A GENDER LENS ON ROWAN UNIVERSITY'S COLLEGE OF ENGINEERING

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EXECUTIVE SUMMARY

BACKGROUND TO THE STUDY

This study was designed to put a "gender lens" on Rowan University's engineering program. Its main purpose was to assess whether the institutional environment of Rowan University's Engineering College is favorable to women's retention, self-confidence, satisfaction and commitment to engineering. The focus on this particular college stemmed from the nature of its program: it was set up as "best practices" in undergraduate engineering education, one of the first in the country which initial set-up followed the guidelines solidified in EC2000, rather than as a "women in engineering" program. Yet many features of the engineering program have the characteristics of being "female-friendly": the interdisciplinary teamwork, the continuous hands-on experience every semester, the integration of communication skills into the required coursework, the entrepreneurial opportunities, the partnership with industry for Clinic projects and internships, the nurturing rather than competitive climate, the personal faculty-student relationships fostered by small class size and faculty mentoring, and the relatively high proportion of female role models (in the faculty and Dean). Because these features of the engineering program overlapped with curricular and climate reform advocated by those trying to help more women succeed in engineering, they were expected to help women (and all other students) feel that they belong and can develop as engineers, and to encourage their persistence in the program to its end.

RESEARCH QUESTIONS

The main research questions of the study were:

Do females enter the Rowan program with any disadvantage in terms of their input into the system (their family background, their math or science background, or the support of significant others for their pursuit of engineering)? Does Rowan help to mitigate any disadvantage women might bring with them?

Do the female students participate in the extra-curricular engineering activities at Rowan as much as the male students do? What is the impact of participation in the local chapter of the Society for Women Engineers on women's integration into the engineering culture of Rowan? How does it impact their self-confidence to be engineers?

Does the Rowan program strengthen women's self-confidence in their pursuit of engineering? Are there certain stages in their undergraduate studies at Rowan that are particularly empowering or problematic for women?

Are the female engineering students at Rowan as satisfied with the engineering program as males are? Is the Rowan engineering program as male-friendly as it is female-friendly? What aspects of the Rowan program are particularly satisfying or problematic for female students as compared to male students? Are males and females satisfied with the same aspects of the program? In particular, how do male and female students react to those aspects of the program that are expected to be "female-friendly", such as the emphasis on teamwork, the personal faculty-student relations, the extensive lab work, the real-world context of projects?

Do the students perceive special problems for women who pursue engineering? How does their undergraduate experience at Rowan affect this perception?

How does the input students bring with them into Rowan impact their academic performance? Does academic achievement differ for male and female students?

Is the retention of female students as high as that of male students? How is retention impacted by students' initial input into the system? By satisfaction with the program? By academic achievement?

POPULATION AND METHODS

The population of the study was all undergraduate female engineering students. Male students were studied as a comparison group against which to evaluate the responses of the female students. This facilitated conclusions about gender-specific reactions to the programs. Students were surveyed during required courses, which ensured a high response rate, less biased toward those particularly committed to engineering than other methods of data collection might be.

Students were surveyed twice during the academic year 2000-1, once at the beginning of the Fall semester, and once at the end of the Spring semester. This allowed the tracking of changes that occurred over the course of the academic year. Official transcripts provided records of academic achievement. Focus group interviews were held with three groups of female students over the course of the year. Interviews were conducted with all department chairs (and acting chairs), the founding Dean of Engineering, the current Dean and Associate Dean of Engineering, faculty members who helped found the program and had seen it evolve from its inception, and all female faculty. These interviews provided more in depth understanding of the program and its impact.

MAIN RESULTS

Understanding Undergraduate Student Progress toward Becoming an Engineer

A model was developed to understand the progress of undergraduate students toward becoming an engineer. The process by which students become engineers is seen as beginning 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.

Input Characteristics Students Bring with them into the Program

Female students at Rowan exhibited few of the disadvantages in pre-college background that the literature had led us to expect. They did not enter Rowan at a disadvantage in terms of having role models in terms of mothers or fathers or siblings in science, engineering or math. In terms of educational role models (having significant others in college), there was no gender difference in terms of fathers, but females had stronger educational role models in their mothers than did males, and males had stronger educational role models in their siblings than did females. Nor did they differ much from males in terms of the support for their pursuit of engineering that they received from significant others.

In terms of pre-college math and science background, the main disadvantage the female students had was fewer computer science courses before college than their male counterparts; on the other hand, they had several advantages over the males students in terms of participation in extra curricular math- or science-related activities, participation in honors math and science classes, and higher grades in high school science classes.

Overall, the gender differences in background characteristics and pre-college preparation seem to be fairly balanced, without one gender having much advantage or disadvantage when compared with the other.

However, females do enter Rowan with less self-confidence that they belong in engineering and with less self-confidence in their engineering abilities. This is not a generalized lack of self-confidence: the female students do not have less confidence in their overall academic abilities or communication skills.

The engineering self-confidence of women is more sensitive to their background influences than that of males, especially among the students with weaker backgrounds. The impact of such background influences is greater in the first year, when students first enter Rowan, and then again in the senior year, when they face the prospects of leaving the university environment.

Engineering Self-Confidence

After being in the Rowan program even for one year, the traditional gender gap in self-confidence, with which students enter Rowan, is reduced. Participation in extra-curricular activities makes a particularly important contribution to the engineering self-confidence of females in the Rowan program, as compared to males. That Rowan strengthens female's engineering self-confidence is reinforced when we compare the self-confidence of Rowan engineering students to engineering students in other colleges and universities: Rowan females have higher engineering self-confidence than female engineering students in other programs, and the gender gap in self-confidence at Rowan is smaller.

However, the empowering effect of the Rowan program on its female students does not appear to persist to the end of the program. As Rowan students get ready to graduate (in their senior year), the gender gap in engineering self-confidence is greater than ever. Perhaps it is the anticipation of the labor market, or a greater awareness of the minority status in the profession, that mitigates the Rowan effect on female students' engineering self-confidence in the senior year. Because of the relationship between engineering self-confidence and commitment to persist in the field, this is a topic of concern we believe merits important consideration.

Performance and Activities in Engineering at Rowan

Family and high school background have relatively weak impacts on how involved students get in engineering activities, even in their first year. Female engineering students participate as much or more than do the male students in the various kinds of enrichment and support activities available at Rowan. Female students are significantly more involved in academic enrichment activities, such as work with faculty, hearing guest speakers, going on field trips. They were at least as likely as men to have had summer or year-round internships in engineering. They are more likely to participate in study activities, such as study groups and tutoring, and as likely as males to participate in counseling activities, such as meeting with academic advisors or getting career counseling. While most of the engineering students participate in one of the five student chapters of professional engineering societies on campus, female students are more likely than the male students to participate in and be officers of these organizations.

Over a third of the women are members of SWE, and over half of the women attend SWE meetings at least occasionally. Participation in SWE adds to the effect of the discipline-specific organizations as a help network (SWE participants are more likely to be involved in "help" activities – and not because they are disproportionately "needy" as measured by high school background and achievement, or fall semester GPA), by enhancing a sense of efficacy in their engineering abilities, by increasing participants' satisfaction with the course load.

Involvement in engineering activities at Rowan enhances engineering self-confidence, and is more strongly related to the engineering self-confidence of female than male students.

Involvement in engineering-related activities also enhances satisfaction with the program for both males and females. Student involvement in academic enrichment and faculty contact, mentoring and counseling activities, and professional organizations are all related to greater satisfaction with various aspects of the program. SWE involvement enhances women's satisfaction with programmatic elements like coursework demands, acting apparently as an additional help network for the women participating in it.

Satisfaction with the Rowan Engineering Program

Satisfaction with the engineering program takes on many aspects. Students distinguish between satisfaction with the programmatic elements of the program (opportunities available, and coursework), how the programmed is actually applied (teamwork, the Engineering clinic, and Labwork), and the interpersonal climate (faculty-student relations, and peer relations).

According to our results, the program, its delivery and the interpersonal climate are indeed female friendly: female students are as satisfied or more satisfied than the male students with the programmatic elements of choice and opportunity, classwork load, with the delivery of lab work, teamwork, and the Engineering Clinic, and with peer and student-faculty relationships. Once high school background has been controlled, most of the gender differences lose their statistical significance, which means that the satisfaction of the female students is not at the expense of the satisfaction of male students.

Involvement in extra-curricular enrichment and counseling activities is related to satisfaction with many of the aspects of the program. The importance of integration into all facets of the program, not just class work, is underscored by this finding: enrichment activities and "help" activities are related to students' greater satisfaction with the program.

Students with stronger engineering self-confidence are more satisfied with the programmatic elements of program opportunities and classwork, and with peer relationships. The relationship between engineering self-confidence and satisfaction with peer relationships is particularly important for female students and reinforces findings in other research about the importance of community and networking for keeping women in engineering. Satisfaction with the way the program is delivered in labs and in teamwork is related to the engineering self-confidence of males. In turn, males who are less successful academically are less likely to stay in engineering.

Perception of Problems for Women in Science, Engineering and Math

Students were asked about their perception of problems for women pursuing careers in science, engineering or math (SEM). Their responses resulted in three factors of perceived problems: societal attitudes toward women in SEM, the conflict between feminine qualities and careers in SEM, and the conflict between family and career for women in SEM. The majority of students do not perceive special problems for women pursuing careers in science, engineering or mathematics with regard to societal attitudes toward women in SEM or the conflict of feminine qualities and careers in SEM, but they do perceive as somewhat problematic possible conflicts between career and family responsibilities. There were few gender differences in the perception of problems for women; however, the female students were more concerned than the male students about discriminatory attitudes toward women in SEM and the conflict between family and career in these fields.

Exposure to female role models in science, engineering or math sensitized both male and female students to possible problems women encounter in those fields. Women were especially more aware of potential problems when they had sisters in SEM, or had more female instructors for their engineering courses. Members of SWE were also more sensitized than were female students who were not SWE members to the potentially negative societal stereotypes about women in SEM and conflicts between these fields and femininity; however, they were less likely to perceive conflicts between career and family as problematic, presumably because they were exposed to ways of resolving these conflicts.

Exposure to real-world experiences also reduced the female students' perception of problems for women in SEM: having job or internship experience in engineering reduced the perception of problematic issues for women in science, engineering or math. This is another reason to support the exposure of female students to positive real-world experiences in these fields, so that their fears may be alleviated.

The perception of problems for women in SEM was related negatively to women's engineering self-confidence, their satisfaction with the engineering program, their expectations from a degree in engineering, and their intentions to persist in the major and the career. Addressing the issues women find problematic, and showing how problems can be resolved, would appear to have a major impact on how comfortable women feel in engineering and whether they intend to stay in the field.

Gender Differences in Engineering Outcomes: Academic Achievement and Retention

The female engineering students have as strong an academic record and rate of retention as the male engineering students at Rowan. As in any program, of course, a certain number of students switch out of the major each year. By analyzing the differences between those who took the survey and stayed in the program, and those who took the survey and left the program, we could answer some of the important questions of the research.

Because of the unusual nature of the Rowan program it was important to determine whether leavers were dissatisfied with the clinic set-up or the emphasis on teamwork throughout the curriculum. However, this was not the case for males or females. Leavers (male or female) were even more satisfied with both the clinic and teamwork than stayers. This apparently was not the reason they left the program.

Previous research has suggested that women in particular leave engineering because they find the coursework too demanding – again, not in the case of Rowan. Other research suggests that interpersonal climate as a factor in students' leaving engineering, especially women. Again, this is apparently not the case for Rowan. Both leavers and stayers are satisfied with faculty-student relationships and peer relationships.

The main difference between stayers and leavers appears to be their grades (for males) and dissatisfaction with the opportunities offered in the program (for males and females. Also, leavers have stronger verbal SAT scores than stayers, which suggests that they may have strengths rewarded better in other majors and careers.

The most important conclusion is that the special "female-friendly" nature of the program does not push men away nor are females pushed away because of dissatisfaction with the interpersonal climate, difficulty of the coursework, or the nature of labwork.

CONCLUSIONS AND RECOMMENDATIONS

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
- 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

- 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)

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.

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. Nor do they drop because of greater dissatisfaction with the workload.

At the same time, the study has found that female students had less self-confidence in engineering and were less satisfied that engineering was the right major for them, much like findings in other national studies, and that they were somewhat more likely to perceive problems for women in science, math and engineering than were males.

