Why are There so Few Female Computer Scientists?
Abridged Version

Abstract

Women pursue education and careers in computer science far less frequently than men do. In 1990, only 13% of PhDs in computer science went to women, and only 7.8% of computer science professors were female. Additionally, the percentage of female computer science students appears to be increasing at only a slow rate or even decreasing. Apart from ethical concerns at women's lack of participation in computer science, the demographics of the country are such that the United States will not have enough engineers and scientists unless underrepresented groups increase their participation. This report examines the influences against a woman's pursuing a career in a technical field, particularly computer science. Such factors include the different ways in which boys and girls are raised, the stereotypes of female engineers, subtle biases that females face, problems resulting from working in predominantly male environments, and sexual biases in language. Finally, I discuss effective and ineffective ways to encourage women. A theme of the report is that women's underrepresentation is not primarily due to direct discrimination but to subconscious behavior that tends to perpetuate the status quo.

This is an abridged version of MIT Artificial Intelligence Laboratory Technical Report 1315.

Introduction

Only a small percentage of computer scientists and computer professionals are female. In the most recent years for which statistics are available, women received a third of the bachelor's degrees in computer science, 27% of master's degrees, and 13% of PhDs. Not only do women make up just 7.8% of computer science and computer engineering faculties, only 2.7% of tenured professors are female [Frenkel 1990, page 38] [Gries et al 1991]. Even worse, these numbers seem to be improving only very slowly or even dropping [Leveson 1989, page 3]. Many girls are still steered away from math and science or choose not to pursue careers in these fields. Additionally, many women who go into computer science are conscious of being treated differently from men or feel that they face additional barriers. This report describes some of these barriers.

As someone who has loved math and computers ever since I was a little girl, I have always found it strange that so few females share these interests. At the computer camp I attended, the boy-girl ratio was six to one. It was similar at high school math club and the math summer program I attended. At MIT, only about 20% of the computer science undergraduates are female, while other departments, such as biology, are at least 50% female. I researched this report to explore why females so consistently stay away from computer science, why people of both sexes seem to expect less from women, and why a woman is considered unfeminine if she is an engineer. Because math and computer programming came easily to me and to many other women who have had the opportunities, women clearly are not inherently unable to do well in them. Instead, girls and women are choosing, consciously or subconsciously, not to go into or stay in computer science. While one cannot rule out the possibility of some innate neurological or psychological differences that would make women less (or more) likely to excel in computer science, I found that the cultural biases against women's pursuing such careers are so large that, even if inherent differences exist, they would not explain the entire gap. In this paper, I describe the biases that women face in pursuing careers in computer science and how they deal with them.

Organization

My report examines the following topics, each occupying a chapter:

1. Societal pressure against women's being successful, particularly in engineering.

2. Ways in which the male-dominated environments discourage women.

3. Inequalities in language, their causes and effects. *(This chapter is omitted from this abridged version of the report).*

4. Negative consequences of some attempts to help women. *(This chapter is omitted from this abridged version of the report).*

5. Conclusions and recommendations.

In the unabridged version of this report, there are appendices which contain additional information, such as the methods I used for data collection and implications of recent research on sex-based intellectual differences. Finally, there is an annotated bibliography.

The report does not directly address the problems of racial minority group members, such as blacks and hispanics, who are also underrepresented in computer science. Readers should not interpret my lack of material on this subject as implying that no bias exists against these groups. On the contrary, I have been told by a black female computer scientist that the color barrier is greater than the sex barrier. In many parts of this report, such as Section 1.2.1 on subconscious bias, the experience of people of color is analogous to that of women.

Readers are welcome to contact the author with questions or comments. To do so, send electronic mail to ellens@ai.mit.edu or use the following address:

Room 630
545 Technology Square
Cambridge, MA 02139

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Chapter 1

Societal Factors

> *Women beware. You are on the brink of destruction: You have hitherto been engaged in crushing your waists; now you are attempting to cultivate your mind: You have been merely dancing all night in the foul air of the ball-room; now you are beginning to spend your mornings in study. You have been incessantly stimulating your emotions with concerts and operas, with French plays, and French novels; now you are exerting your understanding to learn Greek, and solve propositions in Euclid. Beware!! Science pronounces that the woman who studies is lost* — R. R. Coleman, M.D., 1889.[1]

In this chapter, I will describe various ways in which women are steered away from professional success, particularly in traditionally male fields such as engineering.[2] Girls and women are subject to societal pressure to stay away from such subjects or to accept themselves as "unfeminine". Academically successful women are generally seen as being less attractive and less happy than less highly-achieving women.[3] Additionally, there are still people who believe, consciously or subconsciously, that women are incapable of being top scientists and who take women less seriously in general.

1.1 Stereotyping

1.1.1 Background

Currently, most people in positions of power and respect are male. Men are rhetorically asked in [Sandler 1986, page 3]:

> Imagine that your lawyer, your doctor, your priest, rabbi, or minister, your Senator and Representative, your mayor, the president of your institution, most of its trustees, almost all of the deans and most of your colleagues were all women. How would you feel?

Not only are these positions held by men, but the media propagate stereotypes of women. A recent study found that "women are often still depicted on television as half-clad and half-witted, and needing to be rescued by quick-thinking, fully clothed men" [Adelson 1990]. Whether or not people realize it, many of

[1] Coleman, R. "Woman's Relations to the Higher Education and Professions, as Viewed from Physiological and Other Standpoints." *Transactions*, Medical Association of Alabama (1889), page 238. Quoted in [Ehrenreich et al 1978, page 128].

[2] Readers outside of the field may be confused by my use of the term "engineer" to include computer scientists. I do this because the field of computer science does not fit neatly into either engineering or science. Despite the "science" in the name, university computer science departments are often attached to electrical engineering departments or are part of the school of engineering. Additionally, computer programmers and designers tend to think of themselves more as engineers than as scientists, although some individuals and organizations consider computer science as a branch of the mathematical sciences.

[3] Of course, the stereotype also exists of male engineers being less attractive than other males. See, for example, [Wolpert et al 1988, page 2], [Turkle 1984, Chapter 6], and [Holland 1990, pages 164–165].

their expectations of men and women are based on what they have observed and by what messages their culture presents. As one Usenet[4] reader wrote:

> This group [comp.society] has been discussing various stereotypes for a long time now. The problem is that we haven't acknowledged the importance of stereotypes to human cognition. We could easily call stereotypes heuristics. A heuristic is a device that allows a processor to use some sort of knowledge to reduce a search. In very rough terms, stereotypes allow the wetware in our heads to do less search when looking for evaluations of people and behaviors to events.
>
> The human brain is the best known implementation of these heuristics. In fact the human brain is so reliant upon heuristics, that when presented information that contradicts such a heuristic we feel confusion and discomfort.
>
> So where is all this going? For better or worse, humans will continue to make stereotypes based on input from their environment. Since the average person rarely meets programmers, and the only programmers that people see are male geek actors on the TV, we will still have the geek image. I have to admit, most programmers I know are not ex-jocks. Most programmers I know are male, have interests in math and the insides of computers and will allow their personal appearance to slip during those wonderful, coffee-filled, marathon programming sessions. See, I have the disease too. (disease = stereotype)[5]

I believe that the author of the message is unusual not in having biases but in being aware of them. It has been empirically shown, as will be described in the following sections, that many people expect less of females without realizing it. These stereotypes are not as harmless as the author implies however, as they sometimes impair people from seeing past the stereotypes. Additionally, people tend to live up or down to the expectations that are communicated to them.

1.1.2 Bias in Children's Toys and Computer Games

The social biases that influence females begin in childhood, where boys and girls are often treated differently on the basis of sexual stereotypes. From the earliest ages, girls are given different types of toys than boys. For example, one study of children from one to six years of age found:

> Boys had more vehicles, toy animals, military toys, educational-art materials, sports equipment, and spatial-temporal objects. On the other hand, girls had more dolls, doll houses, and domestic objects [Rheingold et al 1975].

The difference in toys cannot be explained purely by the children's preferences — the expectations of parents and other gift givers play a major role. Numerous studies, cited in [Pomerleau et al 1990, page 360] have found:

> When interacting with an infant who was introduced as a girl, adults used feminine toys (for instance, a doll) and talked more to 'her'. When the infant was presented as a boy, they used masculine toys (e.g., a hammer) and encouraged more motor activity.

These stereotypes are perpetuated by toy companies, which market toys in a stereotyped manner. A 1969 *Life* ad contained:

> Because girls dream about being a ballerina, Mattel makes Dancerina ... a pink confection in a silken blouse and ruffled tutu ... Barbie, a young fashion model, and her friends do the 'in' things girls should do — talk about new places to visit, new clothes to wear and new friends to meet.... Because boys were born to build and learn, Mattel makes Tog'l [a set of blocks for creative play].... Because boys are curious about things big and small, Mattel makes SuperEyes, a telescope that boys can have in one ingenious set of optically engineered lenses and scopes [Komisar 1972, page 305].

[4] Usenet, a large electronic bulletin board system, is described in the appendix on methods.

[5] Katz, Douglas J. Comp.society, May 14, 1990.

While such an ad would not appear today, it indicates the environment in which today's young scientists were raised.

As recently as 1985, a study found:

> [T]he content of toy catalogues and the pictures of children on the packages of toys are still strongly stereotyped. In catalogues and in stores, special sections are reserved for sex-stereotyped toys. Girls' sections contain dolls and accessories, doll houses, arts and crafts kits, toy beauty sets, and housekeeping and cooking toys. Building sets, sports-related toys, transportation toys, workbenches and tools are featured in the boys sections ([Schwartz et al 1985] in [Pomerleau et al 1990, page 365]).

In addition to marketing toys in a stereotyped manner, such factors influence the design of toys. It was reported that:

> Jaron Lanier, head of VPL, gave a talk at UIST in 1989 about his experience productizing the data glove for Nintendo games....[H]e said that [the] toy manufacturer was very strictly divided from the very highest levels into the girl's toy division and the boy's toy division. He strongly resisted the glove from becoming either a girls' toy or a boys' toy, but he lost. He said that they immediately categorized it as a boys' toy and put all kinds of black Darth-Vader-ish, sports-car-like paraphernalia all over it to make it appeal to boys. He also said, had it been categorized as a girl's toy, it probably would have been pink and frilly.

Not only are there differences in varieties of "old-fashioned" toys given to children, but these biases are carrying over into the realm of computerized toys and games. These games are both based on traditionally male interests, such as war and sports, and are marketed toward boys. [Kiesler et al 1985, pages 456–457] reports:

> On one rack [in a computer store], covers in comic-book style depicted such games as Olympic Decathlon (4 male athletes on cover), Cannonball Blitz (3 men in battle), Swashbuckler (9 male pirates), Thief (1 male detective), Alien Typhoon (1 male space explorer) and Money Munchers (1 man in a suit). In all, 28 men and 4 women were illustrated on the covers. 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).

Girls' lesser usage of computer games could be a factor in their being less positively disposed toward computers and in their lack of interest in computer courses [Lockheed 1985, page 118], particularly as students who have played computer games are more likely to do well in their first college computing course [Kiesler et al 1985, page 457].

It should be noted that nobody with whom I have spoken proposes that a conspiracy exists among manufacturers and advertisers to keep females in their place. Rather, companies aim their products at the largest segment of the population that is predisposed to use them. Additionally, females are more willing to buy products advertised for males than vice versa [Courtney et al 1983].

