

# Getting women and minorities into computer science

Galen Gruman, *Soft News Editor*

A concern for two decades, the low percentages of women and minorities in computer science — and in the sciences and engineering in general — has gained more attention in recent months. Three things have helped focus attention:

- There is a growing need for computer scientists.
- There has been little progress, and even some backsliding, in the percentages of women and minorities pursuing computer-science degrees.
- There is a diminishing interest in computer-science careers by the traditional talent pool: white males.

Increased concern over US competitiveness in high technology — and what a declining talent pool might mean — is helping to transform concern into programs. "The equity issue is certainly an important one, but when the pocketbook gets hit, that's when the message is seen by policy makers," said Jean McDonald of the National Governors Association, which formulated national education goals earlier this year as part of a joint effort with the federal government.

Among those goals, McDonald said, is getting more US students to complete degrees in math, science, and engineering — especially women and minorities.

Evidence of the resurging interest in the low representation of women and minorities in computer science was evident at several conferences in the last year, including at the Computer Society and National Science Foundation's Minorities in Computer-Science Education Conference in August and in a track devoted to underrepresentation of women and minorities in the sciences at the American Association for the Advancement of Science's annual conference in February.

But perhaps the most publicized look at this issue was a National Science Foundation report, "Women in Computer Science," produced by Nancy Leveson, a computer-science professor at the University of California at Irvine. The report looked at possible causes for the continued lack of women in computer science. Based on anonymous comments from both women and men, it also offered possible solutions. This report marked the NSF's first attempt to look at solutions rather than just the problems, said Charles Brownstein, deputy director of the NSF's computing directorate.

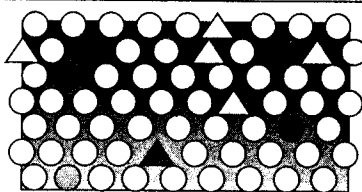
At the federal level, the NSF is leading efforts to increase women's and minorities' participation in science and engi-

neering — even in precollege education, where the NSF usually has only a small role.

Many states and cities have projects at both the college and precollege levels through local school boards and state colleges. A report to be issued July 29 by the National Governors Association will list most state programs.

Private groups, including business consortia, are also involved in these efforts. Professional societies like the Computer Society, Association for Computing Machinery, and IEEE have expressed concerns and have studied the issue, but they have no intervention programs.

## NEWS FOCUS



### Developing the Talent Pool

#### The problems

Computer science is no exception to the combined problems of increased need for skilled practitioners, a declining interest in the field by white males, and a lack of participation by women and minorities that face scientific employers everywhere.

There are several underlying problems, according to education experts, computer-science faculty, and government officials interviewed:

- Science is not made exciting or interesting in the schools, especially during the first three years, which is when children develop a lifelong interest in science. Rote facts predominate curricula, not problem-solving techniques. This affects all students, regardless of gender or race. The enthusiasm of the post-Sputnik science push has not been repeated.

- Yet the need for skilled, problem-solving workers is increasing so much that industry — especially science and engineering industry — will need more than the traditional 20 percent of the population educated to think creatively, reason, and make inferences from data, said Elizabeth Stage, executive director of the California Science Project, a state effort to change teachers' education methods.

- Girls are discouraged from pursuing an interest in the sciences — especially math, which is critical to enter the sciences. This discouragement is subtle and comes from all quarters: family, teachers, and

popular culture. "Years ago, [computer science] looked like a field where women were going to be equal," said Nell Dale, a computer-science professor at the University of Texas at Austin, "but [women's participation] peaked and seems to be going down." Others reported similar drops in the percentage of women.

The discouragement of women appears to occur regardless of race. For example, a study by Geri Lee Grandy of the Educational Testing Service in Princeton, N.J., which administers the Scholastic Aptitude Test precollege exams, shows that black boys and white boys have almost identical interests in math and science, as do both black girls and white girls — although at a much lower level. Table 1 shows the genders' differences.

- Minorities — particularly males — are not challenged to excel. Again subtle, this seems to be based on double standards for minorities, who are expected to do worse and thus are allowed to do so. A California study showed that minorities entered kindergarten almost on par with whites (the differences were due to poverty, not race). But they lagged a half grade behind by third grade, two grades by eighth, and three grades by 12th.

The ETS study also showed that despite their interest in science, black boys scoring in the 90th percentile (of black boys) do not have sufficiently high SAT scores for most colleges, so they cannot follow through on their interest in science.

