

## THE PIPELINE PROGRAM: A MODEL PROJECT FOR ENCOURAGING WOMEN TO ENTER GRADUATE STUDIES IN ENGINEERING AT THE UNIVERSITY OF MICHIGAN

Cinda-Sue Davis and Carol Hollenshead

Center for the Education of Women, University of Michigan,  
Ann Arbor, Michigan, U.S.A.

### Introduction and Goals

Despite impressive increases in the number of women pursuing bachelor degrees in engineering over the past two decades, there remains a marked scarcity of women at the higher academic and professional rank, particularly in university research and teaching. To enter the professorial ranks in a research university, it is necessary to have obtained a graduate degree, generally a Ph.D. Yet all too often, women engineering students elect not to continue their education onto the graduate level, thus effectively prohibiting them from academic careers. The problem of "the higher, the fewer" is still too prevalent.

Even at Michigan, one of only two universities in the United States to rank in the top ten in degree production at all three levels (bachelor, master, and Ph.D.), the overall numbers are most discouraging. Of 457 doctorates granted in the years from 1987 through 1990, women received only 25. This is of especial concern since during the same period, women received 629 of the total 2,724 bachelor degrees and 242 of the total 1,781 master degrees in Engineering at Michigan. At Michigan, as across the nation, we must take steps to increase the number of women going on to graduate school after getting their bachelor degrees. This is the only way we can eliminate the problem of "the higher, the fewer".

The goal of the Pipeline Program, also known as Marian Sarah Parker Scholars, after the first woman graduate of the College of Engineering, is to increase the participation of women in academic research and related careers in engineering through the creation, testing, evaluation, and dissemination of a program for undergraduate women designed to encourage their entry into, and completion of, graduate study in these fields.

There are a number of reasons why undergraduates in engineering and the sciences do not go on to graduate schools. Students may think of graduate school as simply four to six more years of coursework and not as the preparation of autonomous professional<sup>1</sup>; they may not know how to finance graduate school; and the strong job market for bachelor degree recipients may make the financial payoff for graduate study almost non-existent and the prospect of foregone income unpalatable.

Even when women have been as successful as their male counterparts in their academic undergraduate programs, a variety of factors, external as well

as internal, serve as barriers to their achievement. In spite of evidence to the contrary, women may be regarded as "affirmative action" students and seen as basically unqualified for scientific careers; consequently they receive little encouragement to seek the highest levels of attainment<sup>2</sup>. Women may also perceive the climate of their undergraduate program as hostile and inappropriately combative and hence antithetical to their values<sup>3</sup> and they feel they must walk a tightrope between being regarded as too feminine or too aggressive. This experience may be compounded by the lack of female faculty role models and by the large number of engineering and scientific faculty from cultures that do not generally favor the entrance of women into professional life<sup>2</sup>. Women who contemplate graduate education may have difficulty obtaining sufficient financial support to continue their educations, in spite of the available resources. Women perceive that they receive less emotional support from their families for their career decisions than do men<sup>4</sup>. Finally, women's perceptions of their own abilities may differ from those of their male counterparts; even when objective measures of achievement are equal, women may exhibit lower self-esteem and underestimate their potential for graduate study<sup>5</sup>. In the Michigan survey, women in science were less likely than men to feel that they had a strong background in science<sup>3</sup>.

The Pipeline program incorporates components designed to: (1) familiarize students with the graduate education process and with research careers in engineering; (2) build participants into a supportive academic community; (3) deliver appropriate support and guidance; and (4) facilitate the personal and professional growth of Pipeline Program students. Program components include: (1) the identification and nomination of "likely to succeed" women to the honors Pipeline Program; (2) formal seminars focusing on career issues in engineering; (3) internships followed by a research symposium (4) a formal seminar focusing on graduate school issues; (5) support and discussion groups designed to address personal conflicts and work/family issues; and (6) preparation of a research prospectus to be used in the graduate school application process.

### Program Description and Strategies

Women and men may achieve equally well academically, and they may be equally focused on a particular career pathway, but they make their decisions in very different social climates and with different value systems in mind. Women consider a number of different factors when deciding to enter or continue in a traditionally "male" field. Issues of self-confidence, and self-esteem, the problems of combining personal and professional lives, accessing networks, acquiring mentors, and learning how the system works are only a few of the concerns which women, and the academic programs designed to serve them, must address.