1.1.3 Stereotypes of Boys and Girls

Anecdotal evidence suggests that when an infant is dressed in blue, passers-by say how smart he looks; if the same baby is dressed in pink, people say how pretty she is. Boys' clothing is often decorated with cars and trains; girls' clothing rarely is. More rigorously, numerous studies of sex stereotyping of infants are reviewed in [Stern et al 1989], including:

> Parents in one study, for example, were asked to rate and describe their newborns shortly after birth when the primary source of information about the baby was his or her gender (Rubin et al., 1974). Although the infants did not differ on any objective measures, girls were rated as littler, softer, finer featured, and more inattentive than boys. Other studies have revealed that parents treat male and female infants differently.... Fagot (1978) observed that

> parents of toddlers reacted differently to boys' and girls' behaviors. Parents responded more positively to girls than boys when the toddlers played with dolls, and more critically to girls than boys when the toddlers engaged in large motor activity [Stern et al 1989, page 502].

Expecting different behavior from boys and girls can be a self-fulfilling prophecy: If one sort of behavior is expected and encouraged, the child will be more likely to continue it.

Children also have been shown to have formed sexual stereotypes as early as at two years old [Weinraub et al 1983, page 33]. For example,

> Preschool children also have a good grasp of adult-validated sex-stereotyped beliefs about children's behavior. When asked in an interview-like situation which of two paper dolls — 'Michael' or 'Lisa' — would like to do certain activities in nursery school, end up in certain future roles, and have certain character traits, children $2\frac{1}{2}$ to $3\frac{1}{2}$ years old showed an impressive depth of knowledge (Kuhn, Nash, & Brucken, 1978). Children believe that girls like to play with dolls, help mother, cook dinner, clean house, talk a lot, never hit, and say 'I need some help'; they also believe that boys like to play with cars, help father, build things, and say 'I can hit you' [Weinraub et al 1983, page 34].

The careers that children imagine for males and females are influenced by sex stereotypes. By the age of three years, most children "know that girls will grow up to clean the house, be a nurse, or be a teacher, and boys will grow up to 'be boss'" [Weinraub et al 1983, page 38]. These stereotypes affect the careers that children picture for themselves:

> Even preschool children express future aspirations along sex-stereotyped lines. Both preschool and elementary school girls choose a parenting role significantly more often than boys (Looft, 1971; Vondracek & Kirchner, 1974). In addition, the range of occupational choice is more restricted for girls, with nurse and teacher being the most popular answers (Vondracek and Kirchner, 1974; Beuf, 1974). Boys' choices include more action oriented occupations (police officer, sports superstar) and more prestigious careers (doctor, public servant, pilot).
>
> Taking the question one step further, Beuf (1974) asked children 3 to 6 years of age what they would do if they were of the other sex. Approximately 70 percent of the children replied with a job considered appropriate for the imagined sex. More interestingly, boys frequently imagined themselves as nurses and girls imagined themselves as doctors when asked, 'What if you were a girl (boy)?' Several girls confided that they really would prefer to be doctors rather than nurses when they grew up, but couldn't because they were girls [Weinraub et al 1983, page 44].

Thus, from an early age, girls and boys learn to think of most careers as being appropriate for either men or women but not both. This will influence not just their career choice but how they view males and females aspiring to "inappropriate" roles.

Unfortunately, these stereotypes are so pervasive that it is difficult for unprejudiced parents to prevent their children from accepting the stereotypes:

- A female computer scientist told me:

  > We ... have a rather non-traditional household, and I'm surprised at how traditional my two daughters seem to be turning out.
  >
  > Both my husband and I work full-time, but when we are home, [John] does almost all the cooking (I make a meal maybe once every three weeks), he cleans up after himself while cooking so I don't do much of the cleaning in the kitchen, I do the laundry (sometimes), and we let everything else go until a friend comes to clean our house and dig us out from under the laundry I never can seem to get to....
  >
  > [Once,] I asked my 5-year-old who did most of the work around the house, me or her daddy. She said "you". Now, this kid is totally guileless — she has not learned yet how to say one thing to one person and another to another, so I'm sure she wasn't just telling

me this because I was the one who asked the question. So I said, "What kind of work do I do around the house? In the living room, in the kitchen?" She said, "You clean the kitchen." *I couldn't believe it!* I might have believed her if she said I occasionally picked up in the living room — but cleaned the kitchen? Her dad's domain? Where did *that* come from????

- Another parent reported:

  When our daughter was very young — about 3 years old — we audiotaped an interview about what she would be when she grew up. After mentioning a number of possibilities my wife said, 'What about a doctor?' Jessica replied, 'Yeah, I could be a doctor.' Our son who was 5 at the time interrupted saying, 'I think you mean a nurse.' 'Yeah, a nurse,' Jessica said. My wife said, 'She could be a doctor if she wanted,' and our son replied, 'I don't think so...I've never seen any, at least not in Iowa.'

Stereotypes also exist specific to the computer world. One paper reports:

> We have even found that some young children believe computer games and computers are for boys. In one nursery school, Pratto (1982) asked girls and boys aged 3 to 5 to name the toys they played with. Both girls and boys reported that boys played with Atari; it was never mentioned as a game for girls. We returned to that school and asked 42 children whether they thought computers were for girls, and then we asked whether computers were for boys. Most children answered this question. Although the majority thought computers were for both genders, the boys were not as sure of this as were the girls (71% of the girls and 57% of the boys). Of the minority, more children thought computers were for boys only (14% of the boys and 11% of the girls) than thought computers were for girls only (7% of the boys and 4% of the girls) [Kiesler et al 1985, page 456].

The point of this section can be illustrated by the following incident:

> A group of parents arranged a tour of a hospital for a group of twenty children: ten boys and ten girls. At the end of the tour, hospital officials presented each child with a cap: doctors' caps for the boys, nurses' caps for the girls. The parents, outraged at this sexism, went to see the hospital administration. They were promised that in the future, this would be corrected. The next year, a similar tour was arranged, and at the end, the parents came by to pick up their children. What did they find, but the exact same thing — all the boys had on doctors' hats, all the girls had on nurses' hats! Steaming, they stormed up to the director's office and demanded an explanation. The director gently told them, 'But it *was* totally different this year: We offered them all *whichever hat they wanted*'" [Hofstadter 1986, page 156].

1.1.4 The Effects of Stereotypes on Teachers and Advisors

Additionally, stereotypes influence people who advise students, such as their parents, guidance counselors, and teachers. For example, [Stewart et al 1989] showed that, when given artificial case studies, high school teachers were more likely to advise male students than otherwise-identical female students to take courses that would prepare them for post-secondary institutions. Another study showed that high school girls "said that they had chosen business and commercial courses in order to prepare themselves for clerical jobs because they believed these were the jobs open to women" [Stewart et al 1989, page 261]. In response to a survey of female scientists,

> [M]any women felt they had been given inadequate advice on careers and choices of subject — careers advisers seemed to be fixated on nursing and teaching, and some were completely floored by requests for information about nuclear physicists or process engineers [Ferry et al 1982, pages 27–28].

Interviews with high school guidance counselors yielded similarly prejudiced advice to girls:

> A counselor in her early 30's: 'Well, if they bring me their registration card with (an AP [advanced placement] science course) listed I'll check to see if that's really what they meant... but I would never encourage it. I mean, it's usually their last year and there are so many fun things going on. I think they'll be busy enough and they can get into the serious work in college.'
>
> A counselor in her 20's: 'I just hate to see a girl get in over her head. I always try to place students at a level where I know they'll be successful. I mean, wouldn't it be frightful to spoil a beautiful record by doing poorly in a course your senior year.'
>
> A male director of guidance, mid-forties: 'Sure, I'm for the AP Program in general, but not for encouraging girls in science necessarily. Have you looked at the Bureau of Labor Statistics? It's a contracting market. There are men with Ph.D.'s in physics all over the place who can't get jobs. Why should we encourage girls? Why, if they're successful, they'd be taking jobs away from men who need them. No, it wouldn't be fair to the girls' [Casserly 1979, page 12].

Unfortunately, as the interviewer goes on to report, "these comments were chosen not because they were unique but because they represented all too commonly the attitudes of the counselors in many schools".

Additionally, even when girls are in science classes, teachers sometimes treat them differently, as shown by the following remarks from an interview of junior high school girls:

> So this teacher came down from the high school to give a demonstration in physics and said, 'Now this is going to make a pretty big noise, so any of you girls who don't like loud noises better cover your ears.'
>
> He said, 'Now this is going to be dirty so we'd better have a boy do it.'
>
> And he (a high school science teacher performing a demonstration to a sixth-grade class) said, 'Now this will help you boys who fix your own bicycles, so pay attention!'

(See also [Marriott 1991] and [Hall 1982].) The girls then go on to describe the difficulties they had in getting their parents to buy them tinker toys and chemistry sets, which are routinely bought for their brothers [Casserly 1979, page 9].

1.2 Ways that Males and Females are Treated Differently

In addition to the people who consciously believe women less capable, there are those who acknowledge that women can succeed at engineering but consider female engineers to be "somehow suspect" [Turkle 1984, page 200]. I will examine several aspects of this problem: First, based on their preconceptions of women, people often exhibit subtle forms of subconscious bias that cause them to treat women differently from men. Second, men and women are often held to different standards. Strange as it sounds, behaviors — such as succeeding — are sometimes considered attractive in men but not in women. Third, there is something about our culture's view of male-dominated fields such as engineering that causes female aspirants to be considered unattractive.

1.2.1 Subtle Bias

In [Sandler 1986, Sandler 1988, Hall 1982], there are summaries of several studies of subtle, subconscious bias — that is, people observably acting in a biased manner but unaware of their doing so. I was apprised of the importance of subtle bias by the number of respondents who objected to my call for "egregious examples", writing that they thought the subtle behavior to be more damaging. [Hall 1982, Sandler 1988] report the following biases, of which both men and women are guilty:

- Women are interrupted more than men.
- Faculty members make eye contact with male students more often than with female students.

- Faculty members are more likely to know and use the names of their male students than of female students.[6]

- Women are often asked fewer or easier questions than males.

As Sandler writes, "Singly, these behaviors probably have little effect. But when they occur again and again, they give a powerful message to women: they are not as worthwhile as men nor are they expected to participate fully in class, in college, or in life at large" [Sandler 1988, page 149]. Unfortunately, the message appears to have sunk in. Studies have shown that, when engineering students are asked to predict the academic performance relative to that of male and female colleagues, "both sexes anticipated that men would outperform women. This was paradoxical, since the average female student had both a higher grade point average and higher class rank from high school than the average male" ([Ott 1975] in [Zappert et al 1984, page 4]). Another study found that, when male and female college students were asked to predict their midterm test score before taking it, men had higher expectations for themselves than women did for themselves, even though the two groups actually performed the same [Erkut 1983, page 229]. Studies have found that women are more likely than men to attribute success to luck instead of skill [Deaux et al 1974] and to attribute failure to lack of skill [Ernest 1976, page 599]. Women's lack of confidence, and one consequence, is illustrated by an incident at Columbia, reported by Professor Joan Birman:

> I learned last year, to my astonishment, that for about four years running the honors calculus course had been all male, in spite of the fact that admission was based on an open competitive examination. This fall, one of the senior mathematics majors and myself made an intensive effort to encourage women to *try the exam!* The typical answer was, 'I know I won't pass it,' — to which we replied over and over, 'Well , if you try it, at worst you will confirm what you already know, and only an hour of time will have been lost.' After three days of such advising, the big day came, the exam was given, and this year the class has five men and five women! [Ernest 1976, page 604].