- At the college level, there are few role models for women and minorities, both because people from both groups enter the sciences at lower percentages than that in the general population and because even fewer stay in academia. According to several people interviewed, women apparently leave academia for two reasons: higher paying jobs in industry and the perception they cannot succeed in a tenure system where evaluations are subjective and secret and where they feel a constant need to prove their excellence to older male colleagues.

The percentages of women and minorities decline at each successive degree level, as Tables 2 and 3 show. At the current rate of doctorate degrees, it will take two years for each of the 300 doctorate-granting computer-science programs to have one woman doctorate holder on the faculty — assuming that every woman chooses to teach. It will take 20 years to do the same for blacks.

#### What can be done?

There are no quick fixes to the problems of science education, according to those interviewed. Even if the proposed

*Next issue, Soft News will report on the status of women and minorities in computer science in Japan and Europe.*

**Table 1.**  
College interests of top 10-percent scorers on the 1986 Scholastic Aptitude Test by gender. There were 45,000 girls and 40,000 boys in their respective top 10 percents. Blacks and whites showed very similar interest levels in each field and so are not presented separately. There was insufficient data on Hispanics and Asians. Source: ETS.

Field	Male	Female
Computer science	6	2
Math/physical science	7	5
Engineering	31	10
Life sciences	3	6
Psychology/social science	5	9
Nonscience (includes premed and health science)	27	45

approaches prove to be effective, it will take 10 years after their widespread adoption before there will be graduating high-school students schooled under them, and another six years before there will be doctoral recipients schooled under them.

**Making science interesting.** The long-term need is to raise the overall interest and education in science by all students while also narrowing the gap between minorities and whites in performance and between women and men in interest, said the California Science Project's Stage.

The project reflects a fundamental change in California's education assumptions, Stage said: "We used to talk about the problems of language and minorities. We're now realizing there's an advantage to diversity," she said, because problem-solving skills require being able to consider and understand several points of view.

This requires new curricula that focus on problem-solving skills and hands-on

science, not on rote learning, and evaluations that depend less on standardized test scores than on performance, she said. While performance-based measures are inherently subjective, they better focus students and teachers on thinking skills, she said. In May, a presidential task force agreed, and ETS's president, Gregory Anrig, agreed, telling the *New York Times* that "there is too much testing and there is a need for new kinds of assessment."

At the federal level, the National Academy of Sciences and the National Research Council have convened colloquia, issued reports, and promoted math and science standards. The National Governors Association has made several recommendations to improve science and math education as part of the states' and federal government's joint goal to make US students the best in the world in math and science by the end of the decade. It has several recommendations to get more women and minorities in the sciences. The report, "Increasing the Supply of Women and Minority Engineers," will be released July 29.

At the local level, some school districts have formed compacts with local businesses to help disadvantaged children by providing facilities, speakers, and supplies. Such efforts tend to focus on inner-city schools and minority students, said Tom DeMarco, a software engineer involved with such a compact in Maine. The Horizons program there focuses on both gifted students and disadvantaged students who nonetheless have demonstrated that they "are very good at something," he said.

At all levels of education, "most programs we now have for disadvantaged students are boring," Stage said, "The longer they're in them, the worse off they are." Such remedial approaches should be replaced by programs that increase expectations, she said. She cited work at San Diego State University and at Stanford University that shows the effectiveness of increasing expectations.

**Encouraging women and minorities.** At the precollege level, the Education Dept. awards grants as part of its Eisenhower Program for efforts that encourage women and minorities to learn math and science. It spent \$8.4 million to fund 29 projects in 1989. There were more than 500 proposals. The grants are generally for one or two years. The programs' focuses include teacher retraining, partnerships with business to link school and the marketplace, and integrating curricula so students understand the relationships between math and science disciplines, said Jane Glickman, a department spokesman.

But the Education Dept.'s involvement is mainly limited to distributing federal monies to and serving as an information resource for the states and local school boards, which under US law are responsible for most education policies and their implementation, said Alicia Coro, director of school-improvement programs.

To encourage more women to pursue science and engineering careers in college, the NSF has been "getting staff more involved in thinking about funding for women, but there are so few women that this is only partly successful," said the NSF's Brownstein. As for minorities, "there almost aren't any," he said, so there have been fewer efforts.

