I'M A STRANGER HERE MYSELF: A CONSIDERATION OF WOMEN IN COMPUTING

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Look at the faces of the students who use the public computing areas at your school, and you will probably
see a fairly even mix of males and females. Looking around at your colleagues in user services, you may see a similar mix. But poll the faculty of your school's Computer Science or Engineering departments, and you are likely to find few, if any, women.

In the U.S. in recent years, women earned about half of all associate degrees in computer science, more than one-third of the bachelor's degrees, 27% of master's degrees, and 13% of PhDs (Spertus, 1991; Chronicle, 1992). Yet women account for only about 7% of computer science and engineering faculty, and only 3% of the tenured professors in these fields are female (Spertus, 1991). In other words, 92% of CS and engineering faculty -- and 97% of the tenured faculty -- are male. And about one-third of the computer science departments polled employ no women faculty at all. (Note 1)

What happens between undergraduate classes and final career choice? Why are women so underrepresented among computing and engineering faculty? And why should we in user services be concerned?

POSSIBLE FACTORS

Many explanations have been put forward to account for these discrepancies, including aptitude and expectancy, cultural factors, lack of institutional support, and outright discrimination. Although definitive conclusions may be beyond the scope of this paper, it is certainly worthwhile to review the evidence on each of these counts and examine some possible courses of action.

Aptitude and Expectancy

One of the most frequently espoused explanations for the paucity of women in "hard" computing professions is the alleged prevalence of math anxiety and mathematical ineptitude in females. This belief originated in studies from the 1970s indicating that boys outperformed girls on tests of mathematical ability. Early in the 1980s, however, these same data were reexamined with startling results: when other variables such as course experience were factored out, gender accounted for only 1% of the variance in mathematical ability. The apparent sex differences in math ability actually reflected differences in the number and type of math courses taken prior to testing. Later studies confirmed this: once math experience is partialled out, most of the sex differences disappear. (For a review of this literature, see Clarke, 1992 or Hornig, 1984.) And indeed, math grade point averages for boys and girls are virtually identical (Klein, 1992).

There *are* differences, however, in the way students perceive their own math and computer science abilities, with females generally having less self-confidence and more anxiety about their skills. This lack of confidence in young women is very specific to themselves as individuals: they don't attribute their perceived lack of skill to being female; rather they see it as an individual inability or disinterest. In others words, they feel that women in general are capable, but they are not (Kramer & Lehman, 1990). When asked why they do not perform well in math, women cited low ability and discouragement by others as the main reasons (Klein, 1992).

There appears to be some basis for this sense of being discouraged by others. As Clarke (1992) summarizes, self-reports by teachers show no sex differences in student computer use in class. But students' reports and independent observations show that teachers are more likely to call on boys to answer questions or use computers, they respond more quickly to requests from boys, and they are more likely to take over and complete a task in response to girls' questions. This is not to imply that the teachers' behavior is deliberate; in fact, it is almost certainly unconscious. Klein (1992) reinforces these findings by citing a study noting that boys received no negative feedback in any activity during math lessons, while girls received rather a lot. These cases illustrate the point that low self- confidence in females must not be confused with limited abilities.

In addition to debunking the myth that girls aren't as good as boys at math and computing, another assumption must be examined here. This is the strongly-held belief that computers are closely linked to mathematics. Actually, Clarke (1992) argues, "computers are not inherently mathematical. In fact, most work with computers involves manipulation of information and communication with people, which relies as much on verbal and interpersonal skills as on mathematical abilities... For example, the primary role of a systems analyst is to enter an organization, find out about its organizational needs, and design a computing system that will meet those needs." (page 72.) She continues, "To be a highly sophisticated user, it is not essential to be a technician." (page 81)

Bernstein (1992) takes this a step further and advocates that in order to attract women, introductory computer science classes ought to concentrate on applications rather than on math or programming. "While men may be passionate about computers, women use computers to solve problems," she writes. "When women fail to see indications that computers are efficient tools, they may lose interest. However, when men and women use computers as tools to solve problems, both groups perform equally well and like using computers equally." (page 87.) A discussion about whether this is "really" computer science is beyond the scope of this paper, but interested readers may consult Bernstein (1992) and Frenkel (1990). (Note 2)

