COMPUTER SCIENCE

Computer Culture Deflects Women And Minorities

When Sandra Johnson Baylor entered a master's degree program to learn computer engineering at Stanford University in 1982, she was taken aback by the sink-or-swim atmosphere. Advisers didn't offer much advice and instead expected students to be independent. The climate was "not so much hostile as indifferent," she says—although several professors told her point-blank that she wasn't graduate-school material. It was a dramatic change from the one-on-one attention she'd enjoyed as an undergrad at historically black Southern University in Baton Rouge, Louisiana. But Baylor and other minority and international students formed a support group, and Baylor stayed for her M.S.—and then switched to smaller, friendlier Rice University. There, she thrived, earning her Ph.D. in electrical and computer engineering in 1988. She's one of the rarest of the rare: That year, only two African Americans of either sex were awarded Ph.D.s in computer science, and only 56 women of all races.

And most disturbingly for a field that prides itself on being "open and progressive," as one researcher put it, the numbers have actually gotten worse since 1988. Computer science is now on the list of fields having difficulty attracting and keeping the students it claims to want most: women and underrepresented minorities. The statistics showing a drop in diversity are so new that researchers are still speculating about the reasons. But overall, studies show that socioeconomic and cultural forces—the kinds of factors that bothered Baylor at Stanford—are discouraging women and minorities from studying computer science "at every level, from grade K right through to graduate school," says Paul Young, assistant director of the computer science directorate at the National Science Foundation (NSF). To keep diversity up, educators are focusing on solutions ranging from Barbie on computer to supportive college programs, all aimed at making the field more welcoming to women and minorities.

The gender disparities in computer science are all the more striking because the field has had the reputation of being open. Women have been part of the field since its inception (see box on p. 1916) and quickly joined the rush to earn computer science degrees in the 1970s and '80s, when many departments were first established. In 1976, 1124 women earned undergrad degrees in the field; a decade later, the number had jumped to 14,431. But in recent years, while other fields have seen a slow but steady increase in diversity, the percentage of computer science degrees awarded to women has actually declined by 5%, and the percentage of female Ph.D.s has also slumped (see chart). NSF data on underrepresented minorities show little improvement.

No one is exactly sure what's behind the drop, for there's very little data to go on, explains Francine Berman, a computer scientist at the University of California, San Diego, and co-chair of the Computing Research Association committee on women (CRAW). Nevertheless, Berman and others have compiled lists of causes, and high on their list are cultural and socioeconomic factors that contribute to a lack of self-confidence. "That loss of confidence is a very common finding, and the biggest factor in deterring their participation," says Elaine Seymour, a sociologist at the University of Colorado, Boulder, who studies women and minorities in science.

Indeed, recent studies support the notion that cultural factors are largely to blame. For example, preliminary results from an ongoing study of computer science majors at Carnegie Mellon University (CMU) in Pittsburgh reveal no lack of confidence among female students who recently immigrated to the United States—even though American-born women in the same classes are filled with self-doubts. And these "international" women had little if any previous experience with computers. "It goes against that common belief that you have to be a hacker to succeed," says Jane Margolis, a visiting researcher at CMU who is doing the study with CMU's Allan Fisher.

What, then, happens to their American-born peers? Apparently, the seeds of self-doubt are sown at an early age. Until age 6, girls and boys show an equal aptitude for computers, according to studies compiled by Mattel Inc., the toymaker. But by age 7, when sociologists say that gender differences accelerate, girls lose interest in the machines, perhaps because most computer games are designed for boys. "The games are often misogynistic, violent, or sports-oriented," notes Barbara Simons, a computer scientist with IBM's Santa Teresa Laboratory in California. As a result, boys often spend long hours at the keyboard or delve into a computer's innards, while girls seldom do. And that early imbalance, researchers say, only increases over the years.