Because of the successful research design of the study, changes could be traced over the course of the academic year at each level of the program. We could thus locate the impact of experience in the program for both males and females. With regard to self-confidence in engineering, for females it was strengthened during the course of each academic year except the senior year, while male self-confidence was undermined during the course of each academic year except the senior year, when it was strengthened. As a result, the gender gap in self-confidence narrows during the course of the first years of the program, a significant finding in contrast to other studies, which have shown deterioration in female self-confidence after the first year. It seems that while women enter the program with less engineering self-confidence than men, apparently the first years of the Rowan program reinforce female self-confidence to reduce the gender gap in self-confidence -- but the gap grows again in the senior year, This pattern needs to be given more attention. It suggests that as nurturing as a program is, unless it empowers women to deal with their transition to the wider engineering world, its impact may be limited.

RECOMMENDATIONS

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.

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

FUTURE RESEARCH

Tracking the changes over the course of the academic year gave us much insight into the impact of the engineering program on the students. To better understand the impact of specific parts of this program, it is important to add to this research design:

- longitudinal study to track students as they progress from their beginning in the program to their graduation.
- comparison of the Rowan experience to other programs which also have been set up in accordance with EC2000 and incorporate the principles of teamwork, personal attention, real-world context, communication skills and entrepreneurial experience, which seem to be fundamental to the Rowan program and to cutting edge engineering programs.

If we have mastered a model that reduces the gender gap in persisting through the undergraduate years, we can concentrate our efforts on:

- implementing this type of program in other settings
- recruiting more women so that they will have the opportunity to participate in a female-friendly training ground for engineering,
- empowering women as they turn to leave the nurturing undergraduate environment, so that they can with confidence address and resolve workplace and career issues which serve as obstacles to long-term careers in engineering.

CHAPTER I-A

INTRODUCTION

The under-representation of women in engineering and other sciences has been a topic of national concern (Brainard, et. al., 1998; NSF, 2000; Rosser, 1995; WEPAN, 1993). A general decline in engineering enrollment has led to societal concern regarding a shortage of engineering professionals, and women, who continue to be seriously under-represented in the profession, are one of the potential sources for future engineers which have been targeted for cultivation (Bergvall, et. al., 1994; CAWMSET, 2000; National Science Board, 1993; Oakes, 1990). From the individual women's point of view, the under-representation of women in training for engineering undermines their qualifications for a lucrative, rewarding profession (Bergvall, et. al., 1994; Hanson, 1996). Efforts have therefore been taken to recruit and strengthen the retention of female engineering students beyond the current national average representation of 15% of engineering students being women (Anderson, 1994; Johnson, 1993). However, despite these efforts, a high proportion of women avoid science concentrations and engineering in particular, have a higher rate of attrition from college engineering programs (Adelman, 1998; Huang, et. al., 2000; Strenta, et. al., 1994), have a higher attrition rate than males from the profession after graduation (see for example, Boyce et. al., 2002; CAWMSET, 2000; National Research Council, 1994), and continue to be underrepresented in these professions.

The process resulting in the under-representation of women in engineering has been likened to an extensive "leaky pipeline" beginning in childhood, continuing through elementary, junior high and high school experiences, and continuing up through labor force employment and promotion. The under-representation of women in undergraduate engineering education is one critical segment along this pipeline. This under-representation reflects greater difficulty in recruiting female engineering students as well as greater obstacles for women during the years of undergraduate education (CAWMSET, 2000; Hanson, 1996; Rayman and Brett, 1993).

Our focus in this project is on gender differences in the experience of undergraduate engineering education. Our research is based on the engineering program at Rowan University, which seems to have addressed many of the problems women encounter. Even more importantly, its program has been designed as "best practices" in undergraduate engineering education for all students, not just for women. Therefore, it is important to evaluate how this educational model works for women, and why it succeeds when it does.

In this introduction, we will review the literature on the major sources of problems for women in engineering that stem from institutional factors. We follow with an introduction to the elements of the Rowan program, describe the study in more detail, and describe the student population we have studied. We then present the results of the study in terms of students' involvement in engineering activities at Rowan, engineering self-confidence, satisfaction with the program, and perceived problems for women in engineering. We show the outcomes of academic achievement and retention of the female students, compared to the male students. Our analysis of how women experience and react to the main aspects of this program, compared to men, allows us to reach conclusions about how "female-friendly" the program really is. We conclude with suggestions for engineering programs that would like to build on the Rowan model to incorporate an inclusive pedagogical design, and suggestions for further research to further validate the claims suggested by our findings.

REVIEW OF THE LITERATURE

Much research and rhetoric has been devoted to trying to understand why a higher proportion of women opt out of undergraduate engineering programs, and to pinpoint the alienating features of traditional programs. The major deterrents at the institutional level to women's persistence at the undergraduate level can be grouped into programmatic and climate issues, summarized below and in Table IA-1.

TABLE IA-1

CHARACTERISTICS OF UNDERGRADUATE ENGINEERING WHICH DETER WOMEN

PROGRAMMATIC ISSUES DIFFICULT FOR WOMEN IN TRADITIONAL ENGINEERING EDUCATION
▪ Competitive atmosphere; lack of cooperative pedagogy or group work ▪ Inadequate opportunities for hands-on experience ▪ Inadequate attention to contextual and social implications; narrow, fragmented scope of application ▪ Lack of validation of women's experiences

CLIMATE ISSUES DIFFICULT FOR WOMEN IN TRADITIONAL ENGINEERING EDUCATION
▪ Impersonal faculty-student relationships ▪ Lack of "community" ▪ "Male" communication patterns ▪ Few female role models ▪ Women perceived as "other"

PROGRAMMATIC ISSUES DIFFICULT FOR WOMEN IN TRADITIONAL ENGINEERING EDUCATION

Competitive Pedagogy

Many women, even if they are highly qualified, do not respond well to highly competitive "weeding out" pedagogy and have cited it as a major reason for leaving science, math and engineering fields (Seymour & Hewitt, 1997; Center for Education of Women 1992 cited in Ross; Rosser 1991; Hollenshead et al, 1996; Etzkowitz et al, 2000 Ch. 4). A strong emphasis on individualized competition has been found to be alienating to women not only in engineering but in other fields as well (Kramarae and Trieichler, 1990). As Ross (1994) summarizes, research suggests that males are socialized to be more comfortable with competition and to possess both the experience and personal resources to promote themselves in such an atmosphere; therefore, women respond more negatively to this kind of pedagogy than do men.

Further, large, impersonal classrooms relying on competition for individual achievement have been found to discourage women (Nair and Majetich, 1995). When women's inadequacies are emphasized at an early stage of the curriculum, women are more likely to be alienated and uncomfortable in the program (Anderson, 1995). Such pedagogy serves not only to discourage women, it also fails to empower them by not giving them tools to fight gender discrimination and prejudice that they might encounter in their education or employment (Mayberry, 2001).

On the other hand, cooperative and collaborative pedagogy appears to be a style which is much more comfortable, on the average, to women (Busch-Vishniac and Jarosz, 2003; Haller et. al., 2000; Lazarus & Nair, 1996; Ross, 1994). Positive results have been reported for women working in collaborative teams, and therefore cooperative learning has specifically been advocated as a means of retaining women in engineering (Haller et. al., 2000).

Hands-On Experience

Because "tinkering" and experimenting informally with laboratory and computer equipment is less common among women's pre-college experiences, women often lack the familiarity and comfort-level that men have doing the kinds of activities required in an undergraduate engineering program (Margolis & Fisher, 2002; Davis & Rosser, 1996). As a result, multiple opportunities for hands-on experience, including remedial and voluntary activities, are expected to help females overcome their apprehension and lack of ease in the scientific methods (Davis & Rosser, 1996).

Female engineering students in particular tend to lose confidence and self-esteem with regard to their scientific and engineering pursuits if they are not given adequate hands-on experiences, in contrast to males, whose confidence apparently derives from a greater number of extra-curricular activities (formal and informal) in these areas (Nair and Majetich, 1995; Sonnert, 1995), as well as positive societal expectations and role models like them in the field. Hands-on opportunities help women feel more secure about their transition to the workplace and how they will apply their degree, which keeps them committed to engineering (Ross, 1994).

Holistic Approach, Contextualized Applications

The social benefits of science and technology seem to be much more important to females than to male students in similar fields (Sax, 1994; Harding, 1991). The majors women choose tend to be those whose benefit to society is apparent (see also O'Hara, 1995). Providing meaningful contexts for problem solving and applications has been suggested as a means of attracting and retaining women in engineering (Davis & Rosser, 1996). Further, investigating problems of holistic, global scope, with interdisciplinary methods, appeals to women's need for a broader context to maintain interest and motivation (Davis & Rosser, 1996; Farrell, 2002).

Women as "Other"

A lack of female role models, either among graduates, faculty, or successful fellow students, reinforces women's doubt that they belong in these fields ((AAUW, 1992; Bergvall, et. al., 1994; Davis and Rosser, 1996; Dresselhaus et. al., 1994; Ginorio, 1995; Nair and Majetich, 1995; NSF, 1994; Sonnert, 1995)). While large, impersonal settings are alienating to women in particular, apparently a "critical mass" of women aids in establishing an identification with the engineering community (Sonnert, 1995)[1]

The "otherness" of females does not stem only from numbers, however. Pedagogy which does not incorporate women's experience as an integral part of the curriculum, or which treats women as "other" either through fragmentation of presentation, omission, or segregation, runs the risk of alienating women. Henes et al (1995) claim that women in engineering have difficulty because examples in required courses often are not drawn from examples familiar to women's experience. Perception by students that engineering is a male profession results in the marginalization of women not conforming to this culture (Tonso, 1998). This marginalization may result in "stereotype threat", which may

[1] Sax (1996) disputes the importance of this critical mass of women in a major, showing that its positive effects disappear once student characteristics, aspects of the college environment, and particular field have been controlled. She does acknowledge that within a particular field (such as engineering) the proportion of women may still have an impact on student outcomes.

affect intellectual identity and academic performance (Steele, 1997). As Widnall (2004) put it: “We must recognize that women are differentially affected by a hostile climate. Treat a male student badly and he will think you’re a jerk. Treat a female student badly and she will think you have finally discovered that she doesn’t belong in engineering.” Schlossberg (1989) posits that students who feel marginal, as if they do not matter, are less likely to persist in their studies.

Perceiving women as “other” affects not only the way the women perceive themselves, but also how their peers and faculty interact and treat them. For example, part of the “otherness” of females in the engineering culture stems from the dominant male communication patterns, which may be unfamiliar or less comfortable to females, on the one hand, and on the other, result in faculty and peers devaluing female communication patterns as different (Hall & Sandler, 1982; Davis & Rosser, 1996). Further, if a male culture is dominant, males may have an advantage in terms of communication style, familiarity with examples used in class, and any other form of interaction with faculty and peers that may come more naturally to the male majority.

Programs sensitive to this issue incorporate communications techniques and ethics into their programs, to increase the sensitivity to diversity in communications, and prepare all students with the basic communications tools necessary for a career in engineering. Women’s experiences need to be incorporated and validated in classroom discussions and laboratory exercises, so that they are seen as an integral part of the field, not a marginal concern (Rosser and Davis, 1996). Mayberry (2001) even raises a question about the effectiveness of collaborative learning when it does not challenge the dominant masculinist assumptions about knowledge and education or power relations embedded in the wider society. McIntosh (1983) and Fausto-Sterling (1991) posit a stage beyond “female-friendly sciences” as sciences reconstructed to “include us all”.

Reflective Pedagogy

Because the pedagogical issues affecting the retention and commitment of women to engineering are interactive and require feedback, only by institutionalizing a process of self-reflection on the teaching and learning processes can the needs of the students, as well as the standards of professionalization, be met. Lazarus & Nair (1996) thus emphasize the need to incorporate a process of self-reflection in the pedagogical process.