### Nomination of Participants.

We estimate that up to 50% of the female undergraduates are qualified to continue to graduate school but only a small fraction of this number do so. All

potential participants in the Pipeline program are nominated in the fall term of their junior year in one of four ways: (1) College of Engineering faculty members teaching junior students are asked to identify and nominate 2 to 5 women students for the program. This faculty nomination process has several desirable effects. It makes the faculty think consciously about women students and their potential for graduate study. In addition, it bolsters the self-confidence and self-esteem of the women students themselves. (2) Professional societies and organizations within the College of Engineering, specifically the Minority Engineering Program and the Society of Women Engineers, nominate those women who display exceptional talent during their freshman and sophomore years. (3) The Pipeline program is advertised through direct mailing and through College of Engineering information systems. Women who are considering graduate school and wish to participate will be able to nominate themselves. (4) The last nomination process is through an examination of the academic records of the top women students, specifically those with a grade point average of 3.0 or above (out of a total of 4.0). All identified students, regardless of the method of nomination, are mailed a special letter of invitation by the Associate Dean of the College of Engineering.

#### The Fall Term Seminar Series.

Pipeline participants participate in a weekly seminar series throughout the fall term for a total of five sessions. The beginning of the series recognizes and acknowledges the graduate school potential of all the participants. We address factors that women consider when deciding to enter and pursue careers in traditionally male fields.

During the next five seminar sessions, professional women engineers and graduate engineering students, representing various engineering disciplines and careers, are invited to discuss their various fields of study. They are asked to describe the process of how they decided to go on to graduate study, how and why they selected their graduate school, and what they envision they will be able to do in their careers that they wouldn't have been able to do without a graduate degree. Not only do the pipeline participants learn a great deal from this process, they also are able to interact with some excellent female role models, a rarity for women in Engineering. While the professional engineers address the same issues as the graduate students do, they do so from an advanced professional standing. They give the students a perspective on the graduate school environment and experience from the point of view of women who have successfully negotiated it and are now established in the professional community.

#### Winter Term Planning Your Future Groups.

As the second term of the junior year commences, students are ready to begin to address the need for effective personal planning. At this point, students are divided into smaller discussion groups called "Planning Your Future" led by trained counselor/facilitators. Over a four-week period these groups will discuss issues such as how to maintain effective relationships with faculty and mentors, how to build a peer support network, and how to accurately assess one's own talents and strengths. Participants are expected to complete

an informational interview with a professional engineer or researcher in the subfield of engineering in which she is most interested. Another purpose of the groups is to help ensure that peer relationships and networks are built for mutual support. Issues pertaining to women's development and self-esteem are also addressed.

Because research has demonstrated that developmental issues, family backgrounds and hope for marriage and family all play a very significant role in the career decision process for women, in-depth discussion of the issues and concerns surrounding combining one's personal and professional life is an important component of these groups.

#### Winter-Term Workshops.

Following the Planning Your Future groups, a half-day Saturday workshop covering the application process to graduate school is conducted for all participants. Strategies are presented to students on how to determine the best graduate programs, both in terms of academic reputation as well the "climate" for women. General information about financial aid, such as sources, the benefits of a research versus a teaching assistantship, and the value of external fellowships in addition to departmental support is discussed. Sample NSF graduate fellowship proposals are presented. Discussion on networking as well as finding and cultivating a mentor relationship is presented. The importance of obtaining appropriate letters of recommendation and how to do this is outlined. Sexual harassment and discrimination is discussed. Panelists for this workshop typically include financial aid officers from the Rackham School of Graduate Studies, Associate Deans from the College of Engineering, Chairs of Engineering graduate student selection committees and Engineering faculty members.

A second workshop, entitled "Moms in Science and Engineering", is also offered in the spring term. Panelists for this presentation included women faculty members and graduate students in science and engineering who are also mothers. Strategies for juggling a personal and professional life are presented. Every effort is made to insure a wide diversity of mothers, in terms of ethnicity, ages and number of children, sexual orientation (lesbian mothers are included) and life situation (single parents are included).