Cultural factors

Some authors suggest that computers tend to be associated with surroundings or attitudes that women may find uncomfortable or foreign. Kiesler, *et al* (1985) describe this as an alien culture for girls, a culture that makes them less likely to get involved in the new technology:

> Even in preschool, males dominate the school computers. In one preschool, the boys literally took over the computer, creating a computer club and refusing to let the girls either join the computer club or have access to the computer. As a result, the girls spent very little time on the computer. When the teachers intervened and set up a time schedule for sharing computer access, the girls spent as much time on the computer as the boys.... Apparently, girls can enjoy the computer and do like to use it, but not if they have to fight with boys in order to get a turn. (page 254)

Computer games tend to perpetuate the competitive image of computing, with themes of wars, battles, crimes, destruction, and male-oriented sports. When Kiesler *et al* examined the covers of computer games in a typical store, they found 28 men and 4 women illustrated there. As they rather wryly note, "The women were on the covers of Monopoly (2 men and 2 women playing the game), Palace in Thunderland (1 very fat queen), and Wizard and the Princess (1 wizard standing, 1 princess in supplicating position on floor)." (page 457.)

Educational software is not immune from gender bias. When a group of educators with software design experience was asked to design software specifically for boys or for girls, they tended to design learning tools for the girls and games for the boys. When they were asked to design software for generic "students," they again designed games -- exactly as though the students were boys (Huff and Cooper, 1987).

And when students are made to use software designed for the opposite gender, interesting results occur: the students report more stress than when using gender- appropriate software, but only when the gender- inappropriate software is used in public settings. Thus, the presence of an audience affects stress levels (Huff, Fleming, and Cooper, 1992).

In fact, additional research reviewed by Huff *et al* indicates that women report higher levels of situational stress and *perform less well* in the presence of another person than when they do the same task in private. In direct contrast to this, men perform better and report less stress when they perform in public rather than in private. Both of these effects occur only in novice computer users; experts were unaffected by the presence of other persons. Further research indicates that these results are closely linked to expectancy: when users expect to succeed, they perform better in public than in private. When they expect to fail, they perform worse in public.

Although many of the situations described here apply primarily to children or novice students, similar factors affect girls and women of all ages. Indeed, a study of PhD students in a world-renowned computer science department (CMU, as a matter of fact), found that male and female students performed equally well, but the women reported feeling much less comfortable, confident, and successful than did the men (Burton, 1987, as reported in Pearl, *et al*, 1990). It seems likely that cultural factors like those described here may be in part responsible for this difference.

The use of pornographic images as background screens on computers in offices and public labs, for example, is likely to be perceived much differently by women than by the men displaying the images. Constructive responses to situations like this are possible (as described in CMU, 1989), and indeed laudable -- but the need to confront such situations is bound to affect one's perception of the educational or work experience. (Note 3)

And with the shortage of female role models in academic computer science, there are few women to provide tips on dealing with the cultural and sociological barriers (Clarke, 1992). Research tells us that this lack of role modeling affects female graduate students' satisfaction (Gilbert *et al*, 1983); common sense tells us that it affects younger students and women in the workforce as well. "Ultimately," Pearl *et al* (1990) conclude, "everything hinges on increasing the number of women in the field." (page 56.)

Nonsupport and outright discrimination

As Spertus (1991) emphasizes, "for the most part, people are not consciously trying to discourage women from science and engineering. Instead, people's behavior is often subconsciously influenced by stereotypes that they may not even realize they have....While perhaps it is comforting to know that no conspiracy exists against female computer scientists, it also means that the problem is harder to fight. The negative influences are ... varied and decentralized." (page 75)

"Varied and decentralized" though they may be, some of these influences are indicative of the nature of the institutions in which they exist. If a school does nothing to deter patronizing or suggestive behavior, that behavior appears to be countenanced. If a school does nothing to provide a supportive environment for women, it may in fact appear hostile to them.