CLIMATE ISSUES DIFFICULT FOR WOMEN IN TRADITIONAL ENGINEERING EDUCATION

Faculty-Student Relationships

Satisfaction and commitment to math, science and engineering are enhanced by positive faculty-student relationships. Faculty-student interaction was found to be more strongly associated with undergraduate satisfaction than any other factor having to do with characteristics of the student or institution (Astin, 1985), and in their research focusing specifically on science majors, Astin & Astin (1992) found that student orientation by faculty was a central predictor of satisfaction and commitment (for male and female science majors alike). This research reinforces findings from more general literature on student attrition from college.[2]

However, the quality of faculty-student interaction among engineers appears to be troublesome. In a nation-wide sample of institutions, faculty-student interaction in the field of engineering was found to be less favorable than in other fields of study (Astin & Astin, 1993), and faculty-student interaction was found to have some negative effects on students', and especially women's, math self-concepts (Sax, 1994). McIlwee & Robinson (1992) report that half of the women engineers they interviewed had experienced difficulties with their engineering professors, and nearly a quarter had "avoided their professors and felt intimidated by them" (p. 59). Further, women complain about a lack of appropriate advisement (Anderson, 1994) and mentoring (Brainard, 1989). Lazarus & Nair (1996) call for increased sensitivity on the part of faculty to the implications of their

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[2] "Meaningful interaction with faculty both outside and inside the classroom significantly impacts the student's decision to remain in college" (Sax et al 2000 citing Pascarella and Terenzini, 1977, 1979, 1980; Terenzini and Pascarella, 1977, 1978). See also Pascarella & Wolfle (1985), Tinto (1993), Stage (1989), Terenzini & Wright (1987b).

interactions with women students in particular, both in the classroom and in laboratory settings.

Sense of "Community"

Higher college attrition rates for women in engineering have been attributed to a "chilly climate" for women, particularly in fields in which women are a minority (such as engineering) (AAUW, 1992; Bergvall, et. al., 1994; Collins et. al., 1996; Crawford and Macleod, 1990). Again, this echoes more general findings on factors importance to student persistence, which emphasizes the importance of student "integration" through personal contacts (both peer and faculty) (e.g., Tinto, 1993). This "chilly climate" stems not only from a lack of sensitivity to women's sensibilities and needs, but a lack of integration with the engineering community, as well (Bergvall, et. al., 1994; Ginorio, 1995: Nair and Majetich, 1995; Seymour and Hewitt, 1997). This lack of satisfaction with the interpersonal climate can affect the professional persistence and success in the field even among those who graduate (Robinson and Reilly, 1993).

Studying women in engineering (but not comparing men and women), Goodman et al (2002) found that many women undergraduates

> need to feel they are part of a larger community in engineering. Community allows students to build networks and to feel that their presence in engineering is important to others. Networking can counteract the isolation that women experience—providing them with information, support, and the knowledge that they're not alone in the challenges they face." (p. xii)

Seymour & Hewitt (1997) found that women's persistence in science, math and engineering was facilitated by their comfort among male peers and their bonding with other women in similar majors. This bonding apparently enables persisters in the major to seek help from many sources when it was needed. In contrast, a strongly competitive atmosphere separates students from each other and mitigates against alliance and bonding, which women in particular respond to negatively. Therefore, attrition has been found to be more common among those alienated from others in the science, math or engineering field they had been in (Goodman et. al., 2002; Seymour & Hewitt , 1997). It may reinforce women's feeling of "otherness" stemming from more formal parts of the curriculum.

ATTRIBUTES OF A FEMALE-FRIENDLY PROGRAM

To combat these issues which have been raised about traditional math, science and engineering curriculum, the following attributes have been suggested to characterize a program that is more "female-friendly" (see especially Busch-Vishniac and Jarosz, 2003; Nair and Majetich, 1995; Davis and Rosser, 1996):

- Cooperative pedagogy, with teamwork well integrated into the learning process, and decreased emphasis on individual competition and weeding out strategies
- Ample opportunities for hands-on experience at an early stage of the program, to reinforce or build skills as well as confidence
- Holistic approaches which provide broader social contexts for the applications learned, showing the societal relevance of the learning content
- Inclusiveness of experiences more common to females (or other non-white male minorities)
- Awareness of different styles of communication and their impact, and a break-down of barriers resulting from these differences

- Positive, personal faculty-student interaction both within and outside the classroom
- Strong peer bonding and sense of "community"
- Female role models

Many of the female-friendly reforms called for actually overlap with the recommendations put forth by engineering bodies for across-the-board engineering education reform. ABET guidelines for incorporating multidisciplinary teamwork, an understanding of professional and ethical responsibility in a global and national context, the need for a broad educational basis, the importance of effective communication abilities, echoed by recommendations from NSF, ASEE, and EEB, all overlap with recommendations for making engineering programs more female-friendly (see also Rosser, 2001).

THE ROWAN STUDY

With these considerations in mind, our attention was focused on the impact of the engineering program at Rowan University. Coming of age in the late 1990's, the program was designed in accordance with the latest guidelines for engineering education. Not targeting women per se, its basic hallmarks –perhaps inadvertently--directly address a number of the institutional factors cited as diminishing women's persistence in the engineering field.

The current study was designed to assess whether Rowan's institutional environment does indeed prove favorable to women's retention, self-confidence, satisfaction and commitment to engineering. The intent was to evaluate whether the program could successfully serve as a model for making mainstream engineering more inclusive, without raising the familiar objections of singling women out as a category of “others”.

The next chapter (Chapter IB) describes the Rowan program and discusses those features of it expected to make it “female-friendly”. Chapter IC describes what we did in our study; and Chapter ID describes the population of the study (Rowan students). Part II of the report presents the findings. Chapter IIA presents the analytical model we used to conceptualize the process students go through during their undergraduate years to become an engineer. The rest of Part II focuses on the components of this model which are addressed in the study. Part III provides a summary and conclusions deriving from the findings of this study.

CHAPTER I-B

THE ROWAN PROGRAM

In this chapter we describe the basic features of the Rowan engineering program, and discuss which features have led us to expect the program to be "female-friendly". Information about the engineering program was compiled from (a) written material from the Engineering College, material posted on their web page (www.rowan.edu/engineering), and papers published about features of the program[3]; (b) interviews with the founding Dean of Engineering (in office 1996-2000) and the current Dean of Engineering (in office since Summer, 2000), the Associate Dean, the Outreach Coordinator, and the part-time Assessment consultant; (c) interviews with faculty, including all department chairs (and acting chairs), four of whom had been among the formative and founding faculty, all female faculty, three of whom had been with the College from its beginning; and two other male faculty members who had been active in the formation of the program; and (d) focus group interviews with three sets of female students.

The setting for the Rowan Engineering College is a comprehensive, state-supported institution, with an enrollment of approximately 9,000 (8,000 undergraduates) whose primary mission has been undergraduate education since the 1920's. As Rowan's newest College, the engineering program accepted its first matriculated class of undergraduates in the fall of 1996. [4] Beginning with its first undergraduate class at about 80 students, it

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[3] Several papers discuss various aspects of Rowan's engineering clinic. See especially Farrell, et. al. (2001), Hesketh, et. al. (1997), Jahan et. al. (2001), Johnson et. al. (2001), Marchese et. al., (1997, 2001a, 2001b),, Schmalzel et. al. (1998)

[4]In the first few years of the program, there was also a "general" category for first year and sometimes second year students for students who had not yet decided on a specialization. This "general" category was a catch-all for students not yet committed to a

built itself up into a full-fledged four-year (and later, master's) program in engineering, with approximately 350-400 undergraduate students. There are four disciplines incorporated in the program: chemical, civil and environment, electrical and computer, and mechanical engineering, each of which has achieved ABET accreditation. All disciplines share a common core course, Engineering Clinic, which is an eight-semester multi-disciplinary sequence required of all students. The Clinics average 2-4 weekly hours every semester (out of the 16-18 hours the average engineering student takes each semester) over the four years

It is important to note that the program was developed to reflect the "best practices" in undergraduate engineering education, not with the intention of making a program suitable especially for women; rather, the intention was to make this program cutting edge for all students, and it is in this vein that the engineering faculty present the program to their peers[1]. Its newness means that the engineering program came into being at about the same time that the Accreditation Board of Engineering and Technology (ABET) was developing its 13 criteria of accreditation that would eventually become the cornerstones of EC2000; the Rowan program, initially developed by a national team of consultants, was designed to integrate all of these guidelines in the rubric of one program. It is a not unwelcome by-product that the program has incorporated features that address the concerns that have been identified as obstacles for women in engineering (outlined in the previous chapter). And it is precisely because it is a program that is developed for all students that it enables us to address the question, "Will EC2000 Make Engineering More

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particular major, but because of its amorphous nature it was more difficult for these students to be connected to faculty and other students. The disadvantages of this outweighed the benefits of not making an early decision about discipline, and therefore it was gradually phased out, finally eliminated in 2002.

Female Friendly?" (Rosser, 2001). In the following we discuss in more detail those features of the program that led us to expect it to be female-friendly.

Teamwork Emphasis

Teamwork is a central part of the core course required of every engineering major each semester of the four-year program. The teams are multi-disciplinary, representing multiple engineering specialties. In these teams, students learn in their first and second years of the program to effectively solve open-ended problems as a team and to develop and deliver reports on these projects; in their junior and senior years, the teams work on projects, many of which have corporate sponsors, and to deliver reports on their end products to the wider engineering community and corporate sponsors. Faculty emphasized in their interviews that other schools may have teamwork, but not usually on a continuous basis throughout the program: they pointed out that many schools have senior design projects that are team-based, and some have incorporated teaming into first-year programs, but Rowan's incorporation of teamwork into every year of the program prepares students for the team environment they will encounter in the contemporary engineering environment. At the end of each semester, both participants and faculty evaluate the team experience, and grades on the teamwork are given after many factors are taken into account.

Cognizant of research indicating possible damaging effects of having women or ethnic minorities being alone on a team of white males, most faculty try to set up teams, at least in the first year, which do not have only one female or one minority student. There is no overall policy regarding this, and the practice has varied from instructor to instructor and year to year. Some faculty have extended this gender- and minority-sensitive policy to sophomore year clinic as well. [5] However, students generally self-select their project teams in the junior and senior years, and both faculty and students expressed in interviews that they felt this arrangement was appropriate, as by the third year in the program the students know each other well enough to decide with whom they could work best.

Teamwork is often required outside of the required Clinic course as well. The teamwork is perceived as building camaraderie and involvement among the students, as well as preparing them for the work environments they will encounter as engineers.

Interdisciplinary Nature

The interdisciplinary nature of the clinic teams has been noted above. It is seen as a way of introducing the students to the other disciplines, so that students make informed decisions about their own specializations, as well as giving them practice communicating with specialists from other disciplines as they would in a workplace.

The interdisciplinary aspect of the program is not limited to Clinic. Faculty regularly cooperate on research projects between disciplines, and students from multiple disciplines work on these research projects. Some majors have joint required classes with other majors (for instance, a number of the Mechanical Engineering and Electrical Engineering required courses are the same).

The faculty, not only the student teams, models the interdisciplinary nature of the Clinic. The clinic itself is team taught with faculty from multiple engineering majors.

[5] The past two years, experimentation was done in freshman and sophomore clinics forming teams using scores on the Learning Combination Inventory, without attention to gender or ethnic composition, and evaluation of this is currently underway. Since it was done after the current survey data were collected, it is not affecting the students' opinions that we analyze.

While the actual running of the classes varies by the particular faculty members involved, each faculty team has the responsibility to decide collectively on the material to be covered, the projects to include, and the procedures to follow, including how groups will be formed. Faculty may segment the course, each taking responsibility for part, or share the responsibility for each section. In the Sophomore clinic, for instance, not only do the engineering faculty come from different engineering disciplines; the course also integrates faculty from the College of Communications, who are responsible for instruction and evaluation that pertains to written and oral communication skills. At times the Sophomore clinic has been segmented, with engineering faculty teaching part of the course and communications faculty teaching another part of the course; at other times, the two types of faculty have been integrated into several lectures and assignments. Whatever the internal arrangement, all clinic faculty discuss and determine students' grades collectively at the end of the semester, with the rest of the faculty team. This set up thus models the integrative learning that only a handful of engineering schools have taken up (Busch-Vishniac and Jarosz, 2003).

Continuous "Hands-On, Minds-On" Projects

Engineering Clinic institutionalizes at least one hands-on course each semester. However, Rowan faculty like to refer to the projects in these clinic courses as "hands-on, minds-on". The curriculum of the more theoretical courses is integrated with the Clinic sequence, so that each semester students are getting a chance to apply the more abstract principles they are learning in other classes. A "just-in-time" pedagogy insures that the concepts to be applied in the Clinic projects have just been introduced in other courses, so that the material is still fresh in the students' mind (Farrell, et. al., 2002). The faculty work together to continuously create and re-create a coherent curriculum experience that incorporates hands-on experience every semester. This gives the opportunity for any student less practiced in the lab to get ample experience in the early years so that the more complicated laboratory sequences in the junior and senior years are less intimidating.