Not surprisingly, girls at single-sex schools study physical science and math more than in comparable coed schools, "even though girls' schools frequently have less adequate laboratory provision than mixed schools" [Kelly 1982, page 497]

Even more ominously, [Sandler 1986, page 6] reports:

> In one study, first done in 1968 and then replicated in 1983, college students were asked to rate identical articles according to specific criteria. The authors' names attached to the articles were clearly male or female, but were reversed for each group of raters: what one group thought had been written by a male, the second group thought had been written by a female, and vice versa. Articles supposedly written by women were consistently ranked lower than when the very same articles were thought to have been written by a male [Goldberg 1968, Paludi et al 1985, Paludi et al 1983]. In a similar study, department chairs were asked to make hypothetical hiring decisions and to assign faculty rank on the basis of vita. For vitae with male names, chairs recommended the rank of associate professor; however, the identical vita with a female name merited only the rank of assistant professor [Fidell 1975].

Anti-female bias is strongest in traditionally male fields [Top 1991, pages 96–97].

When discussing the results of such studies with fellow students, I found that the males have tended to be more surprised than the females, because many females recalled specific instances of biased behavior, several categories of which are represented below.

In some cases, a woman was viewed as less serious than a man in a similar position:

- A female computer science graduate student had the following experience:

[6] The experience of women I have talked with is that if females are in an extreme minority, they stand out so much that the teachers are likely to know their names.

> I was working at a fairly small company whose communal coffee was *awful.* A group of 6 of us (4 men, 2 women) bought our own coffee maker and had decent coffee which we paid a few cents for to defray the costs of coffee and cream. Anyway, I usually bought the coffee and my male coworker usually bought the cream. A new member to the group (male) approached me and told me we were out of cream. I told him that M2 usually bought the cream. Later that same day, M1 again comes up and tells me we are out of cream. I once again tell him that M2 gets the cream. To this he says, 'But how can I bother M2 with something as insignificant as buying cream?' Needless to say, I told this fellow exactly what I thought about that...

- One female graduate student in mechanical engineering sent the following two stories:

  1. When I first started the [graduate] program, the head of the department (male) was assigning desks to graduate students... ([T]here were two entering females to the particular program at that time.) As he ran out of desks, he said, 'Well, just put the girls together on a desk.'
  2. That same professor put me (a newly graduated math major) into the slower (undergraduate) statistics class, and put a guy who had had a vague introduction to stats 8 years earlier in the faster (graduate) class.

  Both events took place in the past two years, a time period which she has found "very frustrating".

- A female computer consultant wrote:

  > Most of our users ask for and accept help from whichever consultant is available, but some insist on talking with one of the male consultants (only 2 of the 10 consultants are male). One user persisted at this, even after Alan explained to her that he didn't know the package she was working with, and that she would be better off asking me because I specialize in that particular software. Another user did ask me her question, but when she didn't like the answer I gave her (I explained what she could not do and why), she insisted on taking her problem to David (a higher authority?), who proceeded to tell her exactly what I had just explained. What is interesting about the latter incident was that she did not seem to be after a second opinion, because she could have gotten that from a number of people (all female). She apparently specifically wanted a male opinion.

- When a female computer science undergraduate visited one of the graduate schools to which she had been admitted, she and a male prospective student met with a male graduate student to discuss the school. Whenever the woman asked a question, the graduate student directed his answer to the male prospective instead of to her, i.e. by making eye contact and gestures toward the male prospective. This treatment surprised the woman, as she had not encountered such behavior at her undergraduate institution. After the meeting, she delicately pointed out the behavior to the graduate student, and he apologized profusely and sincerely, clearly unaware of the bias while it was occurring. When they met later in the day, his behavior was markedly better. The same woman, however, in a later meeting with two other graduate students, one male and one female, found herself addressing most of her questions to the male until she recognized her behavior and corrected it.

1.2.2 Different Expectations for Men and Women

The following examples show how people sometimes expect women to be less interested or competent in technical areas than they actually are:

- According to a survey of female scientists:

  > Women in mainly male environments are always being taken for secretaries or junior laboratory staff: queries may be addressed to a male technician rather than his female

boss. An engineer offering to help a telephone caller was told 'No dear, this is a technical enquiry. Can I speak to someone who can help me?' [Ferry et al 1982, page 28]

- A female computer science professor told me this story:

  I was visiting a university and arrived before my (male) host. I approached the departmental receptionist to try to make certain arrangements. In one case, I suggested that my host might have made some provision — 'or,' I said cordially, 'maybe not.' 'Oh, probably not,' replied the receptionist. 'After all you know those professors...' Boy was *her* face red when she realized what she'd said.[7]

- A female undergraduate at a women's college wrote:

  The summer after my first year at [X] I took Linear Algebra at [a coed college] nearby. Out of probably twenty people in the class, I was one of two women. I found that the mood of the class was stifling. It was obvious that the men of the class expected me to sit quietly in my chair and contribute nothing and ask no questions. It was also made obvious to me that, in general, they felt they were far superior to me. Because I had had no contact with them outside of the classroom, I must assume they were basing their decision solely on the fact that I am female. In addition, I found the material relatively easy and was getting an A in the class, so they could not be basing it on my academic performance. One day as we were going over a difficult problem set we had had for homework, the professor asked if anyone was able to do a particular problem which I had been able to solve. When I raised my hand, [a student made] the comment 'What?!?! How could *you* have solved that problem!?!?' He in no way hid his hostility or his feelings that if he, a far superior man, could not solve the problem, I could not have. I was completely shocked that he could make such a comment. No one else seemed to be. It is no wonder that women tend not to contribute in a male-dominated classroom.

- A female computer scientist sent me a copy of the cover of a prestigious computer periodical that showed a family (parents and a boy) looking at a computer. A bubble next to each shows what they are thinking. The mother is imagining her son using the computer to learn math and the father using it to figure taxes. The son and the father both imagine using the computer to play space war games.[8]

These diverse examples illustrate how women are sometimes treated as less capable or interested in technology than men, instead of being treated as individuals. Of course, there exist professors and administrators who treat their male and female students equally as well or even devote extra effort to encouraging women. However, negative events are still common enough to be of substantial concern. Moreover, the above behaviors are the symptom of a more fundamental problem: lower expectations for females. Many of the above events are too blatant to have the insidious effect of subtle discrimination (which probably accompany them). Even if the perpetrators could be coerced into not so openly displaying sexism, it would not eliminate the fundamental biases which would be displayed less directly.

1.2.3 Different Standards for Men and Women

As Sandler writes, the same behavior is viewed differently in women than in men:

[7] It is fascinating to read about how female professionals and secretaries interact with each other. One professor reports that she used to sneak to the typewriter and type her own letters, rather than ask a secretary to do the work for her. Correspondingly, secretaries generally do not like to work for women. "They experience women's authority as 'unnatural', whereas men's authority is taken for granted" [Pringle 1989, page 58]. Additionally, as hinted by a comment in [MIT 1983, page 21], female secretaries feel demeaned when female professionals complain about being mistaken for secretaries. On the other hand, most of the secretaries I have worked with have treated me the same as they treated my male colleagues, and one has even told me outright how happy she was to see women as computer professionals.

[8] Cover, *IEEE Computer*, March 1977.

> He is 'assertive'; she is 'aggressive' or 'hostile'. He 'lost his cool', implying it was an aberration; she's 'emotional' or 'menopausal'. Thus, her behavior is devalued, even when it is the same as his [Sandler 1988, page 151].

This claim can be illustrated by a recent lawsuit by a woman who "repeatedly heard that she had not been given a partnership at [a] huge accounting firm because she was too macho, universally disliked and in need of 'a course at charm school'" [Lewin 1990]. This is despite having brought in more business than any of the other 88 candidates for partnership. "Comments from the lawsuit [say] that she should wear makeup and jewelry and learn to walk, talk and dress 'more femininely'" [Lewin 1990]. A survey of female scientists found:

> Most think their male colleagues are more forceful and aggressive than they themselves want to be; some have resigned themselves to low status rather than changing their personalities, while others have decided to fight with men's weapons — and are often labeled unfeminine as a result [Ferry et al 1982, page 30].

One study found the same behavior judged more harshly in female professors than in males:

> [According to] Susan Kay's classroom studies... male students were far more likely to give lower ratings to those female faculty perceived to be hard graders... This finding is consistent with a series of experiments at the University of Dayton that indicated that college students of both sexes judged female authority figures who engaged in punitive behavior more harshly than they judged punitive males... ([Martin 1984, pages 484–485] in [Koblitz 1990]).

See also [Kierstead et al 1988] and [Bennett 1982].

A "halo" effect seems to exist where people tend to interpret behavior according to their preconceptions. The same action is often interpreted differently, depending on whether it is performed by a woman or a man, as the following stories illustrate:

- When a high-ranking female engineer was at the airport to make a business trip, she saw a male acquaintance who worked for the same company. He asked where she was going, and she answered San Francisco. He then said something like, 'Oh, going to do some shopping?' She told me how angry his remark made her, as she works extremely hard at the company, putting in long hours and taking frequent business trips, with too little free time for her to go on out-of-state shopping trips even if she were inclined to do so.

- A female computer science graduate student told me that it is common to see different reactions to men and women dropping a class. According to her, when a woman drops a class, people remark that the class must have been too difficult for her; when a man quits, people say he must not have found it interesting.

These examples are troubling because they show one way in which stereotypes are perpetuated. In each case, someone interpreted the actions of a woman based on their prejudices, reinforcing their own stereotypes.

Additionally, women at American universities are often the victims of other cultures' stereotypes. Foreign nationals outnumber Americans as students in doctoral engineering programs [Widnall 1988, page 1740], and there are many foreign-born professors. In one survey, female graduate students at MIT "reported that foreign-educated faculty — many from cultures where women are not held in high esteem — pose problems for women in graduate programs, both in class and in research" ([MIT 1987] in [Baum 1990, page 49]).

1.2.4 Career-Related Success Unfeminine

Not only are some strong traits considered unfeminine, but "femininity and individual achievement continue to be viewed as two desirable but mutually exclusive ends," a shocking position argued in [Horner 1970, page 46], based on empirical research and interviews. In one of Horner's studies, females were given the sentence "After first-term finals, Anne finds herself at the top of her medical school class." Males were given a similar sentence with a male name. Subjects were asked to write a story about the student. While only 8 of the 88 male subjects exhibited fear of success through negative stories, 59 of the 90 females did. Horner divides the negative stories into three categories and includes sample stories, of which I include a subset:

1. Fear of Rejection — "Anne doesn't want to be number one in her class. She feels she shouldn't rank so high because of social reasons. She drops down to ninth in the class and then marries the boy who graduates number one."

2. Concern about Normalcy or Femininity — "Anne is completely ecstatic but at the same time feels guilty. She wishes that she could stop studying so hard, but parental and personal pressures drive her. She will finally have a nervous breakdown and marry a successful young doctor."

3. Denial — "Anne is really happy she's on top, though Tom is higher than she — though that's as it should be.... Anne doesn't mind Tom winning" [Horner 1970, pages 60–62].

Additionally, when questioned about Anne, "[m]ore than 70% ... described Anne as having an unattractive face, figure, or manners" [Horner 1970, page 63]. Females thus consider success to lessen their femininity, a sacrifice many are not willing to make [Horner 1970, pages 69–72]. See also [Mednick et al 1975].