Past NSF programs have focused on funding individual women and minorities through research assistantships and the like. Such programs will continue, but the NSF has started a new project to encourage institutions to attract and *retain* women and minorities at the doctorate level, rather than leaving it to individuals to find supportive environments on their own, said Sue Kemnitzer, deputy director of the engineering infrastructure division.

A popular technique to help those women and minorities who do pursue computer-science careers is mentoring, where professional women help female students and address student groups, according to several people interviewed. "Having someone to relate to is very im-

**Table 2.**  
Doctorate degrees awarded. "Total" reflects the field's percentage of all science and engineering doctorates; the other categories reflect the percentage of doctorates awarded for that field. There were 17,048 doctorates awarded in 1978 and 20,257 awarded in 1988. "Noncitizen" includes only temporary residents, not permanent residents. Source: NSF.

Field	Total		Male		Female		White		Black		Asian		Hispanic		Noncitizen	
	1978	1988	1978	1988	1978	1988	1978	1988	1978	1988	1978	1988	1978	1988	1978	1988
Computer science	0.7	2.5	90.9	89.1	9.1	10.9	71.1	60.1	0.8	0.8	13.2	30.5	0.8	1.4	21.5	33.9
Science	85.8	79.3	77.7	68.3	22.3	31.7	77.2	69.6	2.8	2.6	8.7	14.2	2.9	3.4	13.9	19.4
Engineering	14.2	20.7	97.8	93.2	2.2	6.8	61.3	49.2	1.4	1.6	26.0	34.8	3.2	3.0	31.7	41.1
All	100	100	80.5	73.4	19.5	26.6	74.9	65.4	2.6	2.4	11.2	18.5	2.5	3.3	16.5	23.9

portant," Dale said, "There's something to be said about critical mass."

But the Leveson report described a difficulty in mentoring: Mentors must assume this task in addition to their teaching, research, and family obligations — it is usually not accounted for or rewarded at work.

Reentry programs, which are targeted to women who left the work force, are effective to retain those women who have the interest and sufficient math and science education, Dale said. In the 1970s, she ran such a program to retrain women with experience in other science to become computer scientists. Although Dale said the program was successful, it ended when the pilot funds ran out.

**Challenging students to excel.** Another approach, pioneered 10 years ago by Uri Treisman, a mathematician at the University of California at Berkeley, encourages students to learn cooperatively. Based on his observations of the study habits of blacks and immigrant Chinese students — all of whom had good grades in high school — he found that the successful students (in this case, the Chinese) studied the required homework individually but then got together to compare answers and to work on tougher, additional problems as a group, said Rose Asera of the university's Professional Development Program. By contrast, black students tended to complete assignments and follow study guidelines, as this had helped them succeed in high schools, and they did so alone.

Treisman's observation became the basis for a cooperative learning program now in use at several dozen universities. In addition to studying, students participate in monthly parties, volleyball games, and other social activities meant to reinforce the feeling of being part of a community where you trust your peers and feel comfortable in taking risks and making mistakes, Asera said. At Berkeley, the program is multiethnic, since targeting one race or gender would reinforce isolation, she said.

At the University of Texas, which instituted a similar program recently, it is not as easy for the program to be multiethnic, said computer-science professor Susan Gallagher, because "you need enough minorities [in the program] to get funding."

At the AAAS annual conference in February, several researchers from the New Jersey Institute of Technology described several programs from the last decade to help minorities and women from primary school through college. They included summer camps, internship programs at the university for high-school students, and teacher training. Asked by audience members their status, the researchers said that many had been curtailed or ended because of lack of funds.

Table 3.

Degree level of employed computer-science graduates, excluding full-time graduate students. Bachelors and masters data is for recent graduates (from 1986 to 1988); doctorate data is for all graduates employed (up to 1987). Source: NSF.

Degree	Number	Male	Female	White	Black	Asian	Hispanic
Bachelors	73,000	65.5	34.5	82.1	4.0	5.5	3.2
Masters	19,900	70.9	29.1	76.4	2.5	13.1	3.5
Doctorates	18,600	89.8	10.2	87.6	1.1	9.7	1.6

Table 4.

Academic rank of computer-science doctorates teaching in four-year colleges and universities in 1987, when there were 4,900 such professors. "Total" refers to the percentage of computer-science professors at the rank compared to all professors at that rank. Dashes indicate too few data for statistical analysis. Source: NSF.