Integration of Communication Skills

As mentioned above, the focus of the sophomore clinic is on technical communications skills, which are taught by faculty from the Department of Communications in collaboration with the engineering faculty. The writing and speaking components of the general education requirements common to the rest of the University are thus incorporated in a setting unique to engineering. Students are given presentation tools (such as Power Point) as well as presentation opportunities before the general engineering faculty as well as industry representatives. This set-up addresses any disadvantage a student may have in terms of being unable to communicate in a professional style acceptable in the wider world of engineering. It also forces the students to communicate among themselves in order to get to an acceptable presentation of their team product.

Partnerships with Industry

Rowan has a special “Clinic Affiliates Program” through which industrial partners in the region provide technical issues for study and financial sponsorship for a team of engineering students, together with a company liaison and college faculty, to work on the issue and feed the results back to the industry. Students are thus exposed to “real-world” problems to work on, as well as intermingling with the corporate liaisons.

Cooperation with local industry includes sponsorship of summer internships for a high proportion of the junior and senior students, and occasionally students at lower levels. The PRIDE program (Partners with Rowan in Developing Engineers) provides scholarships and internship opportunities by local and international companies. A full-time Outreach Coordinator, who works on internship and career placement, reports that 90% - 100% of the graduates seeking engineering employment after graduation have been placed from the first three graduating classes.

Personal Faculty-Student Interaction

With a student to faculty ratio of approximately 17:1, and class sizes not exceeding 35, personal faculty-student interactions are facilitated. Faculty offices are walled in glass, most frequently with open doors. As one faculty member put it, "The biggest strength [of the Rowan engineering program] is the faculty-student interaction. It's pretty unique in an engineering program. Not every student needs it, but it's good to have it." Faculty know by name each of the students in their major, and develop strong personal relations with students both in the Clinic setting and in advisory capacities, as well as in research activities and informally. The policy of accessibility to students extends well beyond the classroom, including but not limited to faculty-student soccer and basketball games, after-school dining and drinking, faculty and student participation in professional conferences, faculty advisement of student chapters of professional organizations.

Not only faculty are impressed by this relationship. In focus group interviews, students also emphasized their close relationships with faculty. Department chairs report that students, in their exit interviews (before graduation), mention the faculty-student interaction as a major strength of the program.

Strong Cohort Solidarity

Because the curriculum is tightly structured, most of the students take many of their courses together. By sophomore year, each disciplinary cohort has formed a strong bond, which often extends into other disciplines because of the interdisciplinary Clinics. In the focus groups, students reported that it often feels more like high school than what they had imagined as college, because of the strong personal ties between students. Up to now, few transfer students have entered the cohort, minimizing any break in this cohesiveness. Solidarity is facilitated by active student chapters in each of the disciplines (IEEE, the Institute of Electrical and Electronic Engineers, AiChE, American Institute of Chemical Engineers, ASME, American Society of Mechanical Engineers, ASCE, American Society of Civil Engineers, SWE (Society for Women Engineers), and most recently SAE, Society of Automotive Engineers, and NJE, the New Jersey Epsilon Honor Society).

Reflexive and Flexible Pedagogy

The engineering faculty and staff are committed to excellence in teaching and the scholarship of teaching and learning, and this distinguishes it from many traditional engineering programs. Nearly every faculty and staff member mentioned this in their interviews with the principal investigator. Many of the faculty are young, with new outlooks on engineering education, and all have been recruited expressly to further the pedagogic ideals of the new College. The number of publications discussing the pedagogy (see footnote 1 to this chapter), and a number of awards earned by faculty from the American Society of Engineering Education, suggest this is not an empty commitment, but actually reflects active engagement.

Assessment has been incorporated into the very design of the Rowan curriculum and is carried out meticulously each semester, overseen by an assessment specialist on the College staff. Careful attention is given to student feedback, and faculty reevaluate course offerings and pedagogy every semester. The voices of all students (including women's) are heard and respected.

The faculty is also flexible in terms of meeting student demands. For instance, in response to student requests, one instructor set up a voluntary evening machining class for women.[6] The class has been repeated every semester, upon popular demand.

THE FIT BETWEEN ROWAN'S PROGRAM AND "FEMALE FRIENDLY" GUIDELINES

Rowan's infrastructure addresses many of the key issues that have been flagged as problematic for women in engineering (summarized in Table IB-1). Its interdisciplinary, team-based, hands-on Engineering Clinic addresses the need for more cooperative learning and women's feelings of inadequacy with respect to hands-on and laboratory performance. Its intention to nurture each student to graduation, rather than weed out students in the first year or two, minimizes the competitive atmosphere between students and fosters a camaraderie among members of a cohort who take most of their coursework together semester after semester. Because the projects the students work on are often actual problems provided by industry, and because the students must work up

[6] While there have been requests to open the class to men as well, the class has been limited to women to help them to become more comfortable with a part of the curriculum they felt they needed more practice in. It has been renewed for three semesters for women only.

presentations convincing to practicing engineers, including the marketing aspect, students are made aware of the societal and contextual implications of their applications. Ross (1994) suggested that when the culture of an engineering school is oriented toward industry and undergraduate education, being a woman might be less of a liability than in a program oriented strongly toward graduate education. She suggests that hands-on laboratory training, internships and co-op experiences, help women feel more secure about the transition to the workplace and possess more information about what engineers really do on the job. She laments that freshmen and sophomores have little opportunity to participate in such programs. The Rowan program incorporates such an emphasis throughout the undergraduate career.

TABLE 1B-1

FEATURES OF THE ROWAN PROGRAM AND HOW THEY ADDRESS NEEDS FOR WOMEN IN ENGINEERING

WHAT FEMALE-FRIENDLY PROGRAMS SHOULD INCLUDE	FEATURES OF THE ROWAN PROGRAM THAT ADDRESS THESE NEEDS
▪ Cooperative pedagogy	▪ Teamwork built in to Engineering Clinic each semester; lack of "weed-out" competition on individual level
▪ Adequate opportunities for hands-on experience	▪ Hands-on project integrated with classroom learning every semester
▪ Attention to contextual and social implications and applications	▪ Real-world projects sponsored by industry; marketing presentations developed in Clinic
▪ Broader context, interconnections	▪ Interdisciplinary teamwork, classwork, faculty cooperation
▪ Inclusive communication patterns	▪ Communication skills incorporated in Sophomore Engineering Clinic
▪ Internship, employment opportunities facilitated	▪ Partnerships with industry
▪ Reflexive teaching and pedagogy	▪ Faculty commitment to undergraduate education, and scholarship of teaching and learning
▪ Personal faculty-student relationships	▪ 17:1 student-faculty ratio; accessible faculty
▪ Women's concerns can be heard	▪ Flexibility, feedback
▪ Sense of "community"	▪ Strong cohort develops through common core curriculum
▪ Adequate female role models	▪ >20% faculty female, female Dean

In addition to these features, Rowan has more than the expected share of female role models in the Engineering College. More than 20% of the faculty is female – higher than the national average (see, for example, Farrell, 2002; Young, 2004), and the current Dean is female. There has been at least one female department chair. Further, many of the students who receive awards or make the Dean's list are female. Female students make up a disproportionate percentage of the officers of the student chapters of professional organizations. In addition, there is an active SWE (Society for Women Engineers) chapter on campus, which sponsors speakers several times during the academic year, field trips, participation in regional and national conferences, and service projects.

Designed for all students, the Rowan program appears to have reached McIntosh's (1983) Stage IV, "science reconstructed to include us all", at least on face value. The question we address is whether it works. Is reconstructing the infrastructure enough to make women feel like they belong in the field as much as men do? This is the focus of this study and the rest of this report.

CHAPTER I-C

THE POWRE STUDY

To assess the experience of female engineering students in the Rowan undergraduate program, to determine the impact of the features of the Rowan program on them, and to explore the differential impact of the program on males and females, surveys were conducted, focus group interviews given, and objective data collected for each student. Interviews with faculty and administration and printed information from the College of Engineering provided greater insight into the nature of the program and the educational climate.

Surveys

All Rowan students were surveyed for the study. The first full set of surveys was administered toward the beginning of the Fall of 2000; the second full set of surveys toward the end of Spring, 2001. The beginning of the year survey gathered background data on family background and support, pre-college preparation both formal and extra-curricular, self-assessments of strengths and weaknesses, and learning style preferences to be used as control variables in the analysis of gender differences. It also queried attitudes toward engineering as a field of study and as a career, self-confidence in engineering-related skills and abilities, perceptions of difficulties for women in engineering, and future plans and commitment to engineering. The end of the year survey repeated most of the questions about self-confidence in engineering related skills, satisfaction with engineering as a major and a career, perceptions of difficulties for women in engineering, and future plans and commitment to engineering. Students were asked about their involvement in extra-curricular activities during the course of the academic year and their satisfaction with many aspects of the program they had experienced during the year. Each questionnaire had close to 150 variables for analysis. A summary of the topics asked at each time of survey can be found in Table IC-1. All questionnaires used can be found in Appendix A.

Questionnaires were developed after studying previous survey instruments. Those most comparable to the survey instrument developed include: the WECE questionnaire (especially for extra-curricular activities and support of significant others), the WEPAN questionnaire (especially for perception of the interpersonal climate and learning environment), the Pittsburgh Survey (especially on evaluation of the program at the end of the Spring semester), the Pathways survey (including perceptions of problems for women in math, science and engineering; high school background questions; and attribution of academic success or failure). Where available, comparisons are included between the Rowan survey and other survey results for comparable questions.

TABLE IC-1
SURVEY TOPICS INCLUDED BY SEMESTER OF SURVEY

TOPIC Semester of Survey:	Fall 00	Spring 01
Background		
Demographic information (age, sex, family status, race/ethnicity, parents'/siblings' education, occupation)	√	Partial
High school background (math/science classes and extra-curricular activities, SAT scores)	√	
Evaluation of adequacy of high school preparation		√
Support for engineering pursuit from significant others and high school staff	√	√
University Experience		
Major	√	√
Year	√	√
Living arrangements	√	√
Participation in student organizations and activities (non-engineering)		√
Work experience	√	√
Academic Performance (Overall GPA and engineering GPA	√	√
Engineering-Related Experience and Attitudes		
Participation in extra-curricular engineering-related activities		√
Preference for group/individual learning	√	√
Attribution of academic success/failure	√	√
Engineering self-confidence		√
Satisfaction with major		√
Satisfaction with specific elements of program		√
Contact with faculty outside of class (including research)		√
Satisfaction with student-faculty relationships		√
Satisfaction with peer relationships		√
Perception of problems in field for women/men	√	√
Commitment to engineering	√	√
Job expectations		√
Future Plans		
Highest degree expected	√	√
Financial concerns about university education	√	√
Plans for pursuing engineering employment in future		√
Preparations for post-graduation (for seniors)		√

Additional Information from University Sources

Additional information from university records was added to student's data for those students consenting to link their survey information up to school records (see consent letter in Appendix A).[7] This information included: GPA's and whether the student made the Dean's List, from university records, results from the College of Engineering survey of computer background of incoming freshmen in the Fall of 2000 and participants in summer internships arranged by the College. Retention data collected by the Institutional Research office provided additional insight.

Focus Group Interviews

In order to better understand the meaning of the survey questionnaires, particularly for the women's experience of the engineering program, four focus groups with a total of 19 female students were run. Another faculty member with experience joined the principal investigator to conduct these. The first three groups spanned a cross-section of majors and years. Students were asked about how they got into engineering and when they decided upon the major, how being female had affected their experiences at Rowan, whether they or other students they knew had felt any advantages or disadvantages due to their gender, how confident they felt about themselves in engineering, how they thought their future as an engineer would be affected by their gender, whether they would encourage other women to major in engineering, and what they would recommend to change at Rowan to improve the experience of female engineering students – or students in general. (The interview questions can be seen in Appendix A.) The last focus group was for senior women only, to probe how they felt as

[7] IRB approval was granted for the study in September, 2000.

the program neared its end, what were the most challenging and most rewarding aspects of the program for them, whether they would recommend other women to major in engineering, how they felt about their post-graduation plans, what concerns they had and how they thought those concerns were being or could be better addressed at Rowan.

Faculty and Staff Interviews

Interviews were conducted with all female faculty, all department chairs (and acting chairs), the Dean of Engineering, the Associate Dean of Engineering, and faculty members who helped found the program and had seen it evolve from its inception. A total of 15 faculty and staff were interviewed, each interview lasting at least one hour. The Associate Dean provided guidance throughout the study and was the major contact for the faculty, arranging protocol for the survey, supplying written information, and answering numerous questions about the program and the students.