This attitude can also be illustrated by the following incident, reported in [Franklin et al 1981, page 20]:

> One woman earned high grades in a traditionally male field. Her professor announced to a mostly male class that this represented an unusual achievement 'for a woman' and was an indication, first, that the woman student was probably not really feminine, and, second, that the males in the class were not truly masculine, since they allowed a woman to beat them.

Instead, the proper area for a woman's success is seen as her ability to attract high-status men. In a study for the National Institute of Education, researchers Holland and Eisenhart found:

> Men's prestige and correlated attractiveness come from the attention they receive from women *and* from success at sports, in school politics, and in other arenas. Women's prestige and correlated attractiveness come *only* from the attention they receive from men [Holland 1990, page 104, emphasis in original].

This attitude is exemplified by the way one college woman attempted to insult another: "[You] may be able to do calculus, but I'm dating a football player" [Holland 1990, page 104, brackets in original]. The study found that female friends often did not even know each other's majors [Holland 1990, page 14], although they spent large amounts of time together discussing other matters, primarily boyfriends [Holland 1990, page 14].

1.2.5 Implications of Gender Double Standards

The double standards discussed above should be a significant concern. Aggression, competitiveness, and even some brashness are necessary for a graduate student, for example, who must compete with other students for equipment, funding, and attention from professors. One doesn't get far by politely waiting to be noticed or for other people to stop using the computer. In her paper on being a female graduate student at MIT, Candace Sidner addresses some stumbling blocks women face:

> Receiving an advanced degree, in fact, any degree, from MIT is rather like being admitted to a fraternity. One has a certain set of rituals to go through, and both the process and one's performance define one's position in the fraternity in the years that follow....
>
> It surprises no woman to say that women are socialized differently than men in our cultures. What is surprising is the effect of that socialization when women take roles traditionally held only by men. The most significant role change centers [on] developing confidence and

> competence. Part of the process of hurdle jumping is not just the getting over, it is the form which one presents in doing it. For the MIT fraternity ritual, the form is confidence; a woman student must use what I call strutting behavior, that is, she must look and act like she knows what she is doing.
>
> While developing confidence from accompanying competence, is difficult for all initiates, for women there is a subtle, but remarkable difference; women in the everyday world are not supposed to appear very confident and competent.... As a result, women must not only build and show confidence and competence, just as their male counterparts do, but unlike the men, they must *decide* first to unlearn their normal behavior patterns....
>
> The strutting behavior appears slowly; there are stops and starts, forward and backward progress. A woman student begins to act from a little bit of confidence in her competence, and tests out this confidence among her peers and superiors. Two more difficulties follow. First, a woman feels less feminine, because in fact she is less feminine according to the prevailing behavior patterns. In her personal life, her feelings may be communicated to her partner(s) who may find her less attractive. This threatens her personal status. Eventually a woman can learn to find personal friends who value her confident image, but the time in between is frightening [Sidner 1980, pages 2–3].

Empirically, a comparative study of male and female Stanford graduate students in technical areas [Zappert et al 1984] found that women were less self-confident and assertive than their male peers:

> [W]omen less frequently than men reported that they felt free to disagree with their advisors...and that their ideas were respected by their advisors [Zappert et al 1984, page 9]....
>
> [W]omen more often reported having trouble saying "no" and in giving criticism. Women also more often reported having difficulty sticking up for themselves and tended to let annoyances pile up [Zappert et al 1984, page 12].

1.2.6 Specific Stereotypes Against Female Engineers

As if the culture-wide inhibitions to success were not enough, there are additional barriers in engineering. Nowadays, high school girls from middle- and upper-middle-class families are expected to go to college and to do reasonably well, but going to a technical institute or majoring in a technical field is still considered unfeminine, as these anecdotes indicate:

- When a female student at an engineering institute went home for vacation, her mother leafed through the book of photographs of the freshman class and exclaimed in surprise, "Why, some of these girls are pretty!"
- A male computer professional wrote:

  > Back in 1983, I was a freshman here at [X] and one of my friends was a genius who happened to be a pretty blonde girl....
  >
  > She was also a freshman and spent one of her first days here searching for her advisor's office. While hunting around [Y] Hall, a man in his early 30's came up to her and asked if she needed help. She said that she was looking for her advisor's office. The man responded with a puzzled, 'What major are you?' When she answered, 'I'm in Electrical Engineering.' The man smiled at her and oozed, 'Oh, you're *far* too pretty to be an EECS major.' [She] immediately left and told us in the dorms about this slimy guy.
  >
  > The next day we went to our first lecture for [the introductory computer class]. [She] gasped as one of the lecturers entered the hall. He was the same slimy guy she had encountered the day before....
  >
  > I'll never forget the quote, "Oh, you're *far* too pretty to be an EECS major."[9]

[9] In a later note, the writer added: "[The teacher] was fired two years after this incident. According to my advisor at that time, his attitude toward female students was one of the reasons. (He was not tenure track. He was a lecturer only.)" This story was later confirmed by a former professor from the university.

- A male computer professional wrote:

> I used to teach undergraduate computer science classes, and saw a number of cases in which very promising and talented women abandoned computer science, much to my disappointment since they were some of my better students.... At least where I was teaching, the discouragement from that field was given more by other women, particularly in the sororities, rather than from within the field itself.

It is worth repeating, however, that the stereotype of male engineers is almost as bad. Jokes and television portray male engineers as unattractive, unpopular, awkward, and either unsuccessful with or uninterested in women.[10] However, I believe that in our culture, females are more susceptible to such stereotypes. This is in large part because, as described earlier in this chapter, femininity is considered to be at odds with success, while masculinity is not.

While the stereotype that female engineers are inherently unattractive seems to be without rational basis, scientific fields may well be in conflict with some values traditionally thought of as feminine and currently held by a majority of females. The situation seems not to have changed since the following was written:

> I think [women's lack of achievement] comes from the general orientation of girls, young women, and even older women, toward 'others' (in David Reisman's sense of being 'other directed'). Women are constantly urged to consider 'Am I doing the right thing?' and 'What shall I be or do that will please my husband, children, and parents?' Occupational success never comes out as the positive answer to these questions. Pleasing others and doing the 'right thing' always means holding back, and retreating from a position of strong ambition and career commitment [Epstein 1974, page 15].

I would add that being other-directed might steer women away from objective sciences into the humanities and the more people-oriented social sciences. Thus, the values that are encouraged in women would not only make them less career-oriented but more likely to avoid the sciences.

1.3 Summary

In our society, males and females are regarded very differently. Assertiveness, confidence, and high achievement are considered consistent with masculinity but not with femininity. In addition to the stigma associated with success in general, technical fields are considered particularly unattractive for females. These factors can influence a girl not to pursue an interest in math or engineering, and they can sabotage a woman's career because either she acts feminine, e.g. demure, and is not taken seriously, or she acts masculine and is met with disapprobation. Of course, as mentioned in [Sidner 1980, page 3] and [Horner 1970, page 70], confident females eventually find male and female friends who like and respect them. The problem is thus not insurmountable. Still, it is an additional barrier that females face, and the playing field will not be level while these stereotypes exist.

[10] See [Turkle 1984] for an interesting discussion of the male engineering student's self-image.

Chapter 2

The Masculine Environment

> *I do not see that the sex of the candidate is an argument against her admission... After all, we are a university, not a bathing establishment* — David Hilbert, arguing unsuccessfully for the appointment of Emmy Noether to the faculty at Göttingen.[1]

Currently, the majority of professionals in computer science departments and workplaces are male. As a consequence, these places often have masculine environments in which women feel uncomfortable or unwelcome. The behaviors described in this chapter are generally not meant to be harmful to women, which makes the participants often hostile toward criticism. Such behaviors include the display of nude pictures, discussing sex, telling dirty jokes, and expressing negative stereotypes of women in an attempt at humor. Additionally, other activities are morally faultless, such as coworkers playing basketball together, but they may tend to make a woman feel less part of the group if she does not enjoy the same activities.

2.1 Sexist or Sexual Humor

Often, men make sexist or sexual remarks in attempts at humor. As the following examples show, this happens in classrooms, computer magazines, and at conferences. In most of these cases, the speaker probably means no harm. However, the behavior makes some women feel uncomfortable. In order to highlight the effect such statements have on women, their reactions have been included where available.

- A female graduate student had the following experience:

  > [A professor] in the introductory part of a guest lecture on robotics to the graduate core AI class: (approximate quote) 'Pretty soon we'll have robots that are sophisticated enough to wander around in shopping malls and pick up girls.' I didn't listen to the rest of the lecture, so I don't know what else he had to say.

- A female computer science professor wrote:

  > When I was in graduate school, the professor in automata theory introduced the topic of decomposition by saying: 'Machines are a lot like women — many forms for the same function (wink wink).' As the only woman in the class, you can imagine that I felt terrific. And all of a sudden the guys sitting next to me sort of tensed up — instead of a fellow student, his remark had made them see me as something else, something kinda dirty.

- The narrator of the industry gossip column in the trade journal *Infoworld* is an adult male with a young girlfriend Pammy, shallow and uninterested in computers, whose silly statements and actions

[1] Weyl, Hermann. "Emmy Noether", *Scripta Mathematica*, VIII, 3 (July, 1935), page 207.

pad the columns, such as her return to beauty school. ("[A]t 21 she's older and can handle the pressure now.")[2]

- A female computer science professor wrote:

  > [A]t a conference in France, a male speaker (French), who was speaking about the importance of testing, showed an overhead slide of a naked woman with a caption of the sort — 'Would you buy this product without testing it first?' There were only 2 or 3 women in the audience (of about 150), but I had fleeting feelings of having accidentally walked into a stag party and wondering if he had either not expected any women to be there or had discounted the importance of directing his remarks to the women in the audience.

What these examples all share is that the male speaker or writer was attempting to make a cute statement but that females (and some males) had negative reactions.

2.2 Sexual Displays and Discussions

2.2.1 Different Reactions

At the workplace, many women feel uncomfortable with the "locker room atmosphere", which includes pictures of nude or partially nude women on posters or computer screens and the telling of dirty jokes. Unlike the sexist remarks described above, however, there is disagreement among women on how inappropriate these actions are, with a significant number of women not personally offended by the behavior (although some of these women oppose it on the grounds that it upsets other women). This point is illustrated by the different reactions in the following examples:

- When a graduating engineer was touring a company that wanted to hire her, they took her through the laboratory, which had a pin-up on the wall. The other people in the lab (men) and the men showing her around seemed oblivious to the poster and to her discomfort. She felt uncomfortable with the idea of working in a laboratory with a picture like that up and ended up refusing the offer, partly for this reason.

- When a graduating computer scientist was taken out to lunch by engineers of a small computer company, one of the topics the employees (all male) discussed was a series of lingerie shows in the region. The student did not feel uncomfortable about the subject matter, and it did not affect her decision about the company, but she thought it was something which might make other female interviewees uncomfortable.

- When a computer science undergraduate had recently begun working in a research group at her university, some male graduate students entered the office and began playing an "adult" computer game, "Leisure Suit Larry," crowding around the screen, discussing the game loudly. The undergraduate left the office because the situation made her too uncomfortable for her to work there. When she recounted the story a year later, she said that she would not react the same way now and would either be able to keep working or would say, "Hey, get out of here, guys." The change was due to her feeling more confident about her position in the group and knowing the individuals personally.

