

WOMEN GRADUATE STUDENTS IN ENGINEERING

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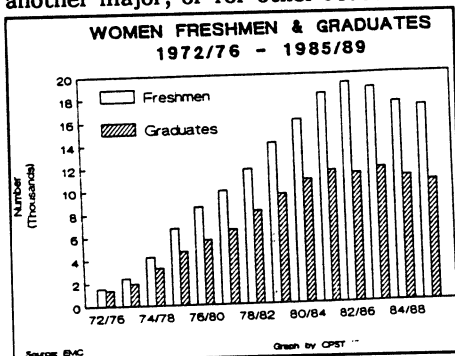
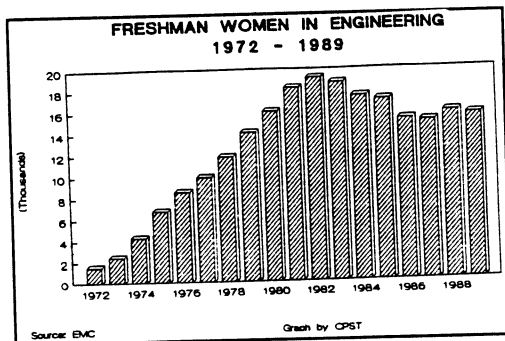
Commission on Professionals in Science and Technology
Washington, D.C.

Although women stopped increasing their share of baccalaureate enrollments and degrees some time ago, so that graduate enrollment has had a chance to catch up with the steady increases experienced earlier, women are not enrolling and remaining in graduate school in the same proportions as their undergraduate participation. This is unfortunate because employment opportunities for women engineers with graduate training are excellent and expected to get even better.

Undergraduate participation also is dropping numerically, because of decreases in the college age population, and has stopped rising as a percentage of total enrollment at the 15, instead of the 50 percent level that would represent parity.

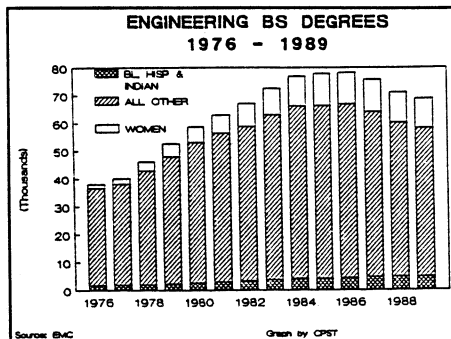
Freshman enrollment of women peaked in 1982, and dropped by 4,000 women, or 21% of the total, over the next four years. The slight upturn in 1988 probably is related to the one year increase in births 18 years earlier.

We lose far too many of these freshmen before the baccalaureate, either because they find they do not like the field, and transfer to another major, or for other reasons. It is rarely related to failing grades.



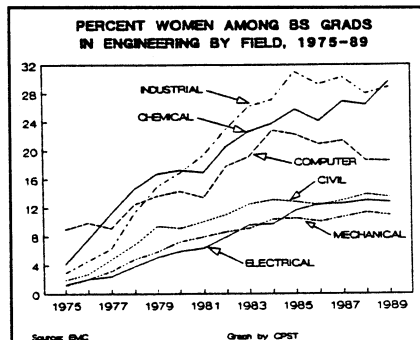
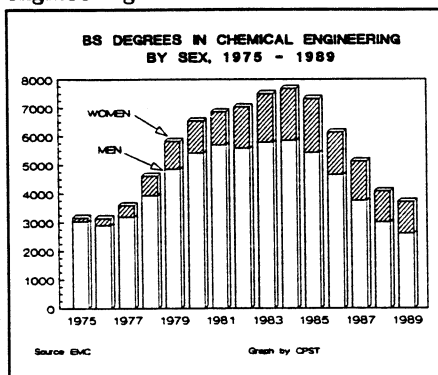
Although not a true retention rate, measuring as it does the graduating class against the freshman class four years earlier, and thus ignoring both the inflow of students after the freshman year, from other majors and from two year institutions, the ratio of freshman women to graduates gradually declined through the first half of the 1980s, and the dropoff for women remains somewhat higher than for men.