Faculty were asked what they saw as the major strengths and special features of the program, how they had seen the program change (in ways which might be affecting the different cohorts), what gender differences they perceived, whether there were any gender issues among the faculty, and how they saw the program evolving in the future. (The interview questions can be seen in Appendix A.) In addition, the principal investigator met with several of the engineering departments to explain the study in depth and enlist their cooperation.

Printed Information

Written material provided by the College of Engineering and posted on their website added to the understanding of the special features of the program. Papers published on the program were also helpful. References to the program are available through the website: http://www.rowan.edu/engineering.

CHAPTER I-D

THE ROWAN ENGINEERING STUDENT POPULATION

This chapter describes the Rowan engineering student population. The students can be seen as the "raw material" entering the Rowan engineering program, and understanding their characteristics sets the stage for understanding initial gender differences and the role of Rowan in addressing these gender differences. We can also get a sense of the extent to which Rowan students are unique or representative of the broader population of engineering students. We begin by describing the study population in terms of gender, year in school, and engineering major. We follow with a description of the students' academic background and family background data gathered in the Fall, 2000 survey.

THE POPULATION OF THE SURVEY

During Fall, 2000 and Spring, 2001, 352 students were surveyed for this study. As some were surveyed in the Fall but not the Spring, and some were surveyed in the Spring but not the Fall, a total of 283 repeated the survey in Fall and Spring[8]. A breakdown of the students surveyed by year in school is presented in Table ID-1. The percentage in parentheses indicates the percentage of students completing the survey out of the total who were actually enrolled in this category in the Fall of 2000.

[8] For those students who were surveyed for the first time in the Spring, some demographic and background information was collected which could be used for analysis even though not all of the Fall questionnaire was repeated.

TABLE ID-1

SURVEY SAMPLE BY SEMESTER, YEAR IN PROGRAM, AND SEX
(Response rate out of total enrolled in parentheses)

	Semester of Survey		
Year in Program	**Fall 2000**	**Spring 2001**	**Completed Both Surveys**
First-year	102 (84%)[a]	85	83
Sophomore	99 (84%)	91	84
Junior	82 (100%)	62	60
Senior	49 (80%)	65	59
Total	332 (86%)	303	283

[a]Number in parenthesis indicates percentage out of total enrolled in this cell at time of survey.

Questionnaires were distributed in required classes, thus ensuring a high response rate (average of 86%). However, some students were absent and could not be reached within a reasonable amount of time to complete the survey. An effort was made to track the missing students (through email and phone contact) to give them the survey at a special time within the next two weeks. Some of the students were not enrolled in required classes and thus missed the survey; some were not enrolled in any engineering classes and in fact were only formally still enrolled in the major; some were ill or had taken a leave of absence. All in all, this is a more complete cross-section of students than many of the recent surveys conducted in engineering schools (for instance, Thorsen et. al. report response rates of under 20% for their 1997 engineering student survey and for their 1993 senior engineering women survey. Cunningham et. al. (2002) report a higher response rate of 66% from their web-based survey, but only women are included in their study).

The rest of this chapter is based on responses to the Fall survey, when the demographic information was collected.

GENERAL CHARACTERISTICS OF THE ENGINEERING STUDENTS

Gender

Twenty percent of the engineering students answering the survey were female, quite comparable to the national average of 19.7% in undergraduate engineering at the time (NSF, 2000) (Table ID-2)[9].

TABLE ID-2
YEAR IN PROGRAM BY GENDER
(%'s)

	Male	Female	Total (n)
First year	79.4	20.8	100.0 (102)
Sophomore	79.0	21.0	100.0 (99)
Junior	83.1	16.9	100.0 (82)
Senior	75.4	24.6	100.0 (49)
Total	79.4	20.6	100.0
(Total n)	(281)	(71)	(352)[a]

[a] Includes data on students who were added in the Spring.

Year in School

There are somewhat more students in the first and second years of the program than in the junior and senior years. The main reason for this is that the majority of students who switch out of engineering do so after the first and second years. According to

[9] These percentages are a little higher than the actual proportion of women in the engineering cohorts, because a greater effort was made to include all female students, since they were relatively few in number. Therefore the female students are slightly more represented in the survey than the male students.

institutional data,[10] an average of 19.7% switched out of engineering after the first year for the years 1996-2001; another 9.7% switched out after the second year for the years 1996-2000; and only 3.8% and 2.1% switched out during the junior and senior years, respectively. As a result, the junior and senior classes are somewhat smaller than the freshman and sophomore classes, in each cohort. Also, the 1997 cohort (seniors at the time of the survey) was smaller to begin with (n=77) than the 1998, 1999 and 2000 cohorts (beginning with 107, 115 and 117 respectively); on the other hand, few students transfer into the program. As we will show below, at any given level, surprisingly fewer women have switched out of engineering than males: totaling the cohorts from 1996-2001, 31.4% of the males who started out in engineering switched out, compared to 25% of the females who started out in engineering. This contributes to a slightly higher proportion of females in the senior cohort than in earlier years.

Major

The Rowan program has four major areas of study: chemical engineering, civil and environmental engineering, electrical and computer engineering, and mechanical engineering.[11] About a third of the students are electrical/computing engineering majors, a quarter mechanical engineering majors, a fifth of the students are chemical engineering majors, and a fifth civil and environmental engineering majors (Table 1D-3). The general major was only available for first-year students who had not decided on their major yet.

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[10] Made available to the principal investigator by Institutional Research at Rowan.

[11] The environmental emphasis was added to the civil engineering major two years after the program started, and the computer engineering emphasis was added to the electrical engineering major three years after the program started. (Adding these emphases allowed for more specialization within the major and was made possible by additional faculty and curriculum development.) For the first four years of the program, students were allowed to enter as "general" engineering majors and guided to select one of the other four majors during their sophomore year and preferably before its start. However, this general major was being phased out in the academic year 2001-2 and completely eliminated beginning Fall 2002.

TABLE ID-3
COHORT BY MAJOR
(%'s)

	Major					
Year in Program	**Chemical**	**Civil/ Environmental**	**Electrical/ Computing**	**Mechanical**	**General**	**Total % (n)**
First-year	14.2	17.9	18.9	25.5	23.6	100.0 (106)
Sophomores	21.9	21.9	32.4	23.8	na	100.0 (105)
Juniors	10.8	26.5	37.3	25.3	na	100.0 (83)
Seniors	24.0	13.8	24.1	37.9	na	100.0 (58)
Total	17.3	20.5	28.1	27.0	7.1	100.0 (352)[a]
Enrollment in major, national average, 2000[c]	*6.8*	*9.4*[b]	*36.1*	*16.9*		
B.A. degrees awarded nationally, 2000[d]	*10.4*	*16.1*[b]	*29.6*[e]	*22.0*		

[a] Includes data on students who were added in the Spring.
[b] Civil only (no data available on environmental engineering majors separated from "others").
[c] Source: CPST data from the Engineering Workforce Commission (posted on www.wepan.org).
[d] Source: National Science Foundation, Division of Science Resources Statistics (NSF, 2002).
[e] Does not include computing engineering.

The distribution across majors varies somewhat by cohort. The proportion of electrical engineering majors varies from 18.9% in the freshman 2000 cohort to 37.3% in the junior cohort; the proportion of mechanical engineering majors varies from 23.8% in the senior cohort to 36.1% in the junior cohort; the proportion of chemical engineering majors varies from 10.8% in the junior cohort to 24.0% among seniors; the proportion of civil/environmental majors varies from 13.8 among seniors cohort to 26.5% among juniors. These fluctuations result from students' choices without any formal enrollment management (because of these wide fluctuations, among other considerations, an enrollment management system was introduced beginning in Fall 2002, in order to achieve a more predictable and even balance between majors).

About 70% of the nation's engineering majors are in the four disciplines that Rowan offers[12] (CPST data via wepan.org website), and about 78% of the B.A. degrees were awarded to these four disciplines in 2000 (NSF, 2002:Table 26), which makes Rowan's engineering students quite similar to the majority of engineering students nationwide in terms of major. Rowan has a disproportionate amount of chemical, civil, and mechanical engineers, compared to the national average; and about the same or in some cohorts less than the national average in electrical/computing engineering.

Female students seem to prefer some majors to others. Since students' majors were a result of their own choice at this point in Rowan's enrollment, it is fair to assume that their distribution across majors reflects their own preferences rather than channeling by the school officials. Most of the female students are in chemical and civil/environmental engineering; fewer are in mechanical engineering and they make up even fewer (less than 10%) of the electrical/computing engineering majors (Table ID-4). The actual proportion of female students varies from cohort to cohort, but the general pattern is similar.

[12] Plus those in environmental engineering, who were not separated out in the CPST data. These figures correspond very closely to the distribution of majors in the national sample used by Astin & Astin (1993). The other major discipline, which Rowan does not have, is aeronautical engineering.

TABLE 1D-4
PERCENTAGE FEMALE IN MAJOR BY YEAR IN SCHOOL

	Major					
Year in Program	Chemical	Civil/ Environmental	Electrical/Computing	Mechanical	General	Total (n)
First-year	26.7	42.1	5.0	18.5	17.5	20.8 (106)
Sophomores	39.1	26.1	11.8	12.0	na	21.0 (105)
Juniors	22.2	40.9	3.2	9.5	na	16.9 (83)
Seniors	42.9	45.4	0	18.2	na	24.6 (61)
Total	34.4	36.1	6.1	14.7	17.5	20.2 (352)[a]
National average[a]	*36.3*	*22.9*[b]	*15.1*	*12.4*	*na*	*19.5*

[a] Includes data from students added in Spring.
[b] Calculated from CPST Engineering Workforce Commission data on Engineering and Technical Enrollments, Fall 1990-2000 (WEPAN website www.wepan.org)
[c] Civil engineering only; statistics for environmental engineering were not available

While it fluctuates from year to year, compared to the national average of proportion female in engineering majors, Rowan's average proportions of females in chemical and mechanical engineering are similar to the national averages, the proportion of female students in civil and environmental engineering is higher than the national average (although it should be remembered that the national statistics were for civil engineering only); but Rowan has a lower proportion of females than the national average in electrical and computer engineering. These majors account for 63% of the majors of female students in engineering nationwide (CPST, 2000), and 85% of the bachelor's degrees awarded to female engineers in 2000 (NSF, 2002), which suggests an overall similarity between Rowan and female engineering students nationwide.

Because of the small numbers of women in some of the majors at Rowan, most of our analysis is not able to differentiate between the different disciplines, although we recognize that there may variation across majors on many of our indicators.

Age

In a number of ways, the Rowan engineering students are quite homogeneous, and therefore variation in these characteristics could not be studied. For example, nearly 97% of the Rowan engineering students are of "traditional" college age between the ages of 17 and 25. Less than 2% are over 30, and another 1.6% are between the ages of 25-29. There were virtually no significant gender differences in the age breakdown. Because of the small numbers of "non-traditional" students, the impact of age was not pursued in the analysis. Similarly, most (96%) of the Rowan engineering students are single, and less than 3% are currently married. Again, small numbers precluded pursuing any analysis of the impact of marital status on their undergraduate educational experience.

Race and Ethnicity

Nearly 90% (89%) of the Rowan engineering students are Caucasian, 5.6% Asian-American or of foreign nationality, and only 5.4% (n=23) are non-Asian minority (African-American, Hispanic, and Native American). When the minority students were divided by gender, there were less than 10 non-Caucasian female students. Therefore, this small number precluded any reliable analysis of minority status as it interacted with the engineering experience.

ACADEMIC BACKGROUND

In this section we present the academic background of the engineering students at Rowan. This is important in order to understand the type of students at Rowan, and also in order to determine the extent to which any gender differences in engineering outcomes might be traced to different preparation before college.

Academic Achievement

The level of academic achievement of students entering the Rowan engineering program compares quite favorably with other institutions in the Mid-Atlantic region (Table ID-5a). About two-thirds of the entering cohort of 2002 were in the top quarter of their high school class. Although there are more selective institutions in the area with regards to this criteria, the SAT ranges of the Rowan students are higher than the other public engineering institutions in the area for which data was available (NJIT, Pennsylvania State, College of New Jersey, University of Delaware). The more elite institutions of engineering, such as Rose-Hulman, Cooper Union, and Princeton, do not have as broad a range of students as Rowan does.