Thus, in addition to the expectancy and cultural factors described above, further examples of negative influences may include:

• invisibility, where women in educational or professional settings may be ignored, interrupted, not looked in the eye, or simply not consulted for professional opinions.

• patronizing behavior, including "talking down" to women, taking over tasks they have started, or extravagantly praising their merest efforts.

• suggestive or obscene behavior that is unwelcome or viewed as inappropriate by the woman to whom it is directed.

Sandler (1986), Frenkel (1990), and Spertus (1991) all provide numerous examples of such behavior. Most women in technological settings can probably provide their own.

Sometimes, negative influences in an institution may cross the line from offensive-but-non-actionable to outright harassment or discrimination. Even within the last decade, cases have been reported of women's grad school applications being tossed on a corner table (Hornig, 1984) or of women being told by the planner of a university-sponsored summer technical meeting that the host would prefer female attendees to wear two-piece swimsuits (MIT, 1983). For examples of merit-based promotion problems, see Spertus (1991).

Whether unintentional, deliberately offensive, or downright illegal, influences like these may combine so that "women administrators, faculty, and graduate students face a chillier professional climate than their male colleagues." (Sandler, 1986.)

Other difficulties may be more closely tied to the structure and operation of the institution itself. In academia, for example, the tenure track often poses conflicts for women with, or planning to have, children. In fields where there are few women, support and understanding during this time are often not forthcoming, and efforts to balance professional and domestic responsibilities may be resented. Employer- provided child care and parental leave policies may help ease the problem, but as Pearl *et al* (1990) emphasize, tenure tracking often assumes a "helpmate-in-the- background" model of life which is inappropriate for today's society.

Finally, there is the bottom-line question of financial compensation. Women in programming tend to be better paid than women in other occupations, and there is less income inequality in programming: female programmers earn about 70% of their male counterparts' wages, compared to women in other occupations, who earn about 62% as much as their male counterparts do. However, women in highly-paid and specialized computing jobs (including management) earn less relative to men than those in lower-paid positions.

To some extent, women's lower pay can be accounted for by lower educational level, fewer years of experience, and other variables. A study based on 1980 Census Bureau data found that women computer specialists earn only 72% as much as their male counterparts, with an average difference of $6,450. Variables other than sex can be factored out mathematically, accounting for 40% of the difference in wages. But 60% of the wage gap in this study cannot be explained by factors other than gender (Donato and Roos, 1987). Part of the remaining wage gap may be attributable to differences in occupational category not defined in the study, but the remainder is attributable to differences in the way women and men are compensated for equal levels of education, experience, and other variables. "This part of the gap, often labeled discrimination, is more difficult to change," the authors note with wonderful insouciance. "Changing it relies not on the characteristics of individual workers, but on altering the way labor market institutions reward workers. Such changes must be accomplished before the computer field offers women opportunities equal to men's." (p. 312.)

WHY THE FUSS?

I take it for granted, as Spertus (1991) says, that readers consider harassment and discrimination to be offensive and harmful, so I will not belabor these points.

In addition to whatever moral or legal stands we might wish to assume, there are other reasons for concern. The declining student population means that total enrollment in science and engineering will drop dramatically. Unlikely though it may seem in these recessionary times, the demand for trained professionals *will* increase in time, certainly within the next decade, and it makes no sense to exclude, or at least discourage, half the population of prospective applicants. (Hornig, 1984; Frenkel, 1990, *Pearl et al*, 1990).

Furthermore, as discussed in the section on Aptitude and Expectancy, it is possible that women may bring with them specific skills and approaches that actually enhance the field of computing. Ought not these skills be welcomed? After all, as Frenkel (1990) notes, "The field is young and flexible enough to modify itself."

WHERE DO WE GO FROM HERE?

The research cited here has implications for those of us working in user services. Some are specifically related to computer services, others are applicable at the institutional level.

As you consider how this research might apply to computer labs, software support, and other aspects of user services, consider the following questions and ideas:

- Are your computing facilities physically safe? Are the walkways, entrances, and facilities themselves well-lit? Is a phone available? Can your campus provide a secure escort service for those frequently-required late-night programming sessions?
- Are women well-represented in your student and permanent consulting staff? When a women enters the facility, will she quickly see that other women are frequently present?

