfortunately, these courses also tend to separate the men from the women—and the white men from just about everyone else.

Moreover, it is not even evident that the "best and brightest" flourish in the current environment. Students sharpening their academic predatory skills and demonstrating their grade-getting abilities have little time to contemplate science, to question and examine what they are learning. And they have little incentive to cultivate the interpersonal skills, the esprit de corps, that characterize most modern research and technological endeavors.

An academic environment that allows only the select to succeed runs counter to the traditions of U.S. science and engineering. Asked by President Franklin Roosevelt to propose a plan to develop scientific talent, MIT engineer and presidential adviser Vannevar Bush and his distinguished contemporaries responded:

"We think we probably would not, even if we were all-wise and all-knowing, write you a plan whereby you would be assured scientific leadership at one stroke....We are not interested in setting up an elect. We think it is much the best plan...that opportunity be held out to all kinds and conditions of men [and women] whereby they can better themselves. This is the American way; this is the way the United States has become what it is. We think it is very important that circumstances be such that there be no ceilings, other than ability itself, to intellectual ambition. We think it is very important that every boy and girl know that, if he [or she] shows that he [or she] has what it takes, the sky is the limit."[6]

So why hasn't this happened? In the pages that follow, *Science* journalists report on many of the causes for our failures over the past decade. NSF hasn't been immune to failures, but we have learned from them and have now initiated a number of new programs based upon our current understanding of the problem of minority underrepresentation. These are programs designed to retain students in the education pipeline by attempting a new approach: rewarding faculty for successful teaching and creating incentives for them to mentor minority students. The idea, as you can guess, is to provide incentives so that today's youngsters won't have to count on good fortune, as I did, to find a supportive hand.

And NSF is doing something else to augment the process: We are holding academic institutions accountable for their success in educating minority students. The numbers show how important this is. In the United States today, there are 366 U.S. doctorate-granting institutions, but only 233 awarded at least one Ph.D. in science or engineering to a minority student in 1991. Of the 149 institutions that awarded Ph.D.s to African-Americans, only six granted 10 or more degrees. Only eight of the 151 universities that awarded science or engineering Ph.D.s to Latinos granted 10 or more degrees. And only 45 institutions awarded even one doctorate degree in these fields to a Native American.[7]

Clearly, more colleges and universities must develop and demonstrate a capacity to produce minority scientists and engineers. Through a new program, Alliances for Minority Participation, NSF is linking institutions that graduate significant numbers of Latino, black, or American Indian students with other universities, 4-year and 2-year colleges, local businesses, and precollege school systems in 5-year regional partnerships. The explicit goal is to increase the number of baccalaureate degrees awarded to minority students in science and engineering. Currently, NSF is providing up to $1 million annually to each of 10 alliances.

But providing funds is not alone sufficient: Each partnership is accountable to meet the numerical goals it has set, and, through yearly reviews, NSF will monitor whether an alliance is achieving its specific goal. Thus, the next year's support will depend upon significant and measurable progress. The 10 existing alliances currently award 8000 science and engineering bachelor's degrees to minority students; they are to double that number in 5 years.

A third thrust I expect to be effective involves the historically black colleges and universities. Of the more than 2100 4-year colleges and universities in the United States, fewer than 1200 awarded even one baccalaureate degree in science or engineering to a black student in 1989. But the 80 historically black colleges and universities alone awarded 30% of those degrees.[8] NSF, therefore, is seeking also to enhance the ability of a select number of these predominantly black schools to educate undergraduates in science and engineering.

Of course, such efforts at colleges and universities must be linked to the ongoing comprehensive reform of education at the kindergarten through grade 12 levels in order to guarantee that all students truly have an equal opportunity to succeed in science. The 24 largest school districts in our nation's cities account for 41% of the minority student enrollments. As a group, however, students in urban school systems take less demanding courses, have lower scholastic achievement test results, and are unprepared, in general, for higher education. To address this problem, NSF invited mayors of the 25 cities with the largest number of school-age children in poverty to conduct a self-study of their school systems. The intent was to help each city develop its own comprehensive plan for systemic reform that articulates the community's vision for mathematics and science education, creates learning opportunities for students, ensures teacher quality, guarantees sufficient resources, and formulates new school policies and structures, if necessary. These plans will be the basis for a new urban initiative, approved by the National Science Board in October.