The level of the Rowan engineering students, as indicated by the average SAT scores, is considerably higher than the national average (Table 1D-5). Over 90% of both the male and female students had math SAT scores of 650 or higher, making them quite comparable to Seymour & Hewitt's (1997) sample of students whom science, math and engineering faculty "expected to be capable of handling the course work", with a minimum math SAT score of 650. In the national WECE sample of women (Women's Experiences in College Engineering; Goodman et. al. 2002:43), the average math SAT score ranged from 650-699 (a little higher than the average for Rowan engineering women), and the average verbal SAT score ranged from 600-649 (also a little higher that of the Rowan engineering women).

TABLE ID-5
NEWLY ENROLLED STUDENT CHARACTERISTICS OF VARIOUS UNDERGRADUATE ENGINEERING PROGRAMS, 2002*

College or University	Math SAT range	Verbal SAT range	Total SAT range	% top 25% high school class
Monmouth University	560-610	510-570	1100-1180	38%
Widener University	500-670	380-640	880-1310	41%
Drexel University	580-680	530-630	1120-1300	61%
New Jersey Institute of Technology	560-670	480-600	1060-1250	62%
Pennsylvania State University	Hi 659	Hi 591	Hi 1250	na
Rowan University	**550-790**	**430-750**	**1050-1450**	**64%**
LeHigh University	Hi 692	Hi 620	Hi 1312	73%
College of New Jersey	410-630	350-550	760-1180	89%
University of Delaware	Hi 663	Hi 601	Hi 1264	87%
Renssaleur Polytechnic Institute	580-680	640-720	1220-1400	91%
University of Pennsylvania	na	na	na	95%
Old Dominion University	550-740	530-650	1080-1370	na
Rose-Hulman Institute of Technology	640-720	570-670	1220-1390	96%
Cooper Union	700-800	620-800	1320-1600	100%
Princeton University	600-800	550-800	1150-1600	100%

*ASEE Survey of Engineering and Engineering Technology Colleges, 2002 (www.asee.org/publications/colleges/default.cfm)

In terms of high school achievement, Rowan females were more likely to report that they received A's in their high school science classes than were males, while males had somewhat higher math SAT scores (Table ID-6). There are no significant gender differences in verbal SAT scores; or in grades in high school math classes.

TABLE ID-6
PRE-COLLEGE ACADEMIC ACHIEVEMENT BY GENDER
(Rowan Engineering students and National NCES data)

Indicator of Academic Achievement	**Males**	**Females**
% "Mostly A's" in high school science classes (Rowan)	44.4	50.0
% "Mostly A's" in high school math classes*(Rowan)	51.9	68.2
Mean score on Verbal SAT (Rowan)	584	585
Mean score on Math SAT** (Rowan)	653	635
Mean score on SAT (Rowan total)	1237	1220
National Mean total SAT scores of "engineering path students" "completers" 1982-1993[a]	1092	1112

[a] NCES, High School & Beyond (Adelman, 1998:Table 19). "Engineering path students" have taken a minimum number of engineering courses to be considered in the major; "completers" finished their degree in engineering.
*Chi-square significant at p<.10
**T-test significant at p<.05

Type of High School

Three-quarters of the Rowan engineering students have an urban or suburban background, and even among those who were brought up in rural areas, many went to urban or suburban high schools – a total of 83% of the Rowan engineering students. Most (97%) of the students went to co-ed high schools, and 86% came from public high schools. The lack of variation in this respect precluded further analysis of the effect of type of high school background in the rest of the analysis.

High School Science and Math Background

Students were asked how many semesters of various high school math and science classes they had had. Albeit this is a rather crude measure of high school math and science background, but it is an indication of the extent of training. In terms of physics, chemistry, biology, earth sciences, environmental science, and engineering classes, the gender differences were not statistically significant. Males and females were also equally likely to have had lab experience in high school (Table ID-7). However, males did have more semesters of computer science than the females on the average.

On the average, the female students had participated in more extra-curricular science activities during high school than did male students (Table ID-7). In fact, when we looked at each type of extra-curricular activity individually (including summer programs, contests, after-school or weekend programs, and more), more females had participated in each kind of activity during the high school years than had males.

TABLE ID-7
MATH AND SCIENCE PRE-COLLEGE BACKGROUND BY SEX

Pre-College Characteristic / Gender	Males	Females
Mean # semesters of high school science*	3.8	2.8
Mean # semesters of high school math	3.0	3.7
% participated in 2 or more extra-curricular math or science activities in high school**	21.2	42.4
(n)	(266)	(66)

*T-test significant at p<.05
**Chi-square significant at p<.05

Therefore, in terms of academic preparation, the main disadvantage the female students have is fewer computer science courses before college, while their main advantages are in terms of extra curricular activities.

FAMILY BACKGROUND

Parents' Education

One of the factors influencing students' persistence in undergraduate education is parent's education. First-generation college students are at greater risk of encountering difficulties adapting to college culture and requirements and have lower academic self-confidence (Peterman, 2000; Terenzini, et. al., 1996; Van T. Bui, 2002; Zwerling &

London, 1992). Almost a third of the parents of the Rowan engineering students had high school educations or less, making these students “first generation” college students. Another 21% had parents who did not complete an undergraduate degree. About half of the parents had undergraduate or graduate college degrees. As Table ID-8 shows, Rowan engineering students’ parents are somewhat more highly educated than the average postsecondary student (surveyed in the 2000 National Postsecondary Student Aid Study).

In national data (NPSAS:2000), parents of male postsecondary students are somewhat more educated than parents of female students. Among the Rowan engineering students, however, fathers of female and male students had similar levels of education, and the mothers of female students were more likely to have completed a college degree than were the mothers of male students (Table ID-8). Thus, the Rowan female student are not disadvantaged in terms of their parents as role models for education or in terms of the socio-economic resources parents’ education indicates. It seems that more educated mothers might be more likely to encourage their daughters to attend engineering schools.

TABLE ID-8
PARENTS' EDUCATION BY STUDENT'S SEX
(%'s)

	Rowan Students						**National Sample**		
	Father's Education			**Mother's Education**			**Education of either parent (NPSAS:2000)***		
Gender of Student	Males	Females	Total	Males	Females	Total	Total	Males	Females
High school education or less	26.2	27.2	26.5	33.1	23.1	31.1	37.1	34.6	39.0
Some post-secondary education	21.5	16.7	20.5	21.7	18.5	21.1	22.8	21.2	24.1
Undergraduate college degree	33.6	34.8	33.8	31.9	36.9	32.9	40.1	44.2	37.0
Graduate or professional degree	17.7	19.7	18.1	13.3	21.4	15.0			
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(n)	(265)	(66)	(331)	(263)	(65)	(328)			

*Source: U.S. Department of Education, National Center for Education Statistics, 1999-2000 National Postsecondary Student Aid Study (NPSAS:2000) (http://nces.ed.gov/surveys/npsas/table_library/tables/npsas39.asp)

Parents' Occupations

Parents' occupations add to the socio-economic resources supporting a student, as well as give an indication of occupational role models the parents provide. In terms of occupation, the Rowan students' parents are disproportionately managerial and professional compared to the wider U.S. population, and underrepresented in terms of service and blue-collar occupations (Table ID-9) – as are college students' parents nation-wide (CPS, 2000). Fathers of Rowan engineering students are more likely to be in managerial/administrative positions and blue-collar jobs than are mothers; their mothers are disproportionately educators and clerical workers.

Parental occupations of male students are quite similar to those of female students. Female students are slightly more likely to have fathers in engineering, and slightly less likely to have fathers in managerial or administrative positions, than are male students (Table ID-9).

TABLE ID-9
PARENTAL OCCUPATIONS OF MALE AND FEMALE ENGINEERING STUDENTS
(%'s)

	Fathers			Mothers		
Gender of Student / Occupational Group of Parent	Total	Males	Females	Total	Males	Females
Managerial/administrative	21.8	21.8	22.0	8.9	10.0	3.8
Professional	27.1	28.6	27.1	42.9	42.9	45.3
Engineering	8.9	7.4	14.8	0	0	0
Other science, math, computer science	5.0	5.0	4.9	1.9	2.3	0
Education	5.6	5.4	6.6	25.7	25.2	27.3
Technicians/related support	.3	.4	0	2.6	3.3	0
Clerical/administrative support	1.0	1.3	0	26.4	25.7	28.2
Service	5.9	6.3	5.1	5.6	5.7	5.7
Sales	9.9	9.7	10.2	9.3	9.5	9.4
Blue-collar	32.1	31.9	35.6	4.1	2.9	7.5
Precision production/craft	23.4	23.1	24.6	.4	0	1.8
Operators & laborers	8.9	8.7	9.8	3.7	2.3	5.7
Total %*	100.0	100.0	100.0	100.0	100.0	100.0
(n)	(303)	(303)	(303)	(269)	(269)	(269)

*Rounded off. May not total 100.0 due to "other" (e.g. military, farming) among the employed.

We coded the occupations of the students' parents with the latest national survey of prestige scores available in the United States, the standardized prestige scores obtained in the 1989 NORC survey (updated for census categories of 1990) (Nakao & Treas, 1994). There are no gender differences in the mean prestige scores of mothers and fathers (Table ID-10), indicating that the male and female students come from similar social classes.

TABLE ID-10
MEAN PRESTIGE SCORES* FOR OCCUPATIONS OF MOTHERS AND FATHERS, BY GENDER OF STUDENT

	Father's prestige score**	**Mother's prestige score****
Male students (n)	52.8 (237)	52.2 (211)
Female students (n)	52.7 (59)	50.6 (53)
Total (n)	52.8(296)	51.9(264)

* Using the prestige scores measured by Nakao & Treas (1994) and adapted to the 1990 Census categories by Hauser & Warren (1996).
** Based on occupations reported by the students. Students were instructed to give the parent's last occupation if the parent was currently unemployed, retired or deceased.

Role Models

The importance of role models in the field is related to two phenomena: acquaintance with the field and its practices and requirements (knowing what to expect); and an identification that someone like the student can succeed in the field. Role models may also provide needed advice or mentoring from someone that the student can identify with. The concept has come to the fore as a factor weakening women's persistence in the fields of math, science and engineering, where female role models have been scarcer and fewer females have relatives or teachers with whom to identify personally. According to previous research, female students' commitment to engineering is enhanced by having role models in the family, i.e., parents, siblings, or other relatives in engineering or another math or science field (Cunningham et. al., 2002; Seymour & Hewitt, 1997).

We looked at two types of role models: educational role models (parents or siblings who had been to college) and occupational role models (parents or siblings in the fields of engineering or related math and science fields).

As we have mentioned above, about half of the students had educational role models in their parents, who had completed college degrees. A higher proportion of the mothers of female students had completed college degrees than of male students, but there was no gender difference with regard to father's education. More of the siblings of male students were or had been in college (58.9% compared to 49.4% of the female students). Perhaps these balanced out, with females having stronger educational role models in their mothers, and males having stronger educational role models in their siblings.[13]

Most of the students' mothers worked. Nearly 85% of the female students' mothers were working at the time of the survey, and 95% of the mothers were employed at least part time while the student was in high school. Therefore, most of the females had role models of mothers working in the labor force (and the number who did not was too small to pursue analysis).

Less than 10% of the students' fathers and none of the students' mothers were engineers. However, it is interesting that a slightly higher percentage of female students' fathers were engineers (14.8%) than were male students' fathers (7.4%). Another 5% of both males' and females' fathers were in another math, science, or computing field; but only 2% of the mothers were, all of them of male students. About 24% of the students' brothers were in engineering or another math or science field, and about 18% of the students' sisters. The male students were slightly more likely to have brothers in these fields (24.6% vs. 20.4% of the females); the female students were slightly more likely to have sisters in these fields (23.2% vs. 16.2% of the males). In the focus groups, many of

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[13] Although Duggan (2001) found that sibling's educational level did not have a statistically significant effect on undergraduate retention.

the female students indicated that an uncle, aunt or close friend of the family was in engineering, and encouraged them to go into the field.

One of the well-known aspects of having fewer female role models in math and science is that a smaller proportion of high school math and science teachers are female than male. Therefore the students were asked whether they had had any female math or science teachers in high school. Perhaps it is a sign of the times, or a result of a population that had already selected engineering as a field of pursuit, that over 95% of both males and females had at least one female math or science teacher in high school (less than 2% of the female students had not). Therefore, this did not seem to be an important variable to pursue.

Thus, in terms of role models for education, female students have somewhat of an advantage in terms of mother's education. In terms of occupational role models, differences were relatively small, and focus group interviews suggested that females look beyond their immediate family for significant role models in the field.

