

## AN IMMODEST PROPOSAL: A WOMAN'S INSTITUTE FOR ENGINEERING

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*If historically black colleges and universities enroll 18% of students but produce 50% of students with baccalaureate degrees in science, computer science and engineering, what would happen if there were a separate degree granting institution in engineering for women?*

### Background

A rising concern that women and other minorities in the U.S. should be encouraged to enter and stay in science and engineering was eloquently brought to national attention in the Presidential Address delivered at the Annual meeting of the American Association for the Advancement of Science by Professor Sheila Widnall of MIT in 1988. <sup>(1)</sup> This "problem" has been brought to national attention not because of equity but because of economy. By the year 2,000 85% of new entrants to the work force will be women, minorities, and immigrants. It is now clear that a dramatic increase in the supply of scientists and engineers is required to maintain our competitive posture. And given demographic reality, increasing the number of women (as well as under-represented minorities), is one of the only solutions. There simply won't be enough. Why aren't more women seeking careers in engineering? Why haven't we been more successful?

The numbers tell part of the story. For the past several years, the percentage of women in engineering appears to have stabilized between 14 and 15.5 percent. The percentage of all B.S. degree holders in science and engineering who attained a Ph.D. degree has dropped from 12% to 6% over the past 20 years <sup>(2)</sup>. And while in engineering the number of Ph.D's obtained by U.S. citizens per year fell by more than 50% between 1970 and 1984 <sup>(3)</sup>, this downtrend may be over! 1,927 Americans earned doctorates in science and

engineering in 1990 compared to 1,225 in 1980. Women earned 9% of engineering doctorates in 1990, up from 3% in 1980 (4). However, over the past decade or so, a declining number of women with doctorates in the life sciences and engineering have entered teaching (from 1978-88 the number in the life sciences declined from 48 to 36 percent, in engineering from 38 to 22 percent. In the physical sciences the numbers increased by 7 percent). Of those who do enter the academy too few receive tenure. In 1987, for example, only 18% of women with science Ph.D.'s were full professors compared to 46% of men. 25% of women with science Ph.D.'s were Associate Professors compared to 24% of the men. 29% of women with science Ph.D.'s were Assistant Professors compared to 15% of the men (5).

Part of the reason is sociological and historical. Dr. Lilli Hornig described how in a 1964 conference on "Women and the Scientific Professions" held at MIT, several authors essentially judged women's potential and legitimacy to these professions as inferior. "... Providing more of them with access to education and employment might help them to realize such potential as they have, but given the perceived necessities of family life and adaptation to even a cooperative husband's legitimate professional and personal demands, no one holds out much progress of equal achievement . . .", Hornig sums up the presentations (6, page 45). Subtle quota systems such as availability of "female beds" in dormitories and differential admissions and financial support policies in graduate schools "rationalized on the grounds that women were unlikely to practise their professions" were also factors that served as barriers to women's entry even after the Civil Rights Act of 1964 (6). Women returning to work often found the prerequisites for the study of sciences and engineering prohibitive.

But given that 50% of all the Bachelors' degrees awarded in 1990 went to women it makes sense to ask why it is that only 9% of Ph.D.'s in engineering (4), are granted to women. While we recognize that questions must be asked and answered about how to encourage girls to enter academic tracks that would enable them to pursue higher study in engineering, in this paper, we address the questions of how to sustain and nurture the intellectual pursuits of the women students who have chosen engineering as a major in college.

Many people have reported that continuing to pursue a career in engineering with confidence requires not only the interest, intellectual ability and dedication to work, but a certain sense of "entitlement" - the feeling that she has a right to be in that career just as much as anybody else. Surveys of engineers by Dean Eleanor Baum of Cooper Union and by us, indicate that this may indeed be true. While most women answer that they chose engineering because of an interest in science and mathematics, a large fraction also say that their father or brother is an engineer, in response to the question "Why did you choose engineering as a career?" (7,8). Can women persist in engineering only if they see it as a birthright? Our survey respondents also answered that persistence in engineering requires a high degree of self-confidence and a tendency to work harder than their peers in other fields. Is this self-confidence correlated with the experience of seeing a father or brother at their daily work as an engineer?