One female computer science student explained one reason that some women are offended by sexual humor while others do not understand what the fuss is about:

> I have noticed that how offended I am by [gender-related humor] depends very strongly about how comfortable it is to be female and in the present environment.
>
> When I first entered grad school in the CS [X] group at [Y], there were some women graduate students, but only a couple. A secretary deliberately placed me, when I arrived,

[2] Cringely, Robert X. "Notes from the Field". *Infoworld*, September 17, 1990, page 108.

sharing a desk with a male graduate student who was at that time desperately trying to find a woman (she was trying to be nice) — a professor had a 'funny' newspaper article about [a sexual topic] posted outside his door. Don't get me wrong, I found nearly no-one among the faculty and graduate students who was anti-women or took me or my work or my concerns any less seriously than any other first-year student. Still, the graduate students were 90 percent men, and they talked all the time about how hard it was to meet 'available' women, and as a first year student trying to establish myself within their community, I found the 'locker room' atmosphere oppressive and daunting. If someone had sent around [a sexist joke through email] that year, I think I would have hit the roof. In a world where I was struggling to find my place, it would have just helped to undermine it.

Today the graduate student population in CS [X] has quite a few more women, and is much more comfortable. Instead of the "guys" in school here, it's the 'people' in school here.... In my current environment I might have easily [passed along the joke] to my [male] office-mate.

2.2.2 Attempts at Changing Behavior

Some computer science graduate students and staff at Carnegie Mellon were sufficiently disturbed by the display of nude pictures as backgrounds on computer terminals that they got together and tried to change the situation by publicly appealing to the community. [CMU 1989] is a fascinating report describing their appeal and the friendly and hostile reactions. Their appeal included the following passage:

> When a woman sees such a display on your workstation, is she likely to believe that you take her seriously as a fully contributing member of the department? Rather, she may feel that you could be a source of sexual harassment, and feel hostile towards you, or nervous about working with you. If so, that is a loss for you, for her, and for all of us. Among the visitors to the department, some of whom are prospective students, staff, or faculty, there are surely some who will view us as unprofessional if they see these displays, and this hurts us all, too. Conversely, an environment more hospitable to women — specifically, one in which relations between women and men are less strained — is of clear benefit to men as well.
>
> For some people, displays of naked women on workstations, or elsewhere in offices, remind them of the forces in our culture that view women as sexual playthings, not as men's peers. For others, such reactions do not occur. People who are offended will interpret such displays as derogatory, even if that is not your intent. We therefore ask you to refrain from using them out of respect for those who are offended, even if you believe the offended people are just overly sensitive [CMU 1989, page 2].

The appeal closed by making clear that they were not advocating banning such displays but were requesting that people voluntarily remove them out of sensitivity to others. Responses about the appropriateness of the displays and of the appeal were mixed and are categorized in the report. Negative reactions included the position that the writers were advocating censorship "like the Nazis or the Ayatollah Khomeini," that people should not be asked to change their behavior merely because of what others might think, and that a public appeal was inappropriate but instead should have been made by individuals to individuals. Of those agreeing, the majority of responses said that the request was reasonable and not an attempt at censorship, that it prevented people from unintentionally giving offense, and that it was effective at raising consciousness. In response to the criticism that individuals should complain personally, several women wrote that "[w]omen asking for changes in behavior individually are exposed to ridicule and abuse" [CMU 1989, page 4]. This point was echoed by a woman quoted in a paper about the "Garden", a laboratory in the MIT Media Lab:

> [W]hen comments are made about the offensive nature of the music or movies, they are often ignored, or belittled, or are chortled at. Ironically, once you are labeled a feminist in the Garden, your comments are taken less seriously, because you are considered radical and your judgment less fair [Tidwell 1990, page 14].

Both the Carnegie-Mellon and Garden papers conclude that the attempts at changing people's behavior were somewhat, but not highly, successful.

2.3 Behavior Due to Sex-Correlated Differences

An additional category exists of behavior that is not directly based on sex but which nevertheless discourages women. While attempts at changing sexist behavior are partially effective, there seems little that can be done about this category.

2.3.1 Socializing with Co-workers

Through no real fault on any side, a woman sometimes feels out of place being one of the few women in a semi-social gathering with a group of men, even in the absence of any behavior directly related to the sex of the participants. One reason is that, in our culture, men are often interested in activities or topics that women tend not to relate to.

A female graduate student complained about her experiences as a teaching assistant (TA) for a course in a particularly male-dominated area of computer science. She wrote:

> Perhaps because the percentage of males is often high, men tend to dominate non-academic discussions with topics of interest to them, such as sports and cars, topics which women are often uninformed about or uninterested in. The resulting inability to participate in discussions can make it difficult for women to bond socially, and often leads women to feel outright alienated... This is exactly what happened to me at each T.A.–faculty meeting.

Another female computer science graduate student described a similar experience:

> My first summer at [a certain computer company], I worked in a group that was otherwise all male. While I got along okay with them and never had any behavior to complain about, I didn't socialize with the group. For example, every day after lunch, they would go outside to 'shoot some hoops' [play basketball], an activity that I just did not relate to. For my next summer, I joined a group that had other female programmers and a female manager. I was much happier in that group. We would have barbecues, celebrate people's birthdays, and socialize in other ways that I related to better than 'shooting hoops'. My third summer, I chose to return to this group and not to the first one or to find a new group.

However, when she casually discussed her social dissatisfaction in an exit interview with the department head, he pointed out that, coming from a different country, he did not relate to American sports either. This raises the important point, which holds for all examples in this section, that dissatisfaction with certain activities is not strictly divided by sex. There are individual women who enjoy sports and are better at them than some men. Sex-based differences are a tendency, not a fixed rule. Sex-correlated preferences in our society, however, are strong enough that these phenomena tend to work against women (or whoever is underrepresented in a group).

Additionally, female group members do not always feel comfortable joining male group members who go out drinking together. Not only might they not enjoy drinking, but some men are inclined to making lewd remarks after a few drinks. Thus, there are often times when women feel unable to take part in activities to which, as group members, they are invited.

Another problem is that some men do not feel comfortable socializing in a professional manner with a woman, as this anecdote illustrates:

> I was ... the first full-time woman faculty member in my department. There really was difficulty among my male colleagues in associating with a woman as a colleague. I think they literally did not know how to talk to me, and as a consequence often just did not talk to me. They would ignore me. They would not invite me to have lunch with them, which was a very ordinary experience there ... they would walk past my office and ask the next person and

> never ask me. [Years later] I asked one of my colleagues why this was so. And he said, 'You know what would happen if I asked you to lunch ... People would talk' ([Clark et al 1986, pages 36–37] in [Sandler 1986, pages 7–8]).

2.3.2 Different Communication Styles

The language that women use often differs from that of men in subtle ways. As discussed in [Hall 1982, page 9], specific constructions appear more frequently in women's speech than in men's:

- hesitation and false starts ('I think...I was wondering...')
- high pitch
- 'tag' questions ('This is really important, don't you think')
- a questioning intonation in making a statement ('The second chapter does most to clarify the theme?')
- excessive use of qualifiers ('Don't you think that *maybe sometimes...*')
- other speech forms that are excessively polite and deferential ('This is probably not important, but...')

As Hall concludes:

> If, for example, a woman student begins her comments hesitantly and uses many qualifiers, she may be immediately perceived by her teacher and by her classmates as unfocused and unsure of what she wants to say. Her 'overly polite' style may seem to 'invite' interruptions by, or inattention from, both teacher and other students. Indeed, even the most insightful points made in this manner — *especially by a woman* — may be taken less seriously than the identical points made by a man or delivered in a more 'masculine' assertive style [Hall 1982, pages 9–10].

See also [Lakoff 1975].

A large part of Jenifer Tidwell's report on the Garden [Tidwell 1990] describes how men and women react differently to the same treatment, due to their expectations of communication styles:

> The persons I interviewed did not believe that women were treated worse than the men were, nor vice versa, when I asked them directly. ('Everyone is treated equally badly,' said one male informant.) Yet some informants, both male and female, commented that women may not be able to deal with the Garden's harshness as well as the men do — not because of any inherent weakness, but simply because they have not been brought up with the same expectations of 'toughness' (in one man's terms) that men have. Furthermore, it seems more acceptable for anyone there — male or female — to try to solve all one's problems by oneself than to habitually ask for help. All of the women that I interviewed commented on this expectation of independence (whereas almost none of the men did); they did not like it [Tidwell 1990, page 9].

Tidwell writes that the attitude is that "[what could be construed as] harassment may just be social incompetence" [Tidwell 1990, page 15, brackets in original].

Anecdotal evidence suggests that women tend to be more sensitive than men to general obnoxiousness [Widnall 1988, page 1744]. When a female computer science student told me that a male TA had been inexcusably rude to her in front of the class, I looked up the student evaluations of the TA and found this comment, by another student:

> [He] knows his stuff cold, but he's too rude. Honestly, once you humble yourself and tolerate this, he is an excellent source of help. I owe a lot to him.

A student unused or unwilling to being treated rudely would not be able to interact with such individuals.

When I sent electronic mail to a group of women asking for criticism on the first version of this report, one woman replied that my request was unlikely to draw many responses. Instead of asking for "criticism", she told me, I should have asked for "feedback to help me improve the report", something women would feel more comfortable supplying.

Steven Levy's *Hackers: Heroes of the Computer Revolution* extensively describes the hacker culture, including the hackers' apathy and even antipathy toward women.

> Maybe it would have been different if there had been more women around TMRC [Tech Model Railroad Club] and the ninth floor — the few that did hang around paired off with hackers.... There were not too many of these women, since outsiders, male or female, were often put off by the group: the hackers talked strangely, they had bizarre hours, they ate weird food, and they spent all their time thinking about computers [Levy 1984, page 72].

Levy goes on to describe the poor hygiene of one of the most admired hackers, a young man who did not bathe [Levy 1984, page 73].

Male computer environments that exclude women have occurred as early as in preschool:

> 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. 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 [Kiesler et al 1985, page 454].

While it is not clear that one can justify the stereotype of the engineer and computer hacker as socially backwards, women are deterred by the environment.[3] (See [Markoff 1989], for example.) Additionally, whether the stereotype is accurate is to some extent irrelevant: If females believe that to study or work with computers requires hanging around socially incompetent nerds, the stereotype, true or false, may influence their decision.

2.4 Finding a Mentor

Having a mentor or sponsor can be of vital importance to a graduate student or junior professor:

> The sponsor may serve many functions for the protégé. First, the sponsor introduces and initiates the protégé in the customs, demands, and expectations of academic life. Second, the sponsor shares his or her wisdom and knowledge with the protégé, and provides encouragement and comments on his or her work. Third, the sponsor can provide career assistance for the protégé by making recommendations to his or her colleagues at other institutions, or simply by sharing a bit of the deflected glow from his or her own shining reputation. Perhaps most important, the sponsor helps to form with the protégé the sense of him or herself as a member of the profession, encouraging and fostering a self-image as a legitimate member of the community of scholars [Simeone 1987, page 101].

Despite the importance of having a mentor, there are few formal policies to ensure that every graduate student or junior faculty member receives mentoring. Although every graduate student, for example, has a thesis supervisor, the supervisor typically devotes different amounts of energy to different students. It is reported that "women are more likely than men to be excluded from this sort of relationship with senior faculty" [Simeone 1987, page 102] [Hall 1982, page 10]. There are several possible reasons for this exclusion. First, as discussed above, some men feel uncomfortable dealing with women as professionals. Second, some "faculty men may see women as being different from themselves, less intellectually able, less committed and dedicated, or simply inappropriate for academic careers" [Simeone 1987, page 103].

