A WOMAN’S PLACE MAY BE IN ENGINEERING

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I would like to thank WEPAN for the invitation and the opportunity to be present to discuss these vital questions about women and minorities in engineering which have direct bearing on the welfare of our nation and our society. Obviously, women are experiencing challenges in achieving full status in engineering as students, in the academy and the profession. If they were not, we would not be here today.

INTRODUCTION

In the early 1970s, women made up less than 15 percent of engineers in the U.S. The number of women in engineering programs rose steadily through the mid-1980s and then reached a plateau. Women now comprise only 18 percent of engineering students unlike medicine and law where women now represent more than 40 percent of the study body.¹ Thus many researchers agree that “winning respect and acceptance in the workplace is as much of an issue for women in engineering today as it was for the first generation of female engineers.”

A sampling of comments from a recent NSBE Journal special issue, “Women In Engineering,”² is revealing. Dr. Christine Darden of the High-Speed Research Program Office, NASA Langley Research Center, comments, “It’s always been a pet peeve of mine that women are often steered away from this area. Women have great potential–their position in the workplace is growing, and I believe we will see their presence increase in the coming years....” Dr. Zelda Y. Gills, Lument Technologies recalls, “I remember my mom told me...be a good scientist or engineer first and don’t worry about being black or being a woman. Don’t get hung up on obstacles. Produce first; when you worry about obstacles, it can psyche you out.” The founder of Parallax, Margie Lewis says “I think science and the success of science and technology depend upon women entering that arena. The workforce is changing and women have very strong, analytical minds. In order to progress, we have to encourage women to participate in both science and technology.”
Even Howard University's commendable record of recruitment and matriculation of women engineering students is less exemplary with regard to the hiring of female faculty. There are no Engineering women academics whose employment longevity matches that of male faculty. Of the five Howard Engineering departments, only three departments have women faculty - Civil with three female faculty members and Mechanical Engineering and Systems and Computer Science with one each. Perhaps the greater number of women faculty in Civil Engineering can be attributed to the fact that civil engineering is the mother of the engineering disciplines and also the department that I chaired prior to becoming dean.

My discussion is based on the three questions I have been asked to address for the conference.

**HOW WILL THE CURRENT AFFIRMATIVE ACTION CLIMATE IMPACT THE RECRUITMENT AND RETENTION OF WOMEN AND MINORITIES IN ENGINEERING?**

The affirmative action debate continues as it must in a society which refuses to acknowledge some fundamental truths about its race/gender practices and relations. Thus, it is appropriate to pose the question: Do female students pursuing engineering thrive and succeed at a higher rate under certain conditions? Studies suggest that women role models have a greater impact on female students selecting and/or pursuing and persevering in engineering studies than does any other factor.

A 1995 article in *Woman Engineer* identifies affirmative action as one of the major factors in the increased number of female graduates of engineering programs during the 1970s and 1980s. The author notes that the number of women earning bachelor degrees in engineering in 1970 was less than 1,000. However, during "the 1970s and 1980s when the equal opportunity affirmative action climate was at its zenith, those numbers increased dramatically to almost 12,000 in the mid-1980s. In 1990, the number dropped to around 10,000 and has leveled since then." Research studies and anecdotal information show that increasing the participation of women in the engineering profession is a problem embedded in a complex web of gender bias, cultural expectations, self-imposed limitations on the part of women and other factors.

In their book, *Women in Engineering: Gender, Power and Workplace Culture* (1992), Judith S. McIlwee and J. Gregg Robinson found that in companies where engineers are powerful as a group, women are often shut off from that power, and that in companies where engineers are less powerful as a group, women engineers thrive. A 1991 National Research Council study noted that “female engineers, like other female professionals, are subjected to sex-based standards for success in their careers, including ‘mommy-tracking’ and ‘glass ceilings.’” Another study found that male students who leave engineering tended to give academic reasons for their departure, whereas female students more often cited social reasons, including male-dominated labs, isolation, lack of role models and problems with friendship networks.

I strongly suggest that we must not be discouraged by the present affirmative action climate. Instead, we must devise programs using women engineers as role models and...
seek the support of the end-users of engineers--private industry, government and academia--in recruiting, retaining and educating engineers to meet the engineering and scientific needs of the nation.