Based on my own experience—not to mention what we have seen in the past two decades—I have come to the conclusion that it takes more than willingness to increase the number of minority students in science and engineering. It takes commitment, not unlike the kind of commitment my mentors demonstrated toward me, on the part of institutions as well as individuals. I have mentioned here something of what NSF is seeking to do; *Science*'s reporters will discuss what universities, the private sector, the foundations, the professional societies, and individual scientists can do—indeed, must do because providing equal opportunities for all students to succeed in these fields is not only the right policy, it is the best policy. To quote again from Vannevar Bush: "This is the American way; this is the way the United States has become what it is."[9]

Coursework separates the "men" from the "boys"—and the white men from just about everyone else.

1. National Science Foundation, "Blacks in Undergraduate Science and Engineering Education" (Washington, D.C.: National Science Foundation, 1992), 24.
2. Ibid., 26.
3. Ibid., 28.
4. Ibid., 9.
5. National Science Foundation, "Science and Engineering Doctorates: 1960–1990" (Washington, D.C.: National Science Foundation, 1991), 86.
6. Vannevar Bush, Science: "The Endless Frontier" (Washington, D.C.: Office of Scientific Research and Development, 1945; Washington, D.C.: National Science Foundation, 1990), 25.
7. Unpublished data from the 1991 National Research Council Survey of Earned Doctorates.
8. National Science Foundation, "Blacks in Undergraduate Science and Engineering Education," 48.
9. Vannevar Bush, Science: The Endless Frontier, 25.

Data Points I: School

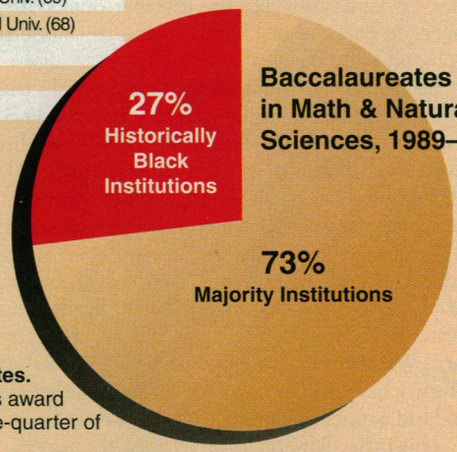
Where Minorities Get Their Doctorates

	American Indians	Asian-Americans	Blacks	Hispanics
1	Oklahoma State Univ. (19)	Univ. of California, Los Angeles (147)	Howard Univ. (123)	Univ. of Texas, Austin (133)
2	Univ. of Oklahoma (14)	Univ. of California, Berkeley (145)	Clark Atlanta Univ. (121)	Univ. of California, Berkeley (74)
3	Univ. of Washington (14)	Stanford Univ. (97)	Univ. of Maryland (111)	Univ. of California, Los Angeles (71)
4	Michigan State Univ. (12)	Univ. of Illinois, Urbana (72)	Nova Univ. (110)	New York Univ. (69)
5	Penn State Univ. (11)	Univ. of Hawaii, Manoa (67)	Ohio State Univ. (104)	Texas A&M Univ. (68)
	Univ. of Wisconsin, Madison (11)			
	Univ. of California, Berkeley (11)			
	Univ. of California, Los Angeles (11)			

SOURCE: NATIONAL RESEARCH COUNCIL, 1991

Minority-friendly. These were the top five producers of minority Ph.D.s from 1986–1990, according to the National Research Council's doctoral records file.

