PART III

SUMMARY AND CONCLUSIONS

Purpose of the Study

This project was undertaken to evaluate how "female-friendly" is a new engineering program which has been designed as best practices in undergraduate engineering for all students, following the guidelines of EC 2000; it is not designed as a program specifically for women in engineering. The program incorporates a strong emphasis on teamwork, interdisciplinary cooperation, multiple hands-on laboratory experiences each semester, real-world context to projects, communication skills integrated into the curriculum, female role models in faculty and dean, close faculty-student relations, and reflexive pedagogy. Many of these elements come together in the innovative "engineering clinic" of the program, required each semester, which entails interdisciplinary teams working on real-world projects, with close mentoring by faculty members. All of these elements have been suggested as needed reforms to traditional engineering education in order to make it more comfortable for females and reduce their disproportionate attrition from engineering programs.

Methodology

To evaluate the program, surveys were made of all engineering students in the fall and in the spring of the academic year 2000-1. Comparison of the fall and spring surveys allowed some insight into changes that occurred over the course of the program. Academic performance was recorded from institutional records. Focus group interviews with female students provided more in-depth understanding of their issues and

experiences. Interviews with faculty and administration provided in-depth understanding of the program and pedagogy and their development.

Students' Development as Engineers

The process by which students become engineers begins with characteristics that they bring with them into the university setting. Students come in with varying family and demographic background, high school math and science background, and initial levels of engineering self-confidence. While gender differences in terms of family and high school background are minimal, female students enter with lower engineering self-confidence than males and their engineering self-confidence is more closely tied to their family and high school background than is males'.

Once in the program, students' progress is indicated by their academic performance in class and their participation in a variety of extracurricular enrichment and help activities each year. As a result of the interaction of their input characteristics and experience over the course of the academic year, their engineering self-confidence may increase or decrease (or remain stable), they reach varying levels of satisfaction with the various aspects of the program and interpersonal climate, and decide whether to continue in the program for another year. At the end of the program, they have either graduated or dropped out earlier. As graduates, they may continue on to graduate school in engineering, get a job as an engineer, or change fields.

Our focus was on the experience of the Rowan students in the Rowan program, as it interacted with the characteristics they input into the program. We followed them for one year in the program, from Fall to Spring. Our study did not follow seniors beyond the end of the academic year.

Evidence that Rowan's Program is Female-Friendly

The most important findings from this research are the extent to which the program does work for the female students. Traditionally, females leave the engineering program at higher rates than male students and complain of marginalization, alienation, discomfort, and loss of interest. In contrast, in comparison to the male students the female students in this program:

- Are as *active* or more in academic enrichment activities, counseling and mentoring activities, study group activities, and student chapters of professional organizations. Women's involvement in academic enrichment and counseling activities is related to greater engineering self-confidence and satisfaction with many aspects of the program. In turn, their satisfaction with the program is related to greater engineering self-confidence, including their confidence that they will stay in the major and the career.
- Are as *satisfied* or more with the program's opportunities and offerings, the course workload, the laboratory work, the clinic program, the teamwork emphasis, the faculty-student relationships, and the peer relationships.
- Are more likely to improve their *self-confidence* as engineers over the course of the academic year, reflecting the positive influence of the program, up until the senior year.
- Have as high or higher *academic achievement* both overall and in engineering specifically.

- Have as high or higher *retention* throughout the program (first-year to second year, second-year to third-year, third-year to fourth-year, fourth-year to graduation).

Rowan's Program is Male-Friendly, Too

Importantly, males were not less satisfied with the program than females. In particular, there was no gender difference in satisfaction among the most-qualified males and females. Among weaker students, females were more satisfied than males, and indeed male students who did not do well in their courses were more likely to drop out of the program. Female attrition from the program was much less linked to their grades than was males'.

Students who dropped out of the program did not do so because they were dissatisfied with the innovative aspects of the program: satisfaction with clinic, with teamwork, with lab work, with faculty-student relations or peer relations was not lower for those who left the program than for those who stayed. Nor do they drop because of greater dissatisfaction with the workload.

These results confirm that engineering programs set up according to the guidelines of EC 2000 and on the cutting edge of undergraduate engineering education can indeed be female-friendly, and that special programs targeted at women are not necessary to reduce the gender gaps that more traditional engineering has demonstrated. Further, the results demonstrate that an innovative, female-friendly, program is still male-friendly; that is, it does not cut into the satisfaction of the male students (for instance, Rowan male students

tend to be more satisfied with the program than male students asked similar questions at the University of Washington).