One such program, now in its seventh year, is the Engineering Coalition of Schools for Excellence in Education and Leadership (ECSEL) funded by the National Science Foundation's Coalition Programs in 1990 and renewed for another five years in 1996. ECSEL members schools are CCNY, Howard, Morgan, MIT, Penn State, University of Maryland and the University of Washington with Howard as the lead institution. The coalition's diverse engineering schools share the common goal of improving the effectiveness of engineering undergraduate education in preparing students for life-long productive careers and significantly increasing the number of women and under-represented minority graduates earning engineering degrees. "Design Across the Curriculum" is the driving force and theme for realizing these goals.

Although we cannot yet quantify ECSEL's impact or that of the other NSF-funded coalitions, women engineering students at Howard have participated enthusiastically and successfully in major ECSEL design competitions including the 1997 Regional Steel Bridge Building Contest sponsored by the American Institute of Steel Construction along with other organizations. Howard made a fine showing by garnering five first-place plaques including overall first place. Women students are also involved in the Solar Car project.

Outreach efforts are yet another excellent vehicle to increase the participation of women in engineering in the face of indifference to affirmative action. College-sponsored summer engineering programs and academic year programs for pre-kindergarten through high school are an enduring legacy of the National Minorities in Engineering Effort. Howard has expanded its summer engineering programs for pre-college students to four or five programs each year. They remain an attractive mechanism and conduit for recruiting and increasing the number of women and minorities in the profession.

WHAT STEPS NEED TO BE TAKEN TO CONTINUE TO INCREASE THE PARTICIPATION OF THESE GROUPS IN ENGINEERING?

It would appear from the experiences they relate, that young women benefit from affirmation of their choice of engineering as a major, and that women entering the profession need mentors and other assurances in a male-dominated profession.

Analysts who track the participation of women in engineering suggest that the presence of so few women in the field may be self-perpetuating because there are a limited number of mentors and role models for females who might be interested in engineering. As mentioned above, the disparity in women attaining engineering degrees is one of the educational challenges being addressed in the National Science Foundation's coalitions programs.

Dr. Carmen B. Cannon, Howard's assistant dean of Engineering Student Services, conducted an informal survey in 1993 of 89 female students. Women role models rated highest as a factor in their decisions to pursue an engineering education. The survey
disclosed that 90 percent of our women students found the climate for women in engineer-
ing at Howard to be “comfortable or very comfortable.” Some gender-related is-
ues mentioned in the survey included perceptions that males dominate classes; males
consider females inferior, and that male faculty make sexist comments, do not take
women seriously and assume that female students are behind in their work or that they
do not understand. The School is considering ways to address these problems.

Results of another survey showed the importance of organizations dedicated to women
and increasing their participation in engineering. Documentation obtained from these
surveys is important because it can serve as a basis for creating programs to improve
services to female students.

The Women in Engineering Program Advocates Network (WEPAN) and the Society of
Women Engineers (SWE) have a leadership role to uphold in conducting activities to
support female students in engineering. Happily, we have an active chapter of SWE at
Howard University and staff members who are active in WEPAN.

A subtle factor to be considered is the environment in which learning takes place
and the role of the faculty educator. In “The Heroic Engineer,” Taft Broome
(Howard professor of Civil Engineering), cites Joseph Campbell and others who
identify several indicators of social immaturity including “cruelty, a disdain for
women and other perceived encumbrances.” Broome posits the question: “How can
we condition engineering learning environments to help students develop character
traits of mature adults?” Faculty, Broome argues, have a role to play.

One modality he suggests is that faculty structure problems in which students are
given opportunities to make heroic decisions, problems which have no simplistic so-
lution and may lead to controversial encounters. This will give students a proving
ground to test their attitudes and discover their strengths. His thesis is that students
may eventually decide to subordinate self-interest to that of others--opting for the
greater good and service to humankind, the linchpin of the engineering profession.
The implication is that the less ego-driven one becomes, the more mature and appreci-
ciative one becomes of the inherent strengths of other individuals.

Increasing the numbers of women and minorities in engineering is a multi-level ef-
fort. Until greater institutionalized interest is forthcoming, colleges and universities
and their faculty, together with staff, must provide the level of support necessary for
women to feel comfortable in pursuing an engineering degree. An atmosphere hospita-
table to female students must begin in pre-kindergarten and continue through high
school where it has been found that female students require greater support in math
classes to achieve their full potential.

Engineering faculty must be encouraged and motivated to set class objectives which
stretch students’ abilities and encourage their development. Faculty must help students
define career objectives and set goals to achieve those objectives. A recent alumni
illustrated this point by emphasizing that his professor insisted that he acquire profes-
sional registration in order to build a lucrative practice.