Women never earned more than 15 percent of the bachelor's degrees, although at particular schools and in some engineering fields, their presence is much greater than that. Their relative share of bachelor's degrees is somewhat greater than the share earned by black, Hispanic and Indian graduates, but of course, in the figure, minority women are counted twice, thus under-emphasizing the continuing predominance of white males among engineering graduates.



Over the past decade, the subfield choices of women have changed (as also is true for men), with higher proportions selecting electrical and industrial engineering, while smaller proportions were choosing chemical and civil engineering.

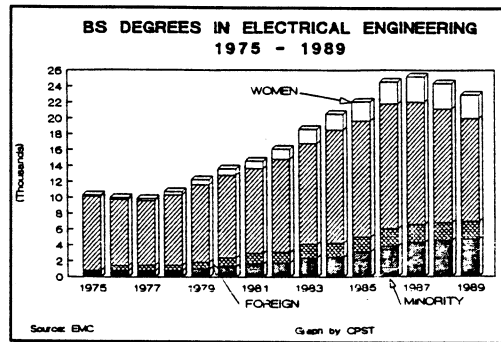
Women's representation increased in every field of engineering from the mid-seventies, but is most notable in chemical and industrial engineering. Computer engineering rose and fell.



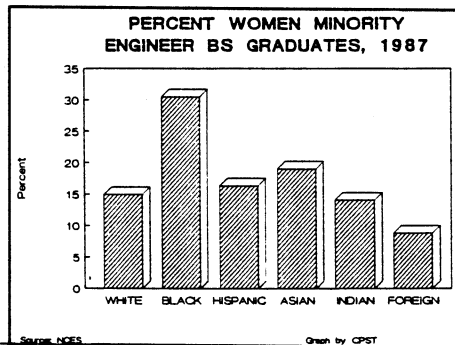
It is interesting to look at some of the individual fields. Chemical engineering has a high proportion of women among graduates, relatively speaking, but has fallen out of favor with both men and women. Degrees in chemical engineering

rose sharply in response to heavy demand in the late '70s and early '80s, but fell even more sharply from 1984 to 1989 as the oil crisis gave way to a relative glut. In 1990, chemical engineers are in such short supply that salary offers to new BS graduates are up 7% from last September to an astonishing \$35,204 average! Women in the field get higher offers than men. Average offers to master's graduates in chemical engineering are \$37,032, and offers to doctoral candidates average \$50,457! So although the starting salary offers are a strong temptation to any BS graduate, the PhD offers also are excellent.

Although more women earned EE bachelor's degrees than were earned in any other field of engineering, their percentage of total degrees in the electrical/electronic field has never reached the 13 percent level because EE also has become the largest field of choice for men and for foreign students, also mostly men. Salary offers to this group also are very high, averaging \$31,628 at the bachelor's level, \$36,776 at the master's level, and \$55,900 for PhDs.



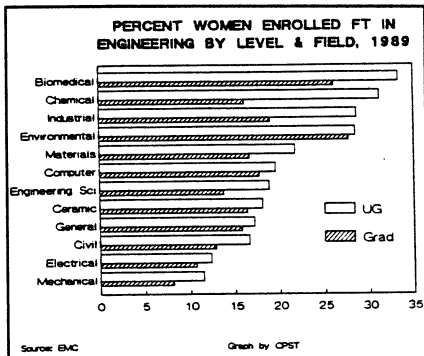
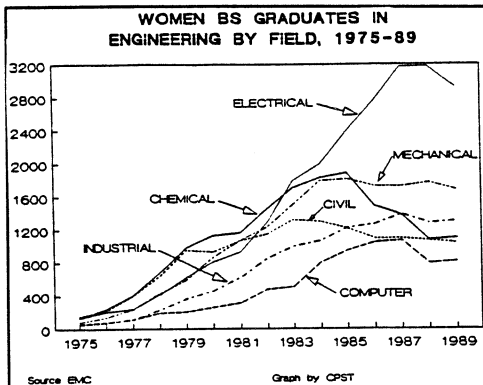
In contrast, civil engineering has been losing ground to other engineering disciplines, dropping from 21 percent of BS engineering degrees in 1975 to 11 percent in 1989. Starting salaries have lagged in this field, along with student interest from both sexes. For comparison, starting salaries are \$27,645, \$32,076 and \$37,200. Women average 13.2 of BS graduates in recent years.