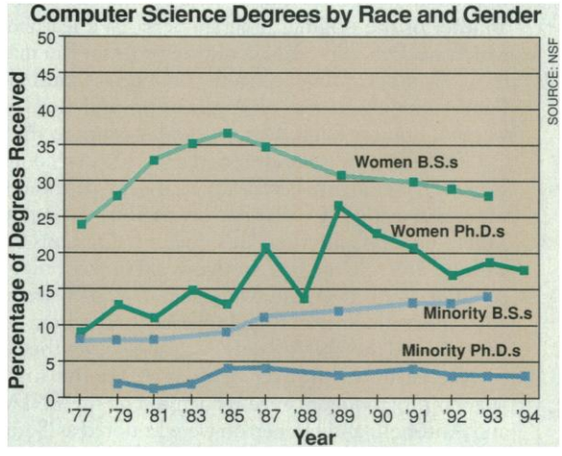
By age 14, girls also often develop an anxiety about math, which educators again believe is largely culturally instilled. "It's something you hear over and over again from young men: 'Girls can't do math,' " says Seymour. That stereotype discourages young women from pursuing computer science, which does require math skills, Seymour says. Women are also turned off by aggressive male hackers and the lack of female role models, say Berman and others. And many young women wrongly think that the field does not involve working with people, says David Messerschmitt, chair of electrical engineering and computer sciences at the University of California, Berkeley: "They see it as a career where someone sits alone in front of a machine, whereas what they want is a career that is social, people-oriented."

As for underrepresented minorities, many don't get an "adequate basic education," says Seymour, "let alone have access to computers." So in computer science, as in other scientific fields, minorities "drop out as fast as they come in."

SHARON GUYNAP

"Roll with those punches—but don't let them stop you."

—Sandra Johnson Baylor



Countdown. Diversity dropped in computer science.

But why, after decades of increase—at least for women—are the numbers falling now? One possibility is that changes in the field itself are tending to turn away women. Indeed, computer science is becoming more mathematically oriented as it coalesces with computer engineering. "As computer science has matured, the two fields are growing closer together," notes Young. "And the more that it looks like engineering, the more the numbers [for women and minorities] look like those for engineering"—which has the fewest women of any scientific area.

Engineering—and perhaps increasingly, computer science—suffers such low numbers because it is taught "in an environment that is not geared toward women," says Seymour. "It's designed to test the mettle of young men, to wean them away from the nurturing bonds they have had with high school teachers." But, she adds, most female freshmen still need a one-on-one relationship with a teacher. Without it, they leave. "Poor teaching: That's the number one reason they cite for leaving science," she says.

While they seek more data on the causes, policymakers and others are also looking ahead for solutions. For example, Mattel Inc.—eager to develop the largely untapped market for girls' computer games—has just introduced a series of CD-ROM videos with Barbie as the star. With funding from NSF, CRAW has sponsored a series of projects, including mentoring workshops and awards for top female students. NSF has similar programs for minorities, and recently awarded large grants to equip inner-city schools and tribal colleges with computers.

Individual institutions are finding ways to support women and minorities too. To help dispel the notion that working with computers is a solitary affair, Berkeley's Messerschmitt has prepared a pamphlet to distribute to high school students, which emphasizes how computer science can "benefit humankind." Stanford, too, after losing students like Baylor, recognized the need to change its ways and in 1989 opened a special office for women and minorities in the engineering school. "It's a different world from when she was here," says Noe Lazano, associate dean of students and minority programs in Stanford's engineering school.

Some women and minorities may also do themselves a favor, Seymour thinks, by pursuing computer science first at community, small, or women's colleges, where the atmosphere is more encouraging, then transferring to a larger institution. Indeed, big universities seeking to boost the diversity of their computer science labs might gain some lessons from Baylor's alma mater, Southern University, where for the past 2 years, women have made up half the graduating class of electrical engineers (which includes computer engineers).