Students, on the other hand, must have or develop an underlying concern for personal
excellence and producing superior work. In addition, students require feedback on
their performance. This feedback should be used to monitor the improvement of the student’s progress by both student and the faculty.

In the workplace, employers will probably need to be educated to assign jobs without reference to gender. Women must be allowed to discover their own strengths, rather than be offered the “soft” jobs in the belief that some favor is being conveyed upon them. Equal pay for equal work and strong policies against sexual harassment must be in place. Women engineers need women role models. This should be encouraged whether through special seminars or occasional programs where senior-level women in engineering are invited to speak at academic, government and private industry facilities.

It is essential that motivational resources be developed and made available in schools and through the media and that organizations such as WEPAN and SWE continue to actively nurture women engineers, using their influence in all venues, including the professional engineering societies, to promote the activity and visibility of women in the profession.

WHAT IMPACT HAVE I HAD ON MY COLLEGE? WHAT ARE MY CHALLENGES?

My personal observation is that whatever Howard University is doing, it is on the right track with respect to recruiting and matriculating female engineers. Female students now comprise one-third of the School of Engineering student population; in Chemical Engineering, they comprise the majority. Contrast Howard’s standing with national figures which show that in 1994, the engineering female undergraduate enrollment was only 19 percent (total enrollment 328,463; female 60,931).

While it is difficult to mediate behavior, conduct and attitudes, perhaps engineering deans, faculty and administrators can work to deliver a curriculum that empowers women, as well as all students, by placing emphasis on learning skills which will translate to added value in the workplace. If nothing else, this will reinforce self-esteem and dispel performance anxiety for the new engineer.

From my own perspective, engineering education at most institutions is driven by a curriculum which has the attributes of a guidance document provided by an accrediting agency. This approach, I believe, produces engineers who are often mechanical in their profession and whose creative skills have been stunted.

An alternative to which I subscribe is a curriculum built around competencies. These are core principles that do not change with time—although their description and how they are taught (chalk and talk versus interactive computer technology) may evolve. A competency is an ability, skill or characteristic that correlates with outstanding performance in an activity, e.g. a given job or graduate education. These include strong fundamentals in science and engineering, strong skills in a specific discipline, effective communication skills, ability to work with a team, multicultural sensitivity, motivation for excellence and leadership skills. Competencies not only describe what is being accomplished but also, the how behind the accomplishment. As a sequel to Broome’s article, we hope that such a curriculum will produce a less ego-driven engineer and one

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who is more appreciative of differences—whether of gender, ethnicity or national origin.

Establishing a curriculum based upon competencies is a dynamic process requiring continual review and improvement and results in an exciting atmosphere in which both students and faculty learn and teach. In addition, ancillary benefits such as a reduction in the number of credit hours required to receive the degree may be realized. Whereas, gender issues do not appear to be a major problem at Howard, introduction of a “non-gender-biased” curriculum should improve the learning environment for females and help allay concerns of female students cited in the 1993 survey by Dr. Cannon.

Students are our prime commodity -- their recruitment and nurture are crucial to our success. Both male and female, students and faculty, are encouraged to be mindful of their attitudes and actions; seek to become aware of gender-related biases and maintain fairness and objectivity in all situations; discourse with each other respectfully, and explore their differences in neutral, mediated forums expressly designed to understand and resolve these differences. Sexual harassment workshops are mandatory for all employees and sexual harassment is also addressed at student orientations.

CONCLUSION

Engineers have been credited with exceptional analytical abilities. The recruitment and matriculation of women and minorities might well benefit from systematic examination and a definitive program built around the major influences of success of women and minorities in engineering.

Open communication, a curriculum which lays the foundation for lifelong learning in education, driven by the economic demands for full participation in the engineering profession, should conspire to bring about a brighter future for women engineers.

This is an era when diversity and flexibility is the primary mandate for every company that hopes to take advantage of the global marketplace. Thus, it is in the interest of the nation and our society that engineering schools recruit and graduate women in numbers consistent with their representation in the society using the production of male graduates as the normative index. Like the National Minorities in Engineering effort launched in the mid 1970s, the effort to recruit and train women engineers must begin at the pre-kindergarten level and intensify in breadth, scope and activities through elementary and secondary school.

REFERENCES

1 Statistics derived from American Association of Engineering Societies (AAES) reports.
4 Statistics derived from American Association of Engineering Societies (AAES) reports.
6 WEPAN publications.

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