[3] It is worth noting, however, that some men are disgusted by the hacker culture, such as MIT professor Joseph Weizenbaum [Levy 1984].

Third, when men and women work closely together, there is the risk of their being suspected of having an affair [Simeone 1987, pages 82–83]. Additionally, many people like to help people who are "like" them, i.e. of the same sex or race. (Indeed, that was a motivation for my writing this report.) As long as most of the people in positions of power are men, and as long as differences in sex are considered to be of great importance, junior men will benefit.

2.5 Behavior Specific to Technical Events

Computer trade shows and technical conferences are often even more male-dominated than the workplace and university. Some of the specific problems of these events are discussed in this section.

2.5.1 Trade Shows

Men far outnumber women at industry and academic conferences. At trade shows, particularly, companies have "historically employed attractive women to draw attention to product exhibits or booths" [LaPlante 1989]. While this practice has been declining, an industry journal article about Comdex 1989 reports:

> A number of companies still insisted on hiring scantily clad female models to attract attention to their booths. And a party thrown by Fujitsu went far beyond questionable taste, seriously offending Comdex attendees of both sexes [LaPlante 1989].

Additionally, when women do attend, they are suspected of not being legitimate attendees:

> [PFS Inc. president Mary] Rich remembers attending the National Computer Conference (NCC), a now-defunct computer convention, where the male attendees outnumbered the female ones by a ratio of 300 to 1. Convention officials as well as hotel staffs were extremely suspicious of single women, Rich said. Women were often suspected of being prostitutes trying to solicit show attendees. Rich said she once tried to go to the hotel room of a colleague for a drink only to be kicked out by security when trying to get in an elevator.
>
> Rich, who co-chaired the 1986 NCC with another woman, said that as recently as three years ago one of the primary concerns was how women were being treated at the show. 'We still had problems with security not believing [the credentials of] women trying to get onto the show floor,' she said [LaPlante 1989].

2.5.2 Technical Conferences

Women are treated better at technical conferences than at trade shows. While I have never seen any reports of a female speaker or attendee being mistaken for a prostitute, people sometimes assume a woman to be the wife of an attendee and not an attendee herself. Additionally, female computer scientists complain of being propositioned by male attendees. While this probably happens at trade shows too, its happening at conferences leads to particularly touchy situations because the women do not want to offend potentially important men in their field and feel obliged to find delicate ways to reject indelicate offers. Because of this, many women act cold to men they meet at conferences, which has the side effect of discouraging friendship with colleagues who could be useful contacts.

A female computer scientist, with experience in several fields, described another problem with being one of the few attendees who needed to bring along their child:

> One difference between biology and computer science that I have noticed is that it is not unusual for childcare to be provided at professional conferences in biology, while I have never seen it offered at AAAI [American Association for Artificial Intelligence], IJCAI [International Joint Conference on Artificial Intelligence], Cog Sci, or ACM [Association for Computing Machinery] conferences. I have a baby that I won't be able to leave overnight for about 2 years (because of breastfeeding), but it is difficult to make daytime childcare arrangements

> for an out of town conference oneself. Even with an older child, it can be difficult to make the night-time arrangements at home if the child is left behind (traveling spouse, single parent, etc.), so bringing the child along might be preferable if childcare were available.[4]

Additionally, another female computer scientist told me that "some conferences organize 'spouse events' which tend to run to fashion shows, shopping, etc. My husband finds this strangely unappealing!"

Presumably, conference hosts do not mean to discriminate when they fail to provide childcare or provide activities of interest to wives of attendees — I assume that, if the issue crosses their minds, they assume that the number of exceptional attendees would be too small to justify the expense of providing for them. This is an example of how, entirely in the absence of any bad intentions and purely due to the ratio, conditions can be such that a class of attendees cannot conveniently take part in a professional event.

2.6 Different Priorities

2.6.1 Family Life

Having a support spouse, usually a wife, is a boon for anyone but especially for pre-tenure professors, for whom it is not unheard of to work hundred-hour weeks. Since women rarely have a spouse willing to tend house for them, while male professors and graduate students sometimes do, the women are often at a relative disadvantage. Additionally, wives are often more willing to relocate for their husbands than vice versa [Ferry et al 1982, page 29]. As one computer scientist said:

> There was an article in Chronicles of Higher Education about 3 years ago by a male professor who wrote about how he and his wife (also a professor) needed to have a third party — a wife... The gist of his argument is that faculty workload is based on antiquated notions of unquestioning, full-time support from a spouse, and that universities need to revise their expectations of professors [Frenkel 1990, page 41].

Women in academia have the additional problem that the years in which they must work to get tenure are a significant portion of their child-bearing years. In [Frenkel 1990, page 41], one woman gives this as a reason for choosing industry over academia. Additionally, some women "prefer to take a less demanding job than their qualifications fit them for, because they feel that the time and attention they can afford on top of their responsibilities at home is limited" [Ferry et al 1982, page 30]. This might be one reason that female computer science PhDs are less likely than their male peers to enter academia, more often choosing industry instead.

Not only are some women unwilling to sacrifice family for work, a choice that men rarely have to make, but when women do decide to put their career first, it is still assumed that they do not take their career seriously. According to a survey of (English) female engineers and scientists:

> The most trying moments in almost every woman's life seem to have been spent in interviews. The women in our survey have nearly all taken the trouble to equip themselves with a qualification that might suggest they had ambitions beyond boiling nappies [diapers] and making their husbands' tea. Yet time and again they have found themselves being pulled apart on the subject of whether or not they are likely to leave soon in order to marry or have children [Ferry et al 1982, page 28].

Similarly, a study of the hiring of scientists and technical staff at the National Health Service found that employers often assume

> that all women will leave to have babies and that wastage due to pregnancy is greater than for any other reason. The pervasiveness of [this myth] was shown by the way in which they influenced practices at selection (for instance, only women were asked questions about marital status and dependent children). They also influenced notions of who can be a manager [Homans 1987, page 90].

[4] I have been told that childcare was arranged for this year's AAAI.

So even if a woman chooses not to have children or not to take time out to raise them, employers will often assume otherwise and treat her accordingly. Furthermore, pregnancy does not always cause women to miss much work. An army study found that "even when pregnancy leave is included, [enlisted women] take less time off than men, who lose it to sports and auto injuries and drug, alcohol and discipline problems" [McNeil 1991].

Power can be another factor in why women choose not to be professors. The following was written by a woman who had been a professor but had switched to an industrial research position:

> A year ago I would probably have agreed with the popular conclusion that academia is difficult for women because of the time demands, coincidence of tenure with child-rearing, etc. After a little more than a year in industry, I've discovered another reason that academia can be difficult for women. I now believe that to be highly successful in academic research, one has to be very interested (invested?) in having power. Power over grants, over students, over committees, etc. I often heard professors referred to as empire-builders, something that I see very little of where I am now. Often the most successful researchers in my current environment are the ones who actively *avoid* politics and power-struggles and just 'do their work'. As a woman I don't think that I am especially comfortable or adept at the power-games that I witnessed in the university.

Of course, there are also men that dislike power and women who revel in it. Nonetheless, the tendency of women to be less comfortable with power than men may hold in our current society.

2.6.2 The Hacker Culture

Some hacker subcultures have the property that the hackers spend nearly all of their waking hours, and miss sleep, to use the computers. In his discussion of the absence of female hackers, Levy writes: "There were women *programmers* and some of them were good, but none seemed to take hacking as a holy calling the way Greenblatt, Gosper, and the others did" [Levy 1984, page 72].

Another hacker classic, Tracy Kidder's *Soul of a New Machine* describes the intensity of the designers of a new computer:

> Going to work for the Eclipse Group could be a rough way to start out in your profession.... [Y]ou don't have any time to meet women, to help your wife buy furniture for your apartment, or to explore the unfamiliar countryside. You work.... You're working at a place that looks like something psychologists build for testing the fortitude of small animals, and your boss won't even say hello to you.
>
> New and old hands told the same story. Chuck Holland: 'I can hardly say I do anything else now. It takes about three days to get Eagle out of my mind, so if you have a three-day weekend, you're just sorry to see Monday come.' Microkid Betty Shanahan, the group's lone female engineer: 'You can end up staying all night. You can forget to go home and eat dinner. My husband complained that the last three times he's had to do the laundry.' Jon Blau: 'I've had difficulty forming sentences lately. In the middle of a story my mind'll go blank. Pieces of your life get dribbled away. I'm growing up, having all those experiences, and I don't want to shut them out for the sake of Data General or this big project' [Kidder 1982, pages 60–61].

I have been told that, after this book came out, MIT students lined up to interview with Data General, so the described work environment does appeal to some computer science students. In our society, however, women are often less willing or able to devote all of their life to a job, particularly because working full force is often difficult without a support spouse to take care of other parts of one's life.

When reading how intensely and single-mindedly the hackers work with computers, it is hard not to question the people who love the computer to the exclusion of all else, an opinion expressed by the writer of the following letter, written in response to [Markoff 1989], but equally applicable to the environment described in *Hackers* and *The Soul of a New Machine*:

> To the Editor:
>
> You regretfully wonder why women have not done as well at computers as men. You define the issue inside out. The problem is not women's experience with computers but men's. If a 'passionate romance' with the machine is the key to excelling, we should pity the men who do rather than the women who don't.
>
> I am not a feminist crank at either end of that interesting spectrum, but no girl or woman I know is so alienated from her fellows that she 'spurns the real world to master a universe locked inside a computer.'
>
> Machines do seem better suited for use than for passionate romances. So why regret women's attitude toward them? Why not worry about yet another generation of men who are sealing themselves off from human contact [Harrigan 1989]?

It is important to remember that women who do not throw themselves into the computer world might not be inferior to men but that sacrificing everything to computers might not be something that a psychologically healthy human being does. Perhaps men and women alike would be better off if some jobs and hacker cultures did not require giving up the rest of their lives.

2.7 Sexual Harassment

Because I take it for granted that readers consider sexual harassment to be offensive and harmful, I am writing little on the subject. It remains, however a serious problem. A recent survey of Harvard students and faculty revealed:

> Thirty-two percent of the tenured female professors, 49 percent of those without tenure, 41 percent of the female graduate students, and 34 percent of the undergraduate women reported having been sexually harassed by a person in authority at least once during their time at Harvard. Fifteen percent of the graduate students and twelve percent of the undergraduates reporting harassment consequently changed their academic plans because of it. Most did not report the incidents [Simeone 1987, page 115–116].

Other studies, such as [Baker 1990] find even higher percentages of women sexually harassed. See also [Gross 1991], an account of the hostile environment for women at Stanford Medical School, which was recently called to attention by the resignation of a female neurosurgeon.

2.8 Summary

Because computer workplaces are often overwhelmingly male, women find themselves in what sometimes feels like a locker room environment, having to put up with behavior they might find offensive, such as sexist or sexual humor and female pin-ups. Additionally, some men use sarcasm or insults to communicate more than women do, causing women to interpret the environment as hostile, even when no offense is meant. Also, because males often have different interests than females do, such as in sports, women may not feel as though they fit in. These factors can cause a woman to feel out of place in a computer workplace and make it difficult for her to picture herself as a computer professional.