- Are women who ask questions in the lab answered with the same level of professionalism as men are?

- Are pornographic images ever used as background screens on computers in offices or public labs? Do you have any policies about their use?

- Are the public labs so crowded that students must frequently compete for computer time? If so, are any time-limits imposed, or does the most aggressive student get the next available computer?

- Are self-paced online or video training tools available? Can a student who may be uncomfortable in a large class find individualized learning resources?

As you consider wider application of this research to your college or university as a whole, keep in mind the recommendations from Pearl *et al* (1990) reprinted elsewhere in this article. Some of these ideas may be outside your own sphere of influence, but many -- including outreach programs, mentoring, and increased awareness -- can be started on some scale in your own department.

Keep your eyes and ears open. To read more about some of the issues described here, try the two articles (Frenkel, 1990 and Pearl *et al*, 1990) included in the special November, 1990 issue of the *Communications of the ACM* on Women and Computing, or the MIT report by Spertus (1991) available through anonymous FTP. Listen to the stories of your colleagues and friends, your children and their playmates.

Finally, remember the closing advice of Frenkel's CACM article: If the issues discussed here are not addressed, everyone stands to lose. The profession could find itself asking uncomfortable questions too late in the game. As it is, one wonders how many ideas that could have been contributed by female talent will never surface to enrich academic computer science. More broadly, what are the repercussions to our increasingly computer-oriented society, if women -- about half the population and professional workforce -- are not as prepared in this discipline as are men? Perhaps we will not have to find out. (Frenkel, 1990, page 45.)

Recommendations for Change:
Strategies Encouraging Women in Computer Science

- ❑ Ensure equal access to computers for young girls and boys and develop educational software appealing to both.
- ❑ Establish programs to encourage high school girls to continue with math and science – for example, science fairs, scouting programs, and conferences in which women speak about their careers in science and engineering.
- ❑ Develop programs to pair undergraduate women with women graduate students or faculty members who serve as role models, providing encouragement and advice.
- ❑ Provide women with opportunities for successful professional experiences such as involvement in research projects, beginning as early as the undergraduate years.
- ❑ Establish programs that make women computer scientists visible to undergraduates and graduate students – for example, invite women to campuses to give talks or to serve as visiting faculty members (e.g. the NSF Visiting Professorships for Women).
- ❑ Encourage men, as well as women, to serve as mentors for younger women in the field.
- ❑ Establish more reentry programs that enable women who have stopped their scientific training prematurely to retrain as computer scientists.
- ❑ Develop and enforce safety procedures on campus. Provide safe access at all hours to public terminal areas, well-lit routes from offices to parking lots, and services to escort those walking on campus after dark
- ❑ Award small grants to female professors for the purchase of terminals or workstations, printers, and modems for home use for safety reasons.
- ❑ Educate all computer science faculty about self-esteem issues that women computer scientists face.
- ❑ Increase awareness of, and sensitivity to, the use of a variety of communication styles, especially less aggressive styles. Increase awareness of subtle discrimination and its effects.
- ❑ Develop effective grievance policies to deal with overt discrimination and sexual harassment. Implement studies of existing policies to determine what makes certain policies effective.
- ❑ Investigate ways of changing the pattern of academic careers and tenure decisions to make them more compatible with childrearing demands. Provide affordable, quality childcare.
- ❑ Expand parental leave policies to allow both fathers and mothers to participate actively in the rearing of small children.
- ❑ Maintain lists of qualified women computer scientists to increase the participation of women in influential positions such as program committees, editorial boards, or policy boards.

From Pearl *et al*, "Becoming a Computer Scientist," *Communications of the ACM* 33(11): 55. November, 1990.

NOTES

1. By comparison, women earned about half of the bachelor's and master's degrees and about 36% of the doctorates conferred in all fields in 1989-90. Over all disciplines, about 73% of faculty members are male, about 27% are female. (Chronicle, 1992)

2. This interpretation of computer as tools, along with the reliance on organizational and communication skills, may help account for the number of women in user services.