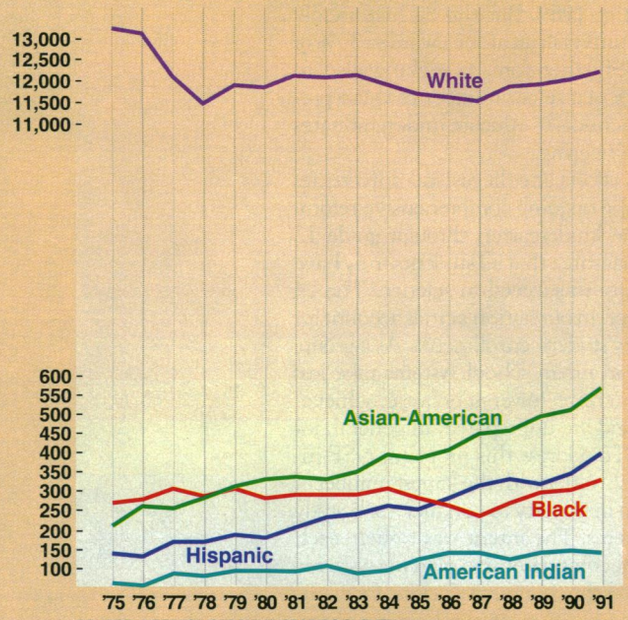
Baccalaureates in Math & Natural Sciences, 1989–1990



Black baccalaureates. Black schools award more that one-quarter of B.S. degrees.

SOURCE: U.S. DEPT OF EDUCATION

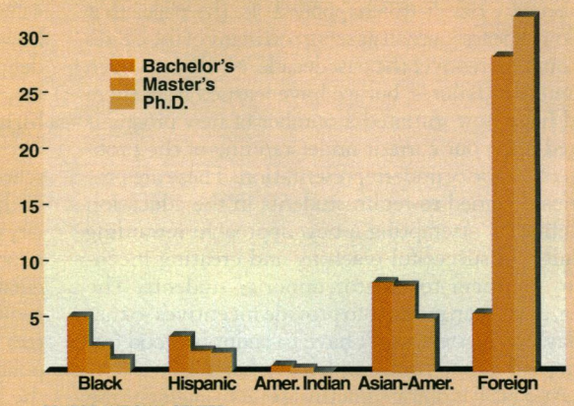
Science & Engineering Ph.D.s Awarded to U.S. Citizens 1975–1991



SOURCE: NSF/NIG/USED/NEH/USDA/NRC SURVEY

Snail's pace. In the past 15 years, the number of Ph.D.s awarded to minorities has grown slowly.

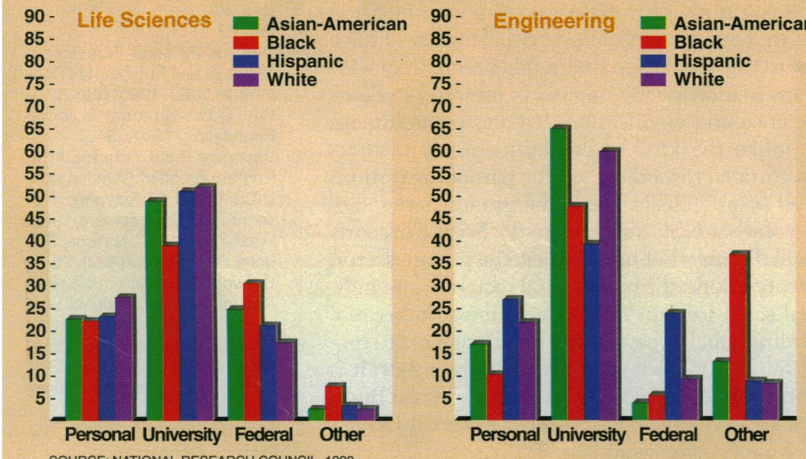
Percentage of Science & Engineering Degrees Awarded to Minorities, 1990



SOURCE: NATIONAL CENTER FOR EDUCATION STATISTICS

Minor impact. Blacks, Hispanics, and American Indians received only a small percentage of degrees in science and engineering, especially at the M.S. and Ph.D. levels. In contrast, Asian-Americans and foreign nationals together earned nearly 40% of Ph.D.s in 1990.

Where Graduate Students Get Their Support



SOURCE: NATIONAL RESEARCH COUNCIL, 1990

Support systems. Grad students of different races get money from different sources. In general, blacks and Hispanics get more federal funding but less university funding than whites. The pattern is reversed for Asian-Americans.