Support for Engineering

Students were asked about the extent of support they received for their pursuit of engineering by family members, friends, and high school faculty and staff. Both male and female students said that they had strong support for their engineering pursuits on the part of mothers, fathers, friends, high school teachers and counselors (Table ID-11). There were practically no gender differences in this. The only statistically significant gender difference was that mothers of female students were somewhat less positive than mothers of male students (86.2% of the female students' mothers had “positive" opinions of their being in engineering, compared to 92.0% of the male students' mothers).

All of the support items were recoded into dichotomies, and summed, to form a composite index of support. On this measure there was no gender difference.

TABLE ID-11

SUPPORT FOR ENGINEERING PURSUIT

(% positive opinions about the student pursuing engineering major or career)

	Males	Females
Mother**	92.0	86.2
Father	90.0	90.8
Best friends	75.5	71.9
Boyfriend/girlfriend	69.3	67.8
Most influential teacher	86.7	86.2
High school counselor	74.7	74.6
Mean score on support index	6.58	6.61
(n)	(266)	(66)

**Chi-square significant at p<.05

In an attempt to understand whether some types of students had more support than others, we analyzed a multiple regression model with the support index as the dependent variable and the independent variables were gender (to see whether males had more support when other background differences were controlled), high school grades in math and sciences, SAT scores (expecting that students with higher achievement would receive more support for their pursuit of engineering), family members as role models (father, mothers or siblings in the field of science or math), father's and mother's education, and father's and mother's prestige scores (to see if social status was related to support). The model explained about 5% of the variance, and none of the independent variables had a statistically significant relationship with support. Thus, background variables, gender and year in school do not account for the variation in support for the pursuit of engineering.

CONCLUSIONS

There were two purposes to this chapter. The first was to provide a description of the Rowan engineering students who form the population of this study, and to allow others to assess how comparable this population is to theirs.

The second was to determine whether there were any significant gender differences that might serve at least as partial explanations for any gender differences in engineering outcomes that we find in the study. In light of previous literature, this was particularly interesting because while earlier research would lead us to expect a gender gap in pre-college preparation, family support for the pursuit of engineering, and same-sex role models (e.g., AAUW, 1992; Blaisdell, 1998; Cunningham et. al., 2000; Kahle and Meece, 1994; Kramarae and Treichler, 1990; Layzer, 1992; Leder and Fennema, 1990; Tobias, 1990), later research has shown parity at least in terms of high school math and science achievement (NCES, 2003), especially among women and men who actually go into math, science or engineering majors (Hoffer, 1995).

In terms of gender differences in background variables, the most important conclusion is that the female students are not weaker in terms of high school math and science background or achievement. In fact, they had higher grades in math and science than did males, participated in more extra-curricular activities for math and science than did their male counterparts; however, they were somewhat less likely to have computer science courses and had lower math SAT scores. In terms of family background, females' mothers had somewhat higher education, and more of their fathers were engineers; however, more of the males' siblings were in engineering or a related math or science field. Males and females shared relatively strong support from significant others for their pursuit of engineering.

The background differences, therefore, are quite minimal, and suggest an equal footing for males and females as they enter Rowan, unlike expectations from previous research.

CHAPTER II-A

INTRODUCTION TO FINDINGS: THE PROCESS OF BECOMING AN ENGINEER

In this chapter we present our conceptualization of the process that students of engineering undergo during their undergraduate years and show how our study contributes to the understanding of that process and the role that gender plays in it. We then explain how the chapters that follow shed light on this process, based on the findings of our study.

As we see it, students come into the engineering program at Rowan with certain characteristics and training, which serve as their input into this process. This input includes:

1) demographic characteristics, such as sex, age, ethnicity/race, marital status);
2) socio-economic background, including parents' education, occupation, and income[14];
3) social support for their pursuit of engineering as a major and as a career goal by significant others (e.g., parents, siblings, friends, influential teachers) and wider societal attitudes about the suitability of people like them (e.g., women or men) being an engineer;
4) exposure to role models which can reinforce their expectations to succeed in the major and in the career as an engineer;

[14] and/or their own, depending on their age and marital status.

5) pre-college academic preparation, including both formal high school instruction in science and math and extra-curricular activity in these fields;
6) initial self-confidence that they belong in engineering or can see themselves as an engineer, and that they belong in college and can see themselves succeeding in college.

Once they have entered the undergraduate engineering program, and during their time in it, students are exposed to and presumably influenced by the program and school they are in and to which they react. Such influences include:

1) the curriculum (such as the extent of laboratory work and interdisciplinary emphases):
2) the pedagogy (such as the extent of group work):
3) the administration of the program:
4) the interpersonal climate with faculty and peers;
5) opportunities for extra-curricular activities both on and off-campus, both during the academic year and in the summer.

The student's input into the process predisposes them for their orientation to themselves as a student, as an engineering student in particular, and themselves as an engineer in terms of the long-term career, and thus affects their experience of the program and its surrounding characteristics.

The interaction of their input factors with the school influences results in engineering outcomes at every stage of the program as well as engineering outcomes at the end of the program. During the undergraduate program, these outcomes include such factors as

1) engineering self-confidence, which may change from the initial engineering self-confidence:
2) satisfaction with the program and interpersonal climate during the course of the program:
3) academic performance;
4) retention at each level of the program.

Outcomes at program's end include:

1) graduation (or early exit from the program, either for another major, another college, or dropping out altogether);
2) continuation in graduate studies (in engineering), or
3) employment in the field;
4) engineering self-confidence that they belong in the career and will stay in it.

Each year students go through another cycle of this process, with the outcomes of the previous year(s) in the program serving as input factors which interact with student's input characteristics (family background, high school background, and initial engineering self-confidence) and the institutional factors of program and interpersonal climate to produce year-end outcomes of satisfaction, academic performance, and retention in the program. These cycles continue until the student reaches the end of the undergraduate program.

For the majority of the students (as we show below), the final stage of the undergraduate process is reached at graduation, usually within 4-6 years of beginning the program. Other students may opt to terminate the program before graduation, either changing major or college or dropping out altogether. [15] Graduation can be followed by graduate school (either in engineering or another field) or employment (either in engineering or another field) (or neither).

The components and the sequence suggested in this process are represented in Figure IIA-1. It shows how the student comes into Rowan with an initial input of background factors and engineering self-confidence, which interacts with their first-year experience – expressed as involvement in extra-curricular activities and academic performance-- to produce engineering self-confidence at the year's end, satisfaction with the program, and retention for the second year. These outcomes at the end of the first year form the basis for the student's experience in the second and subsequent years, until the student reaches the end of the program (or, exits earlier).

This model can also be seen from the institution's point of view, where recruitment targets students with certain characteristics (e.g., a high SAT score, demonstrated interest in science or math or engineering). Students are offered a particular curriculum (at Rowan, for example, the unique engineering clinic), extra-curricular activities (including undergraduate research opportunities, internships), and a certain type of interpersonal climate is fostered (at Rowan, for example, personal faculty-student relations are fostered). The outcomes of each semester are assessed through a variety of

[15] This "input-environment-outcome" research model is similar to that employed by Astin (1991, 1993) and Sax (1994, 1996, 2001), which they have used to analyze the impact of various environments and institutional experiences on individual outcomes (after controlling for input differences among individuals). Ross (1994) employed a similar conceptual model in her dissertation on undergraduate women in engineering. Neither, however, articulated the longitudinal nature of the current model.

measures, including (but not limited to) instructor-driven classroom tests and assignments, and student evaluations. Sometimes student achievement during the academic year results in internal awards (such as making the Dean's List) or external awards, funding a student's future education or other expenses. One of the measures of a program's success from the institution's point of view is how many students continue on for another year of the program. Like students, institutions assess the final outcomes by graduation rates, percent employed who sought jobs, percent placed in graduate school.

The present study collected data on much of this process as students experience it, following a cycle of one year for students at various stages of the undergraduate program. Additional data collection has continued beyond the scope of the present study in order to follow cohorts of students as they progress through the course of the entire program. Once this data collection process is complete, the full model will be applied and analyzed.

This report presents the results obtained for main elements of the process during the academic year 2000-01. The general chart presented (Figure IIA-1) serves as a guideline for the presentation of the results and the assumed interrelationships between the various components of the study. As each component of the model is introduced, some discussion of its importance and role in the process is included.

We have already described the population of Rowan engineering students in terms of their demographic characteristics, family socio-economic background and pre-college math and science background. In the following chapters, we first describe the initial engineering self-confidence students bring with them to Rowan, and the engineering self-confidence at the beginning of each level of the program (Chapter II-B). We show how this self-confidence is interrelated with the background characteristics of the students.

Chapter II-C shows how these input factors of background and engineering self-confidence are related to the student's engineering behavior and academic performance over the course of the academic year. Chapter II-D shows how engineering self-confidence changes over the course of the academic year, and how this change is related to the student's input into the program, and their engineering behavior and performance over the course of the year. Chapter II-E analyzes the students' satisfaction with the various aspects of the engineering program and interpersonal climate at the end of the academic year and how these various kinds of satisfaction vary for students with different input, engineering self-confidence, and engineering behavior and performance. We also discuss how satisfaction with various aspects of the engineering program are related to changes in engineering self-confidence over the academic year. Chapter II-F looks at the outcome of retention throughout the program and graduation, and relates them to the input factors of family and high school background, engineering behavior and academic performance, engineering self-confidence and its change over the course of the year, and satisfaction with the Rowan program and interpersonal climate.

As we focus on each of these components of the process of the undergraduate preparation for engineering (academic performance and engineering activities during the year, self-confidence, satisfaction and retention) we pay special attention to gender differences and how they are interact with the impact of background factors and engineering self-confidence.

Our interest on gender differences in experiencing the undergraduate program at Rowan led us also to ask the students what kind of problems they perceived women to have in engineering, and these perceptions are the focus of Chapter II-G.

In Chapter II-H, we put the Rowan findings into somewhat broader context by introducing comparisons to other engineering populations where similar questions were asked of the students.

Finally, we draw conclusions about the Rowan program and make suggestions for further application and study (Chapter III).

