- MIT has an outstanding ombudsperson, Prof. Mary Rowe, who deals with bias complaints effectively and tactfully. She is a pioneer in the study of subconscious bias [Rowe 1990, Rowe 1981, Rowe 1985].

Each of these points does not hold for many other computer science departments.

A.4 How to Obtain Additional Copies

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2. Type: **ftp ftp.ai.mit.edu**, or, if that fails, **ftp 128.52.32.6**
3. At login prompt, type: **anonymous**
4. For password, enter your user name (or any string)
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Appendix B

Sex-Based Intellectual Differences

> *I deny that anyone knows, or can know, the nature of the two sexes, as long as they have only been seen in their present relation to one another.... What is now called the nature of women is an eminently artificial thing — the result of forced repression in some directions, unnatural stimulation in others.* — John Stuart Mill[1]

> *Dr. Edward H. Clarke's book Sex in Education, or a Fair Chance for the Girls [1873] was the great uterine manifesto of the nineteenth century. It appeared at the height of the pressure for co-education at Harvard, where Clarke was a professor, and went through seventeen editions in the space of a few years. Clarke reviewed the medical theories of female nature — the innate frailty of women, the brain-uterus competition — and concluded, with startling but unassailable logic, that higher education would cause women's uteruses to atrophy!*[2]

Research on Biological Differences

A large amount of research has been done on biological sex-based differences in various kinds of intelligence. Sociobiology is a tricky field, because it is difficult to separate the effects of environment and genetics on individuals. As this report has shown, environmental differences can be immense. Many studies in this field have been flawed by the lack of adequate controls. For example, some studies

[1] Mill, John Stuart. *The Subjection of Women*, MIT Press, 1972, page 22.

[2] Ehrenreich, Barbara and Deirdre English. *For Her Own Good: 150 Years of the Experts' Advice to Women.* New York: Anchor Press/Doubleday, 1978, page 115.

of differential mathematical ability have failed to take into account that the male subjects had taken more math courses than the females [Petersen 1980, page 33] or used different types of toys as children. Researchers have generally found that men tend to have superior spatial ability, while women have superior verbal ability, with both differences developing at puberty [Petersen 1980, pages 31–33]; however, the interplay between biological and social influences is not yet understood [Petersen 1980, Kramer et al 1990]. As discussed earlier in the report, boys are given more toys that would encourage development of spatial skills, while girls are spoken to more by adults. The argument for biological differences, however, was recently bolstered when Doreen Kimura found "that hormonal levels can affect people's performance on certain verbal and spatial tests" [Holloway 1990, page 40].

Reactions

People's reactions to these facts vary. Some people conclude that it justifies women's lack of participation in traditionally-male fields. However, powerful arguments exist against taking such a stand:

> [B]iological factors cannot be the complete answer. In other countries, particularly in Eastern Europe, large numbers of women study science successfully, despite any biological handicap. Nor are biological predispositions necessarily relevant when formulating education policy. Girls usually score better than boys on verbal tests, and boys have more difficulty than girls in learning to read. But schools do not take this as a reason for letting boys drop out of reading classes. Quite the reverse: most schools have remedial reading classes which are used predominantly by boys. Teachers put extra effort into teaching boys to read to make up for any deficiency, whether its origin is biological or social. The same could be done to boost the spatial ability of girls if the problems were considered equally serious [Kelly 1982, page 497].

Additionally, the field of feminist technology argues that technology can legitimately be taught in a manner that plays more to women's strengths, be they biological or environmental, not relying so heavily on fields like mathematics in which men currently outperform women. For example, Sherry Turkle and Seymour Papert found:

> When we looked closely at programmers in action we saw formal and abstract approaches; but we also saw highly successful programmers in relationships with their material that are more reminiscent of a painter than a logician. They use concrete and personal approaches to knowledge that are far from the cultural stereotypes of formal mathematics [Turkle et al 1990, page 128].

Student programmers with the less mathematical style, sometimes men but usually women, are discouraged when in classes that force a more mathematical approach [Turkle et al 1990, pages 131-132]. Turkle and Papert advocate "epistemological pluralism", in which different approaches are allowed to flourish. Similarly, Sally L. Hacker argues convincingly that more mathematics than necessary is required by engineering programs, weeding out students who would be able to succeed as engineers if they did not have to pass timed calculus exams [Hacker 1983]. As one female computer science professor writes:

> [T]here's a committee at the [X] engineering school trying to redesign the school-wide common core curriculum, for freshman and sophomore years. I asked our department's representative to the committee to bring up that the current common core tends to discourage females and minorities because it's too heavily math and engineering oriented (and most of these courses are not needed for CS), and does not provide options to take courses in more people-oriented fields (that are relevant to CS) such as psychology. Apparently the committee chairman said to our representative something to the effect that it is not the mission of this committee to address women and minorities, and thus he would not put this issue on the agenda.

Conclusion

It seems possible that there are biological differences in the way men and women think; certainly, there are currently differences in men's and women's thinking styles. There is no way to tell now how great the biological differences are. While they may imply that women will never reach parity with men in computer science and in engineering, there are two major reasons to believe that women's roles can increase greatly from today's: First, as shown throughout this report, females face immense cultural barriers. Second, as alluded to in this appendix, many technical fields play to men's strong areas. Computer science is built, in large part, on mathematics, which relies on spatial ability. Computer programming, however, does not in itself require spatial ability, and some areas of computer science, such as user interface design, require more knowledge of human psychology than mathematics. Additionally, sex-based differences are a tendency, and their degree of effect in an individual cannot be known.

Appendix C

Advantages for Women

When writing in the body of the report of all the disadvantages women face, occasionally an advantage for women would come to mind. In the name of fairness and in order to end the report on a positive note, I am including them here:

- The flip side of a woman's being less likely to have a spouse devoted full-time to supporting her career (page 32) is that she is more likely to have a spouse who earns money. A female engineer told me how her husband's income allowed her to quit a job she hated and spend three months looking for one that she loved.

- Although males outperform females in mathematical ability, females outperform males in verbal ability (page 83). In the academic world of "publish or perish," being able to write clearly and properly is a large plus.

- If people are more likely to help members of the same sex (page 30), and if women are currently raised to be more sensitive than men (page 20), women will get tremendous support from their same-sex peers. (I have found my female colleagues extremely supportive.)

- It is not entirely disadvantageous that girls tend to be taught how to cook and keep house instead of how to fix bicycles (page 9). Being able to cook for oneself at college is healthier and cheaper than having to rely on cafeterias or junk food.

- While all women are to some extent penalized out of the suspicion that they will take time off their career to have children (page 33), they have more freedom to do so than men. A woman's career can be salvaged if she takes time off to spend with her young children, but a man would be considered insanely irresponsible.

- Ingenuity can transform other disadvantages into advantages, as explained in Betty Lehan Harragan's wonderful *Games Mother Never Taught You.* For example, she points out that, while women hate being constantly in the spotlight, men "fantasize about how well *they* could exploit such a favorable situation.... Today's pioneer women can begin taking command of situations by merely accepting their unique position in the spotlight" [Harragan 1987, page 311].

Most important, with a positive attitude, women can make the most of their situation. The successful female computer scientists I know do not say, "I could have gone further if I were a man." They say, "I had to work a lot harder than a man to get where I am." Although the two statements may be equivalent, self-assuredness is psychologically more useful than self-pity. Additionally, even women who have been discouraged sometimes succeed out of spite.

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