First, most young women, like most young men, do not consider engineering careers because they don't know anything about them. But unlike young men, this seems more daunting for women. Indeed, we hold that only that small fraction of the population who has the confidence and the willingness to work harder chooses this male-dominated field. Perhaps it is because this number is small that the number has stabilized at about 10-12%.

#### How Can We Entitle More Women To Enter The Field?

We clearly need precollege and early college programs which allow women (as well as men) who have never thought of engineering to test their real interest in engineering. We need to provide more students an opportunity to take real engineering courses and discover whether they would like it. The need is more than an occasional "role model" visit to high school classroom would provide (9).

We also need to provide a supportive environment for all undergraduates in engineering - one where their voices are heard, experiences appreciated, and evaluated in ways which make sense to and for them. Third, we need to sustain this in graduate school, an area which has been particularly daunting for women. Finally, we need to sustain women as they become faculty members. Given the complexity of women's lives, this means structures and supports which understand this complexity, and transform the working relationships in the academy and eventually in society.

### The Case For A Women's Institute

For the sake of discussion, we propose that one means of increasing the numbers of women in engineering would be the development of a separate degree-granting institution for women in engineering, or the development of an engineering program at one of the existing women's colleges. Extrapolating from the experience of women's colleges, we have impressive data on the value of single sex education for students and graduates. While it is clear that attending any selective undergraduate institution increases the chance of attending a prestigious graduate or professional school, gender composition also appears to make a difference. There is clear evidence that attending a single-sex institution is associated with higher levels of persistence and educational attainment for women in general <sup>(11)</sup>. When we control for characteristics such as educational aspirations, family background and high school achievement, colleges for women still have a net positive impact on both aspiration and enrollment in graduate and professional schools. These results have been verified by studies of change in educational plan during college and enrollment in gradual or professional school <sup>(10)</sup>. Looking at education through the doctorate, Gruca's 1988 study <sup>(11)</sup> indicates that the percentage of women in the institution had a signify positive indirect effect because if had a significant direct effect on achievement. The evidence supports the claim that women's college provides a uniquely supportive climate.

Research suggests that a large number of women faculty as role models may have an impact on educational attainment. Particularly impressive are studies which look at the relationship of institutional gender to career achievement. The most comprehensive series were done by Tidball (1973, 1974, 1976, 1980, 1985, 1986), and Tidball and Kistiakowsky (1986) <sup>(11)</sup>. This work suggests that graduates of women's colleges and/or colleges with a high percentage of women faculty attain a higher level of career achievement. These differences remain even with controls for selectivity, size and faculty salary. This research also suggests that women's colleges are over-represented in the numbers of alumnae who enter non-traditional (male-dominated) occupations. Equally important for our argument, this includes research scientists and scholars, and doctoral recipients in engineering, physical and life sciences. The overrepresentation of women's college graduates in these non-traditional occupations is substantial, a 4-to-1 for research scientists and scholars <sup>(11)</sup>.

Women's college alumnae make up 42% of the women in the U.S. Congress. Fifteen of the fifty leading corporate women cited in a recent Business Week Magazine were graduates of women's college, even though they accounted for only 5% of all college-educated women in the relevant age group. One-third of the women on the boards of the 1,000 largest American corporations are graduates of women's colleges.

The special qualities of a women's institute which could make a difference is the transforming quality of an environment committed to women's education, a place where both men and women support and encourage each woman to achieve her greatest potential. Women's voices seem better heard where there are no men. For example, at a women's college, women are more likely to see their own abilities in the context of what they as individuals can do, rather than what society believes women can (or cannot) accomplish. Research shows that at single sex colleges, students are more academically involved, interact with faculty more often, and show greater intellectual self-esteem than their co-educational counterparts (11).

A women's institute could offer a range of significant opportunities for young women preparing for a complex future. It would probably employ a number of women faculty. In addition to serving as role models for women, women faculty have been found to be more concerned with the total lives of their students and with helping them to develop a deeper level of understanding than male professors. They are more likely to be mentors, guides and provide insider tips.

There is ample evidence that suggests that faculty members play a nontrivial role in the area of student's career interest in choice during college. Not surprising, the magnitude of this role appears to be a function of the amount of informal interaction. Komarovsky (1985) found that this was particularly true for women (11).