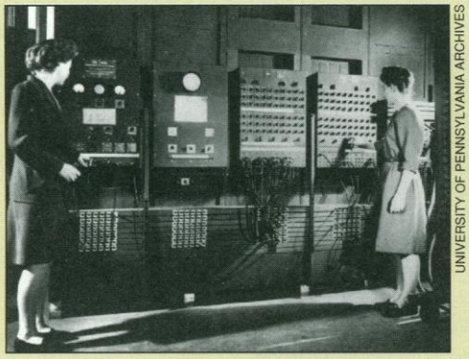
Vernell Trent Montgomery, the interim dean of Southern's college of engineering, says the higher numbers stem in part from the fact that in black culture, women are often the bread-winners in the family, so his female students "may be already subconsciously preparing to be independent." Beyond that, says Montgomery, "we're here for our students, to support and encourage them."

The combination of high expectations and encouragement can lead to big payoffs, a lesson not lost on Baylor, who today is a computer engineer at IBM's T. J. Watson Research Center in Yorktown Heights, New York. She's sure that her Southern education gave her the confidence she needed to stay the course at Stanford. "You have to be determined and ambitious," she says, "but you also need that support, because you will encounter people who think you are not up to it and will tell you so. Roll with those punches—but don't let them stop you."

–Virginia Morell

The First 'Computers'

As the 50th birthday party of the computer—actually of the ENIAC, the first large, general-purpose electronic computer—was coming to a close last month at the University of Pennsylvania, Jean Bartik overheard two men studying one of the giant machine's panels. "Because of the war [WW II], instead of men, they had women programming this thing," one explained to the other. "Of course, they probably didn't know what they were doing." Bartik, 72, one of the six women who had indeed programmed the ENIAC (for Electronic Numerical Integrator And Computer), could only sigh. "It's been like that for years; our contribution to the ENIAC was largely overlooked," she says.



UNIVERSITY OF PENNSYLVANIA ARCHIVES

Birth of a computer. The first programmers at work on the ENIAC.

Bartik and the other women, almost all of whom had math degrees, were initially employed by the Army to compute ballistics trajectories by hand, and so they were actually called "computers." Their subsequent work for the ENIAC was overshadowed by the inventors of the ENIAC's hardware—who were all men. When the machine was finished, it was time for the "softer" job of getting it to run, and the women were called in. The women gave the computer basic instructions by setting dials, flipping switches, and plugging in cables that connected one "accumulator" panel to another. They learned how each of the 18,000 vacuum tubes worked and what each activated, recalls Kay McNulty Mauchly Antonelli, another of the original programmers: "We learned the machine inside-out, which paid off. Not only could we program the machine; we could debug it, too." And according to Steve Brown, assistant dean at the University of Pennsylvania's school of engineering and head of the ENIAC fête, one woman, Frances E. Holberton, can lay claim to the first computer flow chart.

Yet despite their standing as the world's first computer programmers, the six women have largely been forgotten—an all-too-common fate of pioneering women in technology, says Barbara Simons, a computer scientist at IBM's Santa Teresa Lab in California. "It's one of the reasons that young women grow up without any role models" in the world of technology, she says. "You hear this common myth over and over again—'women were never in the forefront of anything technological'—and you even hear it from other women! These women programmed the ENIAC only 50 years ago, yet they've already been forgotten."

Not entirely, however. This year, for the first time, the five surviving women programmers were recognized at the ENIAC's birthday celebration, and Antonelli and Holberton were honored as "luminaries," a title previously reserved for the hardware engineers. Their stories are also told in the current issue of the *IEEE Annals of the History of Computing* (volume 18, #2).

Now in their 70s and 80s, the ENIAC programmers say they never worried about the lack of recognition. "It was a man's world, and we were always overlooked," says Holberton matter-of-factly. "Even when they came to take photos, they'd bring in secretaries to take our place at the machine. But it didn't worry me. I was more interested in getting the machine to work than in getting credit."

–V.M.