3. The term "pornographic" is used here is a very loose sense. Many images which most of us would be unwilling to label pornographic might still be inappropriate as background screens. The questions of what is pornographic (or inappropriate) and who decides what is pornographic (or inappropriate) are central to policy formation, but are, as they say, beyond the scope of this paper.

REFERENCES

Bernstein, Danielle R. 1992. A new introduction to computer science. *In In Search of Gender Free Paradigms for Computer Science Education*, edited by C. Dianne Martin and Eric Murchie-Beyma. Eugene OR: International Society for Technology in Education.

Burton, M. D. 1987. Gender differences in professional socialization: A study of women and men becoming computer scientists. Tech Report, Carnegie-Mellon University, Pittsburgh, PA, June 1987. Committee on Social Science Research in Computing, Social and Decision Sciences Department.

Chronicle, 1992. *The Chronicle of Higher Education Almanac*, Vol. XXXIX, No. 1, August 26, 1992.

Clarke, Valerie. 1992. Strategies for involving girls in computer science. In *In Search of Gender Free Paradigms for Computer Science Education*, edited by C. Dianne Martin and Eric Murchie-Beyma. Eugene OR: International Society for Technology in Education.

CMU Computer Science Graduate Students and Staff, 1989. Dealing with pornography in Academia: Report on a Grassroots action. July 3, 1989.

Donato, Katharine and Roos, Patricia. 1987. Gender and earnings inequality among computer specialists. *In Women, Work, and Technology*, edited by Barbara Drygulski Wright, et al. Ann Arbor: The University of Michigan Press.

Frenkel, Karen A. 1990. Women & Computing. *Communications of the ACM* 33(11): 34-46.

Gilbert, Lucia; Gallessich, June; and Evans, Sherri. 1983. Sex of faculty role model and studentsU self-perceptions of competency. *Sex Roles* 9(5): 597-607.

Hornig, Lilli S. 1984. Women in Science and Engineering: Why so few? *Technology Review*, November/December, 1984: 30-41.

Huff, Charles and Cooper, Joel. 1987. Sex bias in educational software: The effect of designers' stereotypes on the software they design. *Journal of Applied Social Psychology* 17 (6); 519-532.

Huff, Charles W.; Fleming, John H.; and Cooper, Joel. 1992. Gender differences in human-computer interaction. In *In Search of Gender Free Paradigms for Computer Science Education*, edited by C. Dianne Martin and Eric Murchie-Beyma. Eugene OR: International Society for Technology in Education.

Kiesler, Sara; Sproull, Lee; and Eccles, Jacquelynne. 1985. Pool halls, chips, and war games: Women in the culture of computing. *Psychology of Women* Quarterly 9: 451-462.

Klein, Lesley. 1992. Female students' underachievement in computer science and mathematics: Reasons and recommendations. In *In Search of Gender Free Paradigms for Computer Science Education*, edited by C. Dianne Martin and Eric Murchie-Beyma. Eugene OR: International Society for Technology in Education.

Kramer, Pamela E. and Lehman, Sheila. 1990. Mismeasuring Women: A critique of research on computer ability and avoidance. *Signs: Journal of Women in Culture and Society* 16 (11): 158-172. Autumn, 1990.

MIT, 1983. Barriers to Equality in Academia: Women in Computer Science at MIT. Feb. 1983. The Laboratory for Computer Science and The Artificial Intelligence Laboratory,

Pearl, Amy; Pollack, Martha; Riskin, Eve; Thomas, Becky; Wolf, Elizabeth; and Wu, Alice. 1990. Becoming a computer scientist. *Communications of the ACM* 33(11): 47-57.

Sandler, Bernice R. 1986. The Campus Climate Revisited: Chilly for Women Faculty, Administrators, and Graduate Students. A publication of the Project on the Status and Education of Women, Association of American Colleges, 1818 R. St. NW, Washington, DC.

Spertus, Ellen. 1991. *Why are There So Few Female Computer Scientists*? Cambridge, MA: MIT Artificial Intelligence Laboratory. Available via anonymous FTP from ftp.ai.mit.edu, as womcs*.ps in the pub/ellens directory.