In a women's institute of science and technology, faculty members would not have the opportunity to give the best research opportunities, and/or the most personal attention to the students they most identify and feel comfortable with: young men. There simply would not be any men to give them to. Perhaps because of the complexities of confusing traditional relationships with professional relationships, the easy out -- ignoring women -- would

simply not be available. Both men and women faculty would have only women to mentor, to guide in their academic and career choices.

Thus women at a women's institute would have the opportunity -- at a critical age -- to have all of this experience given to them by people they respect.

### The Importance For Graduate Students

In most of the research on women in science and engineering graduate education emerges as a particularly complicated experience for women. Perhaps because the relationship between advisor and advisee is more critical in graduate than undergraduate education, the lack of serious mentorship and support for women in graduate school has led too many to drop out and/or to have their careers derailed by advisors who are less supportive of them than they are of men. Indeed, we believe that graduate students would be more likely to want to attend a women's institute of engineering than undergraduates since it is at this point that it becomes clear to students that they are facing serious problems.

### Building Castles in the Air: or Why This is an Unlikely Proposal?

If it is clear that such an institute would make sense, why hasn't someone started one?

There are a number of easy arguments against our immodest suggestion. One is the feasibility of setting up a women's institute of science and technology. The cost, many would argue, would be prohibitive. This is a real argument with only one counter: what is the cost if we do not? Perhaps it costs too much because it simply is not a priority.

Another important argument is that an institute places attention on the wrong people, indeed that we really need to change the attitudes of men, not provide a single sex technical education for women. While the research on the impact of attending women's colleges as undergraduates clearly demonstrates that women who attend these colleges are more successful in their careers, including nontraditional careers, this argument is also important. However, we also point out that these options are not

mutually exclusive. We could develop programs to encourage women at co-educational institutions as well as operate a single-sex institute for women.

A third argument is the potential lack of credibility of such an institute. One could imagine charges of "power puff mechanics" or "engineering for poets". This, however, is a strong argument for why one should begin a graduate program in the institute. In both science and engineering, the credibility of one's advisor, and the commitment of the advisor to one's career is what makes the critical difference. Assuming that there are enough scientists and engineers committed to equity for women, there should be enough advisors to make any institute credible.

Finally, there is the argument that in co-ed engineering schools where strong programs for women have been implemented, the percentage of women entering and graduating have grown dramatically. In 1990, at three institutions, at least half of the B.S. degrees in engineering were awarded to women. Twenty-three schools awarded between 26 and 99% of their B.S. degrees in engineering to women; another 36 schools awarded 20-25% of their B.S. degrees in engineering to women (4). To us, this is the most compelling argument for changing the existing structure rather than developing a new one.

### Is it Worth it?

This is at best a rhetorical question. Clearly engineering institutions -- be they single sex or co-ed -- where women are regarded as serious students, where their voices are heard in the classroom, and which are less involved in sex role stereotyping would and indeed do make a significant difference. Will our new institute become a reality, will more schools develop strong support programs? Only if people are really committed to changing the situation, not simply to talking about the problem.

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- (2) National Science Foundation, **Human Talent for Competitiveness**, (NSF 87-24), NSF, Washington, D.C., 1987.
- (3) National Research Council, **Survey Report, 1985 doctorate recipients from United States Universities**, U.S. Government Printing Office, Washington, D.C., 1986.
- (4) Ellis, R. A., "Women in Engineering," **Engineering Manpower Bulletin**, no. 99, American Association of Engineering Societies, Washington, D.C., December 1989.
- (5) Angier, N., "Women join the ranks of science but remain invisible at the top," **New York Times**, May 21, 1991.
- (6) Hornig, L. S., "Professional Women in Transition" in Haas, V. B. and Perrucci C. C. , **Women in Scientific and Engineering Professions**, University of Michigan Press, Ann Arbor, 1984.
- (7) Baum, E., **The Cooper Union 1989 National Survey of Women Engineers**, The Cooper Union for the Advancement of Science and Art, New York, 1989.
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- (10) Tidball, M.E., "Baccalaureate Origins of Recent National Science Doctorates," **Journal of Higher Education**, vol. 57, 1986, pp. 606-620.
- (11) Pascarelli, J. and A. Terrencini, **How College Affects Students**, Jossey Bass Publishers, 1991.