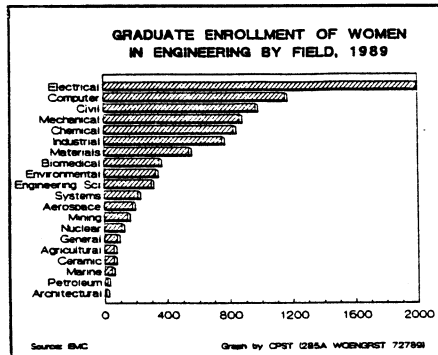
Most data sets on engineering enrollments and degrees double count minority women. But they are in some ways quite different in their representation among persons of the same racial or ethnic group. Black women make up almost one third of black BS recipients in engineering, compared with white women who are only 15 percent of white recipients. Both Hispanic and Asian women have higher representation within their racial/ethnic group than is true for white

women. Women are least likely to be found among foreign graduates, and this, in turn affects women of all racial and ethnic groups because of the high preponderance of foreign men among both graduate students and faculty in engineering. The language barrier affects both men and women, but the cultural differences of the foreign students relative to their feelings about the importance of helping women prepare for careers in traditionally male fields sometimes result in difficulty for women students, both undergraduate and graduate.

It is important to note that although black women appear to be entering engineering in higher ratios than other women, their representation among black graduates is as much the result of the poor showing of black men as it is of the higher participation of black women.

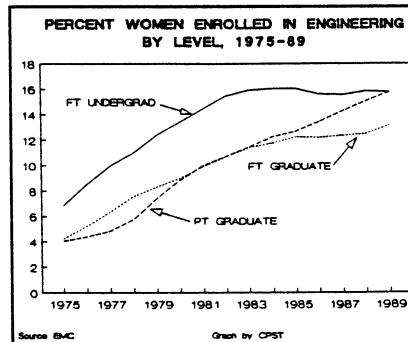


Graduate enrollments depend on bachelor's graduates. The number of degree awards at the BS level is now dropping in every field. This is true not only for women, but also for men.



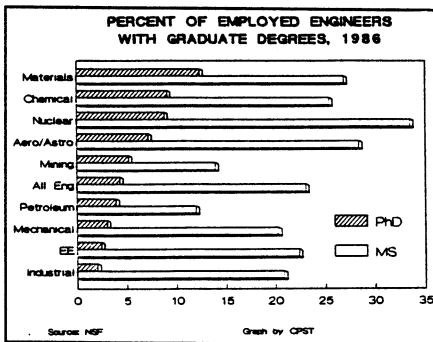
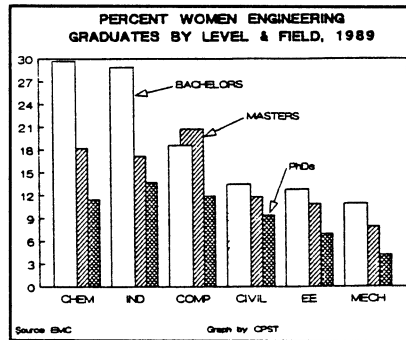
Numerically, the largest numbers of women enrolled at the graduate level are in EE, followed by computer, civil, mechanical, chemical and industrial engineering. However, the higher percentages of women enrollees at the graduate level are in biomedical and environmental engineering, where there are fewer students of either sex enrolled.