#### Summer Term, Junior Year: Internship Program.

One of the most effective strategies for women with uncertainties about career goals and potentially low esteem is the completion of a successful professional experience. As Humphreys points out "One of the best ways to develop motivated and competitive graduate applicants is by offering research opportunities to undergraduates"<sup>6</sup>. Independent research and the resultant interaction with graduate students and the support and encouragement of a faculty mentor are invaluable. Therefore all Pipeline Program participants are given an opportunity to participate in a four-week summer internship program in laboratories within the College of Engineering or in local industry. Students are expected to work 40 hours a week and receive a \$1,000 stipend. This portion is funded through a combination of NSF REU supplements, University of Michigan matching funds, and NSF Model Project funds.

The internship component provides the opportunity to work directly with a faculty mentor and to gain a clearer understanding of the academic research process and social milieu of the laboratory. During the internship period, students also meet as a group to discuss issues of mutual concern and to build an academic support network.

If a participant is unable to remain in the Ann Arbor area for the four-week period during the summer term, a research project during her senior academic year is arranged. Several interns have continued working in their mentors laboratory after the internship period is complete.

#### The Senior Year: The Application Process.

The senior year is when students apply for graduate school and for fellowships. Pipeline Program staff are available for one-on-one counseling, answering questions and providing assistance during the application process. Opportunities for interviewing are scheduled with those graduate schools which come annually to recruit. Interviewing techniques are discussed and practiced. Students are encouraged to share interviewing experiences with one another.

At the end of the senior year, a recognition event and celebration is held. Students are honored at this time. Faculty mentors, parents, program staff and faculty are invited to attend to recognize the students' accomplishments.

Successful completion of the Marian Sarah Parker Pipeline Program is noted on the transcripts of all participants.

#### Evaluation.

A comprehensive program evaluation has been undertaken. At the onset of the program baseline data on all participants was gathered. This included data from student records (GPAs, SAT scores, etc.) as well as data collected directly from program participants designed to assess such factors as career plans, self assessment and self-esteem. Throughout the program, participants' academic performance is being monitored and recorded. Data, including repeat measures, will be again collected from participants at the end of the senior year (May, 1993). Comparisons will be made with appropriate groups: male students, women who met Pipeline Program academic standards but did not participate or who left the Program, and with records of previous classes of women in the College of Engineering. Complete evaluation of the first year of Pipeline participants should be complete by December of 1993.

#### Conclusion

The University of Michigan Pipeline Program is currently in its second year. Although it is too early to evaluate the success of the program, it is clear that student interest and participation is overwhelmingly enthusiastic. Parker Scholars feel honored to be asked to participate and over 90% of them complete all of the above described activities. Many participants have commented that this is the first time that they have had the opportunity to meet other women in engineering, both at the student and faculty level. They also report that they feel that the University is demonstrating a genuine concern for

their academic and professional achievement and success. This sense of concern can be all too rare at a large, impersonal research university setting.

It is imperative that individuals interested in gender issues in science and engineering education look at issues along the entire educational pipeline - from preschool through graduate school. Too often our focus is at the earlier levels of elementary and secondary education as well as the first year of college. Although these do represent crucial points for intervention, the passage from undergraduate to graduate school is also very critical. It is only by increasing women's participation in graduate education can we hope to significantly increase the number of women in our university faculties.

### References

1. Widnall, Sheila E., *AAAS Presidential Lecture: Voices from the Pipeline*, Science, vol. 241, pp. 1740-1745.
2. Daniels, Jane Z., *The Potential for More Women Faculty*, U.S. Woman Engineer, vol. 34, No. 6, pp. 11-13.
3. Manis, J.D., Thomas, N.G., Sloat, B.F. & Davis, C-S, *Determinants of Choice of Undergraduate Concentrations in the Sciences, Mathematics and Engineering at the University of Michigan*, Report # 23, Center for the Education of Women, University of Michigan, 1987.
4. Oggins, J., Inglehart, M. & Brown, D.R., *Entering Traditionally "Male" Fields: Women's Limits or Women's Choices?*, American Psychological Association, Atlanta, Georgia, August 12-16, 1988.
5. Eccles, Jacquelynne S., *Gender Roles and Women's Achievement*, Educational Researcher, vol 15, No. 6, pp. 15-19.
6. Humphreys, Sheila M., *One Department's Response: Women and Minorities in the Graduate Pipeline*, Engineering Education, May 1988., pp. 772-775, 1988,