Chapter 5

Recommendations and Conclusions

A taste for the abstract sciences in general and above all the mysteries of numbers is excessively rare; one is not astonished at it; the enchanting charms of this sublime science reveal themselves only to those who have the courage to go deeply into it. But when a person of the sex which, according to our customs and prejudices, must encounter infinitely more difficulties than men to familiarize herself with these thorny researches, succeeds nevertheless in surmounting these obstacles and penetrating the most obscure parts of them, then without doubt she must have the noblest courage, quite extraordinary talents and a superior genius — Gauss to mathematician Sophie Germain.[1]

As the data from women's career studies and anecdotes from personal experiences of women professionals begin to accrue, one of the questions that arises is not 'Why are there so few successful professional women?', but rather, 'How have so many been able to survive the vicissitudes on each rung of the career ladder?' — Dorothy Zinberg[2]

There are a large number of factors that discourage women from becoming computer scientists and computer professionals. From early childhood, females are treated differently from males, and, to become computer scientists, they often have to face problems that males do not have to deal with. In this chapter, I suggest how people can work to counteract these effects. Because this chapter is based so heavily on material earlier in the report, I recommend that earlier chapters be read first.

5.1 Recommendations

The recommendations are divided into four categories: programs that could encourage women in technical fields, ways for women to build their self-image as scientists, ways for women to deal with biased behavior, and suggestions for men and women who wish to encourage women in the sciences.

5.1.1 Programs and Policies to Encourage Women

Programs that could be implemented to encourage women are discussed by [Keith et al 1990, Leveson 1989, Sandler 1986], and interested readers are urged to read the full suggestions in these documents. Many of the following suggestions are from these sources. While the suggestions are geared to universities, most can be adapted to industry as well. Recommended actions are:

- *Making clear that sexual harassment will not be tolerated.* Individuals in supervisory positions, such as professors or managers, should make it clear that they will not tolerate sexual harassment.

[1]Bell, Eric Temple. "The Prince of Mathematicians", James R. Newman, ed., *The World of Mathematics.* New York: Simon & Schuster, 1956, volume I, page 333.

[2]Kundsin, Ruth B., editor. *Women and Success: The Anatomy of Achievement.* New York: William Morrow & Company, 1974, page 129.

Not only would this discourage such behavior, but harassed females presumably would feel more comfortable reporting any problems that do occur to supervisors who have made it clear that they are aware of the possibility of sexual harassment and want to fight it. One way an EECS department head did this was by announcing during a graduate orientation session that sexual harassment was unacceptable and that any harassment victims or witnesses should alert someone in a position of authority. See [Rowe 1981, Rowe 1985] for advice on implementing effective programs to fight sexual harassment.

- *Educating all members of the academic community — including board members, administrators, faculty, students, and staff — about professional climate issues; the various forms differential treatment takes; and the institution's commitment to ensure equitable treatment* [Sandler 1986, page 17]. One way many schools do this is by teaching about subconscious discrimination when training graduate students to be TAs.

- *Establishing a dialogue with women in the department to make sure their concerns are being communicated and addressed.* Many women have given thought to how their department could be improved but are never asked.

- *Regularly gathering data by sex, race, and age* covering areas such as salary, benefits, promotional analyses, special perquisites, awards, grants, courseload, advising load, committee assignments, and so on to determine if men and women at all ranks and within all units are treated equitably with regard to responsibilities and rewards [Sandler 1986, page 18].

- *Making equitable treatment of women and minorities part of the formal reward structure.* For example, when evaluating performance, give commendations to individuals and extra positions to departments that excel in this area [Sandler 1986, page 19].

- *Providing a method for individuals to turn off the tenure clock so they can have children without sacrificing their career.*

- *Providing opportunities for professors to serve as mentors to students or for graduate students to mentor undergraduates.*

- *Making sure that female students are involved in research.* Much of the information about research opportunities, particularly at the undergraduate level, is communicated informally, and some students may be left out. Additionally, if pre-college experience is a prerequisite for undergraduate research, women and minorities, who tend to enter with less experience, may fall further behind. This could be avoided by informing students what knowledge is needed for interesting jobs and encouraging them to take such classes early, or by setting aside money for research groups that are willing to provide training.

5.1.2 Ways for Women to Build Self Image

As described throughout this report, being a woman in computer science is unusual in that the majority of one's peers are male and many people, consciously or subconsciously, expect the men to perform better. These expectations are subtly communicated to both males and females. Fortunately, there are many ways that a woman can increase her self-confidence and her self-image as a computer scientist.

Attending Classes with Other Women

A female computer science student often find herself in a classes where she is one of the only women. Additionally, she is likely to have few, if any, female professors. Even in the absence of being treated differently, this is likely to affect a student's self-image and perceptions of women. In reality, females in coed classrooms are usually treated differently from the males:

> [T]eachers praise boys more than girls, give boys more academic help and are more likely to accept boys' comments during classroom discussions... While girls sit patiently with their hands raised, boys literally grab teacher attention. They are eight times more likely than girls to call out answers ([Sadker et al 1985] in [Van Nostrand 1990, page 187]).

(See also Section 1.2.1.) By taking classes at women's colleges or in women's studies, which almost always have a large majority of women, female students feel free to more actively participate in the classroom and are taken more seriously by teachers and other students. While advising technical females to consider single-sex high schools and colleges may appear counter-intuitive, particularly because these schools often have less adequate laboratory facilities, studies have shown that females at single-sex schools study more science and mathematics than those in coeducational schools [Kelly 1982, page 499], are more likely to continue in science [Ferry et al 1982, page 27], and are disproportionately successful compared to other women [Gilbert et al 1983].

Another advantage of women's studies programs is their emphasis on women's achievements. One female computer science student had the following experience:

> When I entered my first women's studies class, on literature written by women, I expected to encounter second-rate works that were only being taught when the ground rules eliminated male competition. Instead, the books were first-rate, and I wondered why I had never read them before. The class taught me that women's achievements had often been overlooked. (I had been pretty misogynic before that.)

Because of men's numerical and figurative dominance in engineering classes, a student in a women's studies course can find herself listening to vocal female students for almost the first time since entering college.

Another benefit of women's studies programs is that they document the barriers women have faced. It is important for women to realize that the paucity of women in the field does not imply that women are inherently unable and that negative behavior they encounter may be due to their sex and not to any actual shortcomings on their parts.

Female Role Models

Finding female role models and mentors can also be helpful to a woman's self-image. While male mentors are certainly useful, and many women are happy with male advisors, female role models serve the additional purpose of providing a living example of a successful female scientist. One study found that "[f]emale graduate students who identified female professors as role models viewed themselves as more career oriented, confident, and instrumental than did female students identifying male role models" [Gilbert et al 1983, page 597], although, as the report notes, self-selection may also have been a factor [Gilbert et al 1983, page 605]. As noted in [Leveson 1989, page 20]:

> The importance of mentoring and role models cannot be stressed too much. One female student ... wrote about her experience in a summer job working for a female manager who she described as: 'one of the most respected people in the company. I had never expected that having a female role model would change the way I felt about myself, but it did'.

Thus, a female student should consider finding a senior woman in her field to work for at school or during a summer job. While a person's sex should not be the primary factor in choosing a mentor, spending some time with a female role model can be psychologically beneficial. (See also [Simeone 1987, pages 104–109].)

Women's Groups

In part because female computer science students so outnumber female professors, one-to-one contact is not always possible. Many schools have get-togethers for women in computer science or engineering, ranging from informal annual meetings to regular meetings of the Society of Women Engineers. Women find these activities useful for receiving encouragement and advice, and they "generate a lot of good feeling" [Leveson 1989, page 23].

Perhaps the most effective group currently existing for women in computer science is an electronic mail discussion group with over seven hundred members which provides women with a "forum for discussion of both the problems and joys of women in our field and a medium for networking and mentoring" [Frenkel 1990, page 36]. Women share advice on female-specific topics such as the best time in one's career to have children, how to dress for conferences, and how to deal with sexism, as well as general-purpose networking. The list is particularly important to women in computer science because they are so dispersed and might not otherwise be able to interact with many other female computer scientists and engineers. Being part of a discussion group with hundreds of female computer scientists can change a woman's default image of a computer scientist from male to female (or neutral) — quite a difference from a student's academic experience, where two thirds of the computer science departments have zero or one female professors [Gries et al 1991].

5.1.3 Ways for Women to React to Biased Behavior

In cases of blatant sexual harassment, a woman can usually complain to some authority. In less clear-cut but nevertheless offensive situations, this option is often not open. While acting as a group and writing a report was effective for women at MIT [MIT 1983] and Carnegie-Mellon [CMU 1989], often women must react individually to behavior they find unacceptable.

Reacting to Subtle Discrimination

As discussed in Section 1.2.1, women are often the victims of subtle subconscious bias. For example, a woman may find that comments are primarily directed to men in a group, unintentionally leaving her out. If the woman does not feel comfortable directly confronting the individuals in question, there are more diplomatic methods of calling the behavior to the person's attention:

- In a meeting of three computer science students, the sole female found herself ignored by one of the male participants. Whenever she asked him a question, he directed his answer to the other male present. (See page 8 of this report.) After the meeting, the woman took him aside and mentioned that she had noticed he had directed his answers to [John] and asked, in a concerned way, whether she had done anything to cause this behavior. When he replied that she had not done anything wrong and began to apologize, she dismissed his apologies by saying that she was just relieved she had not given him any negative signals. He continued to apologize.

  The indirectness of her approach allowed the man to save face while still communicating the point. It appears to have been effective, because, when she saw the man later in the day, he made eye contact and spoke directly to her.

- At a social occasion, a young woman found that a male relative directed serious discourse almost exclusively to her brother and not to her. When the woman was alone with the relative, she said to him, 'I hope I haven't given you the idea I'm not interested in your opinions on [X]. I noticed you directed your comments about it to [John]. I want you to know I am interested in what you have to say on the subject.' The male relative replied, sincerely, that he had not realized she was interested in the topic and would include her in the future.

While some people might object to these oblique methods, as they involve the victim's pretending to put the blame on herself, they are effective in situations where the woman does not feel comfortable being more direct, and they often elicit an apology.

Reacting to Overtly Sexist Comments

Indirect methods are also often more effective than direct means for dealing with offensive sexist and sexual comments. As mentioned in Section 2.2.2, the only consequence of complaining is often that one is dismissed as a 'feminist'. In a recent column in *The New York Times*, a woman described her experience as a college journalist:

> Though I was militantly middle of the road in perspective, by the second time I mentioned sexism in print I was pegged. People I met seemed to treat me like a Marxist, a radical, a testosterone-fueled male-basher; others asked me why I suddenly hated men so much; and certain folks at home warned me that I was going to jeopardize my future by scaring off potential male suitors [Kamen 1990].

Two techniques that are often more effective than anger (even when justified) are role reversal, which involves the substitution of other terms for female terms, and humor. Combinations of these two techniques are especially effective.

Role Reversal Treating men in the manner in which they treat women can be an effective response to poor treatment:

- One female computer scientist said:

  > I'm much more often complimented for my dress, my hair, or my accent than for the content of what I say and do. So I just turn the compliments around and tell men how pretty their ties are, or how the cut of their jackets bring out their broad shoulders. They squirm under such scrutiny just as we do [Frenkel 1990, page 41].

- When a group of men were unable to understand why women in the workplace were offended by posters of naked women, a woman put up a huge picture of a naked man. She was asked to take it down, communicating her point.[3]

Substituting terms pertaining to race instead of sex can also be effective:

- Someone who does not understand why it is offensive to call a grown woman "girl" should be asked whether they would call an adult black male "boy", something that also used to be considered acceptable.