It is also interesting to compare the percentage of women enrolled at the undergraduate level with the percentage among graduate students in these same fields. Women's representation among graduate students in chemical engineering, for example, is only half of the representation among undergraduate chem engineering majors.



Comparing women's share of total undergraduate enrollment and graduate enrollment at the same time shows that among part time graduate students, the percentage of women had reached the level for full time undergraduates by 1989. Probably most of the part time graduate students are employed full time, and seeking a master's degree. Among full time graduate students, however, the percentage of women levelled off from 1985 to 1988, well below the percentage of women enrolled as undergraduates.

By 1989, women earned a substantially higher percentage of chemical and industrial engineering bachelor's degrees than was true for either master's or doctorates, but other major fields show closer outcomes. Chemical engineering is the one field where current data can be cross checked from two sources - namely the Engineering Manpower Commission and the American Chemical Society. Both report women earning 30% of the bachelor's degrees in chem engineering, 19% of the master's degrees and only 13% of the PhDs in 1989. Why do women drop off the educational ladder in chem engineering at so much faster a pace than men, and faster than they do in other engineering fields?

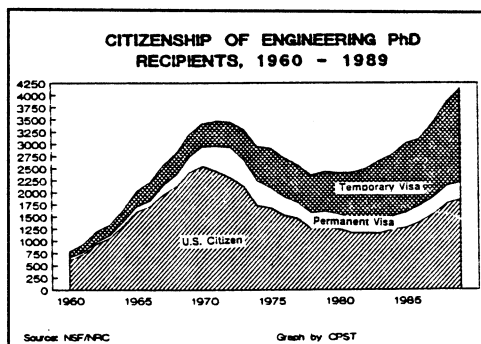


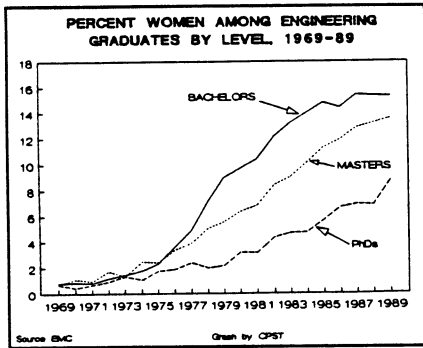
This dropoff is especially worrisome when chemical engineering is second only to materials engineering in the proportion of doctorates among its practitioners. Are undergraduate women in this field (and others) getting good advice about graduate study?

Of course, men in engineering are substantially older than women in the field, and women may not yet have had sufficient time to catch up in graduate programs at least to their baccalaureate

level. However, the age difference also means that a lot of men will be retiring, and women who are prepared with graduate degrees to move into the research and teaching positions that are vacated will be ahead of the game.

As you know, more than half of all engineering PhD awards from American Universities since 1980 have been to foreign citizens. Some of them have permanent visas and will undoubtedly become a part of the American labor force, and some, even with temporary visas, will want to and be able to change their visa type at some later stage. They are an important addition to our workforce. But these foreign graduates are even less likely to include women than is true for American students!





Despite several years of stable output at the bachelor's level, women have not moved very close even to that small 15 percent participation for master's and doctoral degrees in engineering. The sharp increase in PhD awards to women in 1989 is encouraging, but the numbers are so small that even if half of all PhD women wanted to accept faculty positions, and every engineering school wanted women faculty, each school could hire only one woman every four years for one of its departments. It is difficult to see much

chance to increase the percentage of women on engineering faculties beyond its present 2.7 percent at present rates of production. And it is notable that despite the small fraction of the foreign graduates among PhD recipients who are women, the very high fraction of foreign graduates among the engineering doctorates means that only two thirds of the 373 women earning engineering doctorates in 1989 were American citizens.

Looking only at American recipients, and specifically at women and minority men, we see a very discouraging set of numbers. White women and Asian women show a sharp increase in 1989 from 1988, but only eleven doctorates were awarded to black, Hispanic and American Indian women combined! Women faculty as role models will still be rare at the end of the next millenium!