Rank	Total	Male	Female	White	Black	Asian	Hispanic
Full	1.6	92.3	7.7	92.3	—	7.7	7.7
Associate	3.5	93.3	6.7	86.7	—	6.7	—
Assistant	4.2	81.8	18.2	81.8	—	9.1	—

Several programs had survived only by finding a succession of state, federal, and private sponsors.

**Handling discrimination.** How to handle discrimination — especially subtleties that could be based on nongender and nonracial factors, like not being accepted as a peer or slow career advancement — remains a difficult issue.

One option is to not fight. "Women students have other options," Kemnitzer said. "They have seen what happened to their predecessors. The distribution of faculty is different than the distribution of women," she said. Although noting that this is partly due to there being more senior men, Kemnitzer said that there are still "very few women at the senior professional level." Table 4 shows the distribution of women and minority professors.

Another option is for universities to hire several women and "establish a critical mass of women on the faculty and distribute it at different ranks," Kemnitzer said. The same advice applies to minorities, she added. Having such distributions provides a network for the women and minorities and provides role models for students, she said. Schools that have done this — such as the Massachusetts Institute of Technology, Purdue University, Georgia Institute of Technology, and the University of California at Berkeley — have bucked the trend of decreasing woman enrollments, she said.

A third option is to encourage women to go to all-women schools and minorities to go to all-minority schools, Gallag-

her said. While noting this is controversial, "the most successful [women students] seem to be from women-only schools," she said, "Girls don't compete as effectively in coed schools. [In women-only schools] you also get less gender typing." This encourages women earning B's and C's, not just A's, to pursue careers, she said.

Sociological research has shown that female students take failure more personally than males, so "there's a need to bolster a woman's ego," said Myrna Whigham, director of the women in science and engineering program at Iowa State University. "Males can learn better in competitive situations than women and minorities," she said.

University professors tend to focus on competition as a teaching tool, Whigham said, which is not surprising since that is how they were taught. And unlike elementary and high-school teachers, who must get degrees in education to teach, professors are not often exposed to other approaches or education theory, she said.

Women encounter subtle discrimination that tends to turn them away from the sciences, Whigham said. Despite the example of a few successful women scientists, "society is really telling little girls what they can and cannot do and still remain feminine," she said. Gender is typically used as a basis for grouping, she said. Before beginning elementary school, children of both genders tend to play together, but after attending school, they begin to play separately, she said.

In elementary and high school, teachers reward girls for the appearance of

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## Women and minorities

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their work, not its content, Whigham said. "Boys hand in their reports in a messy state — usually folded in quarters to fit in their pockets — so a teacher *has* to focus on its content," she said.

To combat such subtle prejudices, many schools have implemented the Gender/Ethnic Expectations Student Achievement faculty-development program that helps teachers become aware of their behaviors that further stereotypes. "Feminist teachers walk out of there shocked," Whigham said, not realizing that they favor boys by letting them speak more often and for longer periods, for example.

In colleges, there are no comparable programs, Whigham said. However, the NSF has expressed interest in funding

the development of a program tailored to professors, she said.

In cases of more overt discrimination, the secrecy and subjectivity of the tenure system handicapped women and minorities, several people said. But this may change. On Jan. 9, the US Supreme Court ordered the University of Pennsylvania to surrender tenure-evaluation files in a case where a woman charged that she was unfairly bypassed in promotion by five men. The court said universities are not exempt from civil-rights laws allowing federal review in cases of alleged sexism. "If there is a 'smoking gun' that demonstrates discrimination in tenure decisions, it is likely to be tucked away in peer-review files," it said.

**The pull of industry.** The perception of having to try harder to compete with males is one cause for the diminishing number

of women in academia, Kemnitzer said. "It's easier to measure your contribution in industry. In academia, it's more how your peers view you," she said. And in industry, starting salaries for women with computer-science masters degree are higher than for their male colleagues, although this reverses, perhaps because of maternity leave, after five years on the job, she said. Industry does better for "pragmatic" reasons, Kemnitzer said: "They say they need them."

Minorities, too, are courted by industry. The University of Texas's Gallagher recounted one black student who had been called — unsolicited — while an undergraduate "by every major industry player" in the area about job prospects after graduation. "He could probably be employed 10 or 12 times over," she said, "This is typical."