Key Characteristics of the Rowan Model for Engineering Programs

These are important findings for any program interested in restructuring along the Rowan model. Here are key features that seem to work:

- Extensive, interdisciplinary team work every semester in engineering clinic
- Nurturing approach rather than weed-out
- Hands-on laboratory experience every semester
- Small faculty-to-student ratio and personal accessibility and attention
- Extra-curricular engineering activities in discipline-specific professional organizations
- Extensive internship opportunities
- Real-world context of projects
- Entrepreneurial and communication skills built into clinic projects

Weaknesses Concerning Women's Experiences: the Senior Year

At the same time, the results point to some weaknesses in meeting the needs of the female students, particularly as they approached the end of the program. Female students enter the program with weaker engineering self-confidence than male students. While their self-confidence seems to be somewhat higher than in other engineering institutions for which we had comparable data, there is still the traditional gender gap. Since women's engineering self-confidence is more strongly linked to their input characteristics than is males', it seems to be factors outside the purview of the university that account for

this lower engineering self-confidence. However, in keeping with the positive aspects of the Rowan program, the engineering self-confidence of female students is strengthened over the course of the academic year for the first three years in the program. Male self-confidence, on the other hand, is scaled down over the course of the academic year, so that the program has the effect of reducing the gender gap in engineering self-confidence. Female participation in academic enrichment and counseling activities in engineering makes a strong contribution to their self-confidence at the end of the academic year, and lessens the importance of outside or background factors on their engineering self-confidence, and as the pressures of more traditional social norms once more gain influence.

However, the gender gap in engineering self-confidence in the senior year is once again considerable, raising concern about whether female needs are being addressed as they face the outside world of employment and, perhaps, more traditional graduate schools.

Possible reasons for this pattern are suggested by the female students' perception of problems for women in science, engineering and math. Females tend to perceive more problems for women in these fields than do men, but female perception of problems tend to decrease over the course of the academic year in all years but the senior (just like engineering self-confidence increased every year but the senior, and expectations about engineering jobs rose every year except the senior). During the senior year, female perception of problems for women in SEM increased in terms of societal attitudes toward women in SEM, the conflict between feminine qualities and careers in these fields, and, especially, conflict between career and family responsibilities.

It is important to note that having an internship or a paying job in engineering is associated with perceiving fewer problems for women in SEM. It is the women who do not have actual employment experiences who perceive greater problems for women in SEM. This finding reinforces the importance of real-world experiences in engineering for female undergraduate students. However, it also points to the importance of bringing the impact of gender into the discourse about the profession, as Henwood (1998) and Walker (2001), among others, suggest, to help women recognize the complex impact of their gender on their occupational choice and status, whether by their intention or not, and how this impact can be addressed and coped with. Women who seek to deny the gender impact often fear more about actual situations than women who confront the issues.

SWE members seem to be aware of more kinds of problems for women, but less concerned about the conflict between career and family, perhaps because they have been more exposed to solutions to the conflict, just as women who have internships or employment activities have. Perhaps what is needed is increased attention to the concerns of women as they face employment, even if they are not members of SWE.

Implications for the Women's Future in Engineering

How the lower engineering self-confidence of women as they graduate from Rowan is related to their future in engineering is not yet possible to determine, since so few cohorts have yet to graduate. However, if the recent MIT study is any indication, a higher proportion of females are expected to leave the field within ten years than are males. If their engineering self-confidence is a prediction of this phenomenon, it clearly needs to be addressed. Just as Rowan has found ways to reduce the gender gap in self-confidence and persistence in its first years of the program, creative energies can devise ways to mitigate the gender gap faced as their students prepare to leave the program.

This will be Rowan's next challenge. And if their record so far is any indication, they will be successful at doing so.

For Future Research

A word about the methodology used in the project. There were two innovations introduced to differentiate the study from other surveys. The first was the use of focus groups to flesh out some of the experiences and reveal others. They were very valuable in providing insights into female experiences. However, it was difficult to get cooperation to participate. Unlike the surveys which were distributed in required classes (and therefore received a much higher response rate than surveys distributed by mail or over the web), focus group interviews were outside of class and entirely voluntary. Only a third of the women participated.

Further, perhaps because of the group nature of the focus group, an ambience of denial of any gender bias in the school developed. Students were reluctant to be seen as marginalized or "other", and minimized any bias they had witnessed or experienced. Nevertheless, quite a bit was revealed in the transcripts, in addition to more general reactions to the program.

The second innovation was the use of the fall and spring surveys, which enabled comparison over the course of the academic year. We had expected that this would give us a good window on when and what kind of changes took place at various stages of the curriculum. It may indeed have done so. However, great differences between the cohorts led us to be very cautious about constructing the changes that took place over the course of the undergraduate career. We quickly realized that the cohorts differed from each other in composition as well as in the program they had experienced. As a self-reflexive and

new program, many changes were instituted which might have an impact on the students' satisfaction with various aspects of the program, for example.

Therefore the need for a longitudinal study became very clear in order to be able to make appropriate conclusions about how students' attitudes, perceptions and expectations changed over the course of the program. Such a study will validate the hints of changes we unveiled in this report, and clarify the strengths and weaknesses of the program for males and females alike.

As this study continues, we hope to be able to be more specific about the programmatic recommendations for female-friendly programs developed for males and females alike.

As the results clearly demonstrate, *best practices in engineering education can be female friendly without being for women only.*