- A female computer scientist related the following story:

  > [A few years ago,] I wrote to Time Magazine to register my opinion about a 'humor' piece titled 'Women Are Getting Out of Hand', which included lines like 'Women are getting too big for their britches'. I suggested that they would not be likely to publish articles like 'Blacks Are Getting Out of Hand' or sentences like 'Hispanics are getting too big for their britches'.

See also the passages in Section 3.3.3, which, while impractical for conversation, also make the point.

Humor Humor is effective for several reasons. First, when men make offensive remarks, if someone protests, they retort: "Can't you take a joke?" When a woman uses humor to protest an offensive remark, she can offer the same response if challenged. Additionally, humor breaks tension and often allows one to point out that something is wrong without a direct confrontation.

One female computer professional told the following stories:

- Shortly after my appointment, my boss, V.P. of Administration, called a meeting to discuss the problems of the center. All of the attendees were male and deans or equivalent high positions. The discussion in that meeting was quite heated with adamant remarks about the problems in computing on campus. Towards the end of the meeting, one of the attendees started pounding on the table and reviewed the names of the previous male directors of the center, ending with the

[3] Actually, the reason she was asked to take it down was because a nearby man was afraid he would be suspected of being homosexual.

comment, 'No offense meant, [Jane], but we need a man in this job.' I responded with, 'I'm willing to do almost anything to fix the problems in the Computer Center, but a sex change operation is out of the question.'

That turned out to be the perfect response — I got my point across and it broke the tension with laughter. The moral of this story is, that if you can make your point with humor, the message goes down easier.

- Another time, I received in the mail an advertisement from a company that sells disk drives. The advertisement was included in a box that contained Havana cigars. (Obviously, this company assumed that the mailing list they had of CIO's were all men). I wrote a letter to the VP of marketing for the company telling him that I thought that one of his competitors were trying to undermine the intelligence of his marketing organization by sending cigars to female decision makers in his company's name. Two days later, I received a federal express delivery from him — it was a bottle of perfume with a letter of apology. I thought his response was a good recovery.

A computer science professor told the following story:

> [W]hen I first starting teaching 13 years ago, I was married at the time and both my husband and I had teaching positions in the same department. My department head was sitting in my class (at the time we were in a joint math and CS department and my department head was retraining). [O]ne day, one of my students referred to me as Mrs. [Smith] in class and I was feeling pretty frustrated by that point since I had noticed that I kept getting called 'Mrs.' while my husband was [called] 'Dr.', so I looked at him and said 'What do you call Karl?,' and he replied 'Dr. [Smith]'. So I told him that I'd appreciate it if he would use the same title for me since I had the same degree. Well, he wasn't the type to quiet down quickly, so he retorted, 'And what does Karl think of your feeling that way?,' to which I replied angrily, 'It doesn't matter what he thinks; it was a helluva lot harder to get a Ph.D. than it was to get married.' Word apparently got out to the students after that because I wasn't called 'Mrs.' for quite some time. (Of course, I was shaking by the time class ended wondering what my department head thought of that reaction. He never did say anything about it.)

Female computer scientists have combined the techniques, role reversal and humor, as in the following incidents:

- A female computer scientist reported:

> A few years ago I was at a workshop held way out in the country.... There were about forty people there. I don't remember how many were women, but there couldn't have been many.
>
> At one point we were sitting around singing, and after a while someone started one of those make-up-a-verse of your own affairs.... It went around for a while, and someone offered,
>
> I know a girl, her name is Jill.
> dum-de-dum de dum-dum-dum-dum
> She won't do it, but her sister will.
> dum-de-dum de dum-dum-dum-dum
>
> Well, I can't carry a tune in a bucket, but I co-opted the next verse:
>
> I know a guy, his name is Bill.
> dum-de-dum de dum-dum-dum-dum
> He won't do it, but his brother will.
> dum-de-dum de dum-dum-dum-dum
>
> Everyone laughed, and I thought the matter was settled. But some people won't give up, and a few rounds later, the *same* fellow came around with:

I know a girl, her name is Sue.
dum-de-dum de dum-dum-dum-dum
She won't do it for me, but she'll do it for you.
dum-de-dum de dum-dum-dum-dum

Drat! Can't back down now ... I got as far as:

I know a guy, his name is Lou....

when the *rest* of my colleagues shouted down the offender.

- A female computer science graduate student reported the following incident:

> A [campus] career recruitment poster, several years ago ... made quite a splash. The poster portrayed two men in shirts and ties picking up a printout off a line printer, dropping the fanfold paper all over the floor as they ogled at a woman walking by in a miniskirt. The caption: 'We think about more than just work here at [Company Name].' Outraged women began tearing the posters off the walls, then (insert light bulb here) they instead made photocopies and put them up in great numbers all over campus. Meanwhile, the recruiters figured out something was wrong and tried desperately to get rid of them. A number of women went to the recruitment talk to disrupt it, and found that they were the only ones there. Several hack posters were created, for example one with two women in businesslike garb poring over a printout while a scantily clad beach-boy type walked by, with the caption, 'We think about more than just sex here at [Company Name].' I believe the president of the company issued a formal apology afterward. This one is notable as much for the reaction of the student body as for the poster itself.

5.1.4 Ways for Individuals to Encourage Women

Most of the suggestions in this section involve avoiding behavior that was described elsewhere in the report as potentially offensive. Because the reader is assumed to have read the rest of the report, a minimum of justification appears in this section.

Fighting Subconscious Bias

As described in Section 1.2.1, many people treat men and women differently without realizing it. Once people understand that it is possible for a well-meaning person to unintentionally discriminate, they should train themselves to oversee or spot check their behavior to make sure they do not behave in such a manner. Anecdotal evidence suggests that, once people become aware of subconscious bias, they often catch themselves behaving in such a way. This is true of women as well as of men. Fortunately, once a person is aware of the problem, the behavior is usually easy to change. Examples of behaviors to avoid are:

- Assuming, without any information, that women should be given easier questions or projects than men.
- Paying more attention to remarks made by men than by women.
- Assuming, when introduced to a team, that a male is the leader and primarily addressing comments to him.
- If a man, being more friendly and encouraging to male peers and subordinates than to females, even if it is out of a desire to avoid having one's friendliness mistaken for flirtation.
- Assuming that a woman will not pursue her career as seriously as a man because she will leave her job to have children. While some women take time off for children, all women (and no men) are hurt by this prejudice.

Additionally, one can help counteract another person's subconscious bias by either discreetly calling it to the person's attention or by directly offsetting it. For example, if a female colleague keeps getting interrupted or ignored, one can express interest in what she is saying without directly telling people to listen to her, which might be interpreted as patronizing.

A female graduate student provided me with some positive examples of how her advisor treated her. In addition to generally treating her with respect, by giving her challenging projects and the necessary resources to complete them, there were two specific things he did that especially impressed her:

- When the student was preparing a paper the two of them co-authored for a conference, she made a dozen copies to send in, as required by the program committee. When her advisor saw her collating them, he told her that she should have had the group secretary do that. The student was impressed with this remark because she felt other professors might see nothing wrong with a female's doing clerical work but would have only redirected male students to a secretary.

- When the student proofread a paper for her advisor, he thanked her by name in the acknowledgments "for her careful proofreading of this paper and [acknowledged] her ongoing study of [related research area]". By mentioning her research area, the advisor made clear to readers that, despite her female name, she was not a secretary.

Avoiding Unintentionally Offensive or Discriminatory Behavior

While any well-intentioned person avoids behavior that they know to be offensive, some people do not realize that certain behaviors, discussed throughout this report, offend some women. Good intentions are no guarantee that women will not get the wrong message. For example, a woman might feel uncomfortable with a man who has revealing pictures of women on his walls or computer screen. Additionally, by not using language that could be interpreted as sexist, such as "he" for the generic computer architect and terms like "manpower", women feel more included. One positive example is the name on a sample application for the United States Department of Defense fellowships, included in the instruction booklet: "Smith, Dana Robin." Both "Dana" and "Robin" can be either female or male names. Another positive example is the alternating usage of "he" and "she" as the default singular program in chapters of the influential *Computer Architecture: A Quantitative Approach*, by John Hennessy and David Patterson. There are many guides to "nonsexist" communication, such as [Persing 1978].

Someone who supervises a research or work group or organizes its events should try to choose activities at which all group members would feel comfortable. While it is not always possible to choose an activity that everyone relates to — for example, some people are uninterested in any sport — an effort should be made to include everyone in at least some of the social occasions. I have seen people repeatedly left out of social activities springing from the workplace because they are poor athletes or disabled, have unusual dietary requirements, or do not drink alcohol. Anyone who cannot socialize with the group will not feel as though they fully belong. (Conversely, anybody who does not want to socialize with the work group, for whatever reasons, should not be made to feel unwelcome as a worker.)

Encouragement

Some professors rarely encourage or praise their students, but such encouragement, even if just a few spoken words, is greatly appreciated and rarely forgotten [Widnall 1988, page 1743]. For example, suggesting that a student consider graduate school can make a substantial difference [Leveson 1989, page 23]. In one survey of female scientists, "[t]he encouragement of teachers — along with that of fathers — was the influence most frequently quoted as steering [them] towards science" [Ferry et al 1982, page 27]. In practice, women often do not get encouragement from teachers and guidance counselors ([Cooper Union 1989] in [Baum 1990, page 48]). While encouragement should be directed to worthy males and females, it has greatest effect with people who receive little encouragement and who have low self-esteem, often women [Zappert et al 1984, page 8]. (See, for example, page 7 of this report.)

Additionally, it is important for parents to encourage their daughters as well as their sons in technical areas. "According to one computer camp director, 'Mothers bring their boys to the classes. Girls have to beg to enroll'" [Hess et al 1985, page 201]. Even if parents do treat their children equally, it is impossible to make girls feel that it's as normal for girls to use computers as it is for boys, with all the biases in our society (Section 1.1.3) and in children's toys and computer games (Section 1.1.2). Nevertheless, it is clearly important to encourage one's daughters, and many female computer scientists attribute their career choice and success to parents who encouraged them.

5.1.5 Discussion

Readers will notice that there are many situations for which I made no recommendations. For example, I had no advice for the woman who told me about dining with a group of men after a conference who then began telling jokes that were specifically degrading of women. I also have found myself with nothing to say when a brilliant female graduate student says she avoids a certain research area because of the specific men at the university involved in it. Unfortunately, there is a substantial class of behavior which is both offensive and non-actionable.

5.2 Conclusions

A common thread through the previous chapters is that, 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. Additionally, when companies direct technical games and products to men, their intent is not to perpetuate stereotypes but to target the largest existing audience. That some women feel uncomfortable in mostly male environments is not primarily a result of men's trying to make them feel unwelcome but of dynamics resulting directly from the male majority and societal sex-based differences in behavior. 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 described in this report are so varied and decentralized that there is no simple way to level the playing field.

One positive factor is that women and other underrepresented groups are becoming a crucial resource pool. The number of white males of college age is decreasing, while the need for engineers and scientists is increasing [Leveson 1989, page 7]. I have been told this is causing even the most conservative businessmen to begin aggressively targeting women and minorities as highly-trained technical workers.

Another reason for optimism is seeing how greatly the situation has changed. Although discrimination against women continues, it is nothing compared to the level earlier this century or in the previous one, as some of the quotations at the beginning of chapters have indicated. Unfortunately, there has been retrograde motion before: In the 1920s, feminist activity reduced sexual discrimination at prestigious universities, but "this trend toward equity was reversed in the 1930s and not resumed until the 1960s" [Simeone 1987, page xi].

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