FIGURE IIA-1

PROCESS OF UNDERGRADUATE ENGINEERING EDUCATION

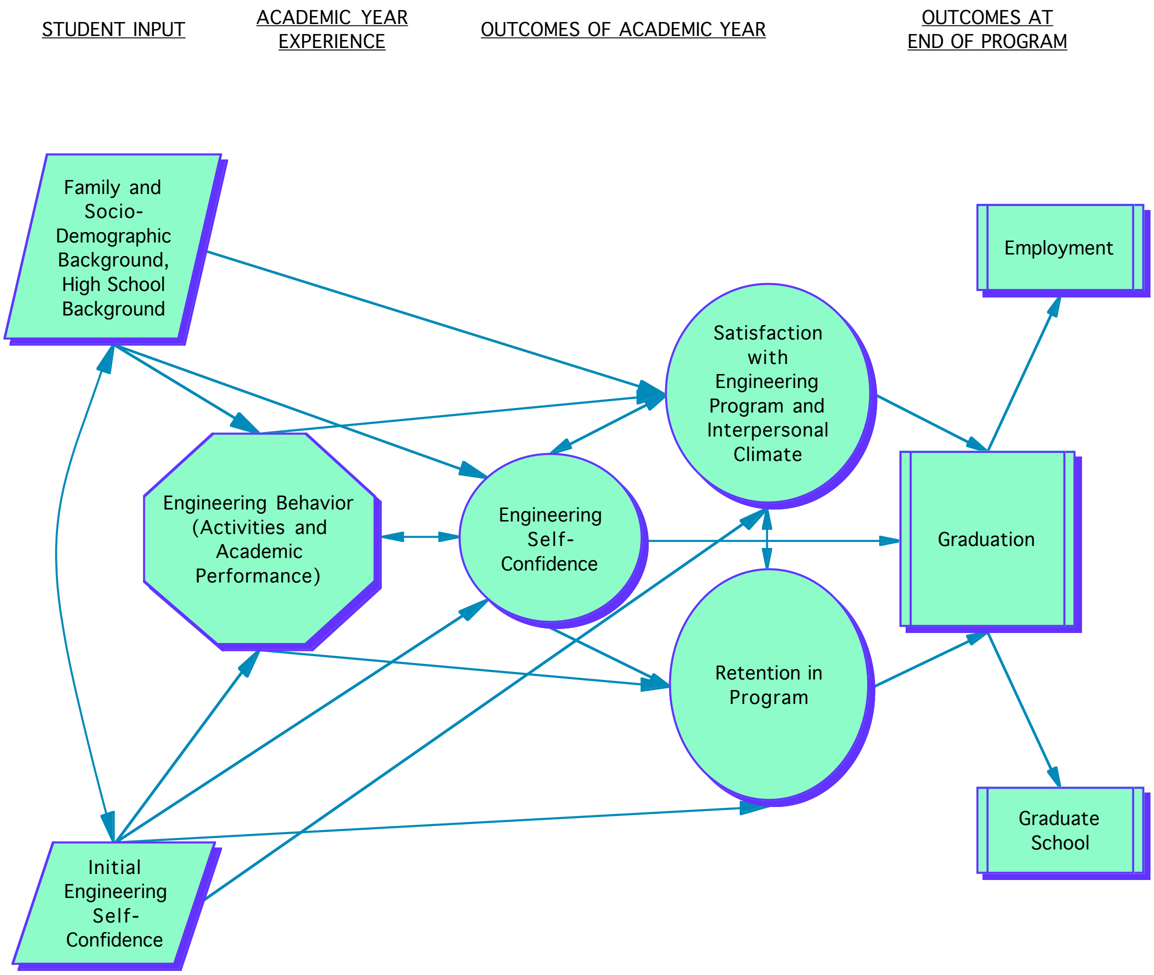
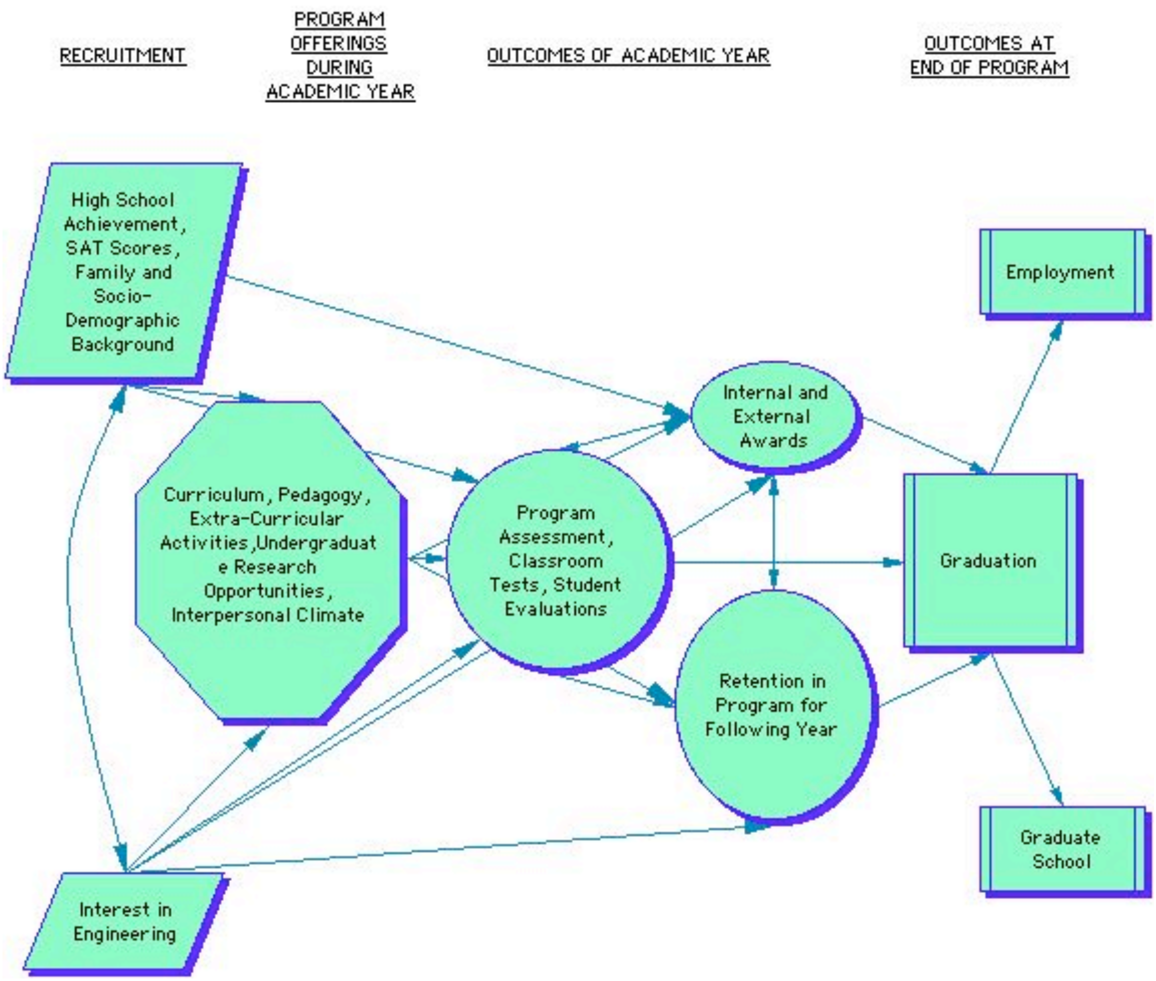


FIGURE IIA-2

PROCESS OF UNDERGRADUATE ENGINEERING EDUCATION FROM INSTITUTIONAL PERSPECTIVE



CHAPTER II-B

THE RELATIONSHIP BETWEEN ENGINEERING SELF-CONFIDENCE AND BACKGROUND FACTORS

In this chapter we focus on the interrelationship between the students' engineering self-confidence and their background characteristics. We begin by presenting the measure of engineering self-confidence developed in this study. We then show the relationship between this engineering self-confidence and background characteristics of the first-year students, and then show how the relationship changes with level in the program.

THE MEASUREMENT OF ENGINEERING SELF-CONFIDENCE

Self-confidence in engineering was measured by about 20 questions for which the students rated their self-confidence in a number of engineering-related areas, including such indicators as how confident they were that engineering was the right major for them, how confident they were in their academic abilities generally, how competent they were in skills required for their major. Indicators were factor analyzed. The analysis showed that these indicators contained four factors, thus reducing the number of indicators into four main indices that were used to reflect the main aspects of engineering self-confidence.[16]

The first factor (CONF STAY ENG) expresses how confident the student is that they belong in engineering and will stay with the major and the career. Indicators contributing the most to the score on this first factor were the student's agreement that: "engineering is the right major for me", that they are unlikely to drop out of the program before

[16] See more details about the construction of the factors in Appendix B.

completion; that they are well-suited for their major and their chosen career. This is the main factor indicating engineering self-confidence (λ=20.1).

The second factor (CONF ENG ABIL) reflects confidence in the students' competencies or skills required in engineering. Indicators contributing the most to the second factor include: the student's agreement that they are mechanically inclined, technically inclined, and good at designing things (λ=18.1).

The third factor (CONF ACAD ABIL) addressed the student's assessment of more general academic abilities required for engineering. Indicators contributing the most to this factor included the student's rating of their overall academic ability and their mathematical ability compared to other students their age (λ=15.5).

The fourth factor (CONF COMM SKILL) expressed the student's self-confidence in their communications abilities (e.g., writing, speaking), skills needed for presentations in many of their classes as well as for more informal interpersonal interaction, but again less specific to engineering than the first two factors (λ=14.0).

For much of the analysis, we concentrate on the first or the first two factors, as they express the more important aspects of engineering self-confidence for the students.

As standardized factor scores, the mean score for each factor is 0 for the whole population of respondents (all students). The scores ranged between –5 and +3. The higher the engineering self-confidence (on any of the factors), the higher the factor score.

ENGINEERING SELF-CONFIDENCE AS STUDENTS ENTER ROWAN

We begin by focusing on first year students. Students enter Rowan with some uncertainty that they belong in engineering. Their mean scores on the first engineering self-confidence factor are -.356 (Table IIB-1). As an example of the individual indicators making up this factor, while 22.4% of the first-year students "strongly agree" they are well-suited for their choice of college major, nearly 20% are unsure or disagree with this statement; while 30.8% "strongly agree" that "Engineering is the right major for me", 37.5% are unsure or disagree with the statement.

With respect to the most important of the factors of engineering self-confidence, males enter with more self-confidence that they belong in engineering and that they will stay with the major and the career (Table IIB-1). Their mean score on this factor is significantly higher than that of the female students, and their answers to the individual indicators reflect this same gender gap. Males express more confidence that engineering is the right major for them, that they are well-suited for the major and the career, and they are very unlikely to drop out before finishing the engineering degree.

TABLE IIB-1

ENGINEERING SELF-CONFIDENCE OF FIRST-YEAR STUDENTS BY SEX AND YEAR IN PROGRAM

(Mean Scores on Self-Confidence Factors)

Self-Confidence Factor	First-Year Males	First-Year Females	Total First-Year Students	Students at All Levels
CONF ENG STAY	-.281	-.654	-.356	.000
CONF ENG ABIL	.123	-.241	.049	.000
CONF ACAD ABIL	-.087	.310	-.007	.000
CONF COMM SKILL	-.110	.112	-.113	.000
(n)	(79)	(20)	(99)	(324)

As to the second factor, first-year students enter with confidence in their engineering abilities that is close to the mean for all students. Again, however, males enter with significantly more confidence in their engineering abilities than do females, reflecting that a higher proportion of the males than females enter with confidence that they are mechanically inclined, technically inclined, and good at designing things.

While some have proposed that the reason the female students have less engineering self-confidence than the male students is that perhaps females simply express less self-confidence in general than male students, the results for the third self-confidence factor suggest this is not the case. Female students enter with higher self-confidence in their overall academic ability than do entering male students. As an example of an individual item contributing to this factor, 28.6% of the entering women rated themselves in the highest 10% of academic ability compared to other students their age, while only 16.5% of the entering men did likewise. Similarly, entering females have more self-confidence in the communication skills than do entering males, reflecting their self-confidence in their speaking, writing, and more general communication skills. Perhaps the social norms about women excelling academically and in terms of communication are more supportive of women's efforts in these areas than in the more non-traditional pursuit of engineering.

ENGINEERING SELF-CONFIDENCE AND BACKGROUND CHARACTERISTICS STUDENTS

To explore the relationship between background characteristics and self-confidence, we looked at the relationship between family background, high school background, and engineering self-confidence. We concentrated on the first factor, as it was the most important expression of engineering self-confidence. We used multiple regression analysis, with the first self-confidence factor, confidence about staying in engineering

(CONF STAY ENG) as the dependent variable. The independent variables were: family background characteristics, including: mother's and father's education, and the prestige score for father's occupation[17], as indicators of the family's socio-economic status and familiarity with the college setting; whether the respondent had siblings who attended college, as indicative of the role models that siblings set, as well as the general socio-economic status of the family. Finally we included the index of support by family and significant others for the student's pursuit of engineering, expecting that the stronger the support the higher the student's engineering self-confidence. Our expectations were that students whose parents were more highly educated and who came from a higher social class would be more likely to consider themselves as belonging in a professional occupation like engineering and therefore have higher engineering self-confidence; and that self-confidence would be reinforced by the positive opinions of others.

In terms of high school background, we included as independent variables: high school math and science grades, math and verbal SAT scores, and an index of extra-curricular activities during high school which were related to math, science or engineering (EXTRA). We expected that students who had higher achievement and involvement in math and science before entering Rowan would be more likely to have self-confidence that they belonged in engineering and should stay in the field.

The first regression analysis in the table ("Model 1") includes the first engineering self-confidence factor, CONF ENG STAY, as the dependent variable and family background characteristics as independent variables. The second analysis ("Model 2")

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[17] Since not all mothers were employed, we did not include the prestige score for the mother's occupation, as it eliminated too many of the students (in a listwise deletion). We did consider mother's employment history as a possible influence on self-confidence, especially of women, but it did not make a significant contribution to the explanation.

adds high school background characteristics as independent variables. Regression analyses were performed separately for first-year students, and then for students of all levels. We separated out the first-year students represent the input students bring into Rowan, before they have been exposed to much of the program. We expected that they would show the greatest impact of background characteristics on engineering self-confidence; more advanced students may have distanced themselves from factors outside of Rowan, especially regarding anything concerning engineering. We look at the relationship between background and engineering self-confidence for all students to see how much influence background characteristics retain on engineering self-confidence after students have been exposed to the program for a while. We go on to show the differences between males and females in this relationship.[18]

The Relationship between Engineering Self-Confidence and Background Characteristics of First-Year Students

Among first-year students, both family background and high school background are related to engineering self-confidence (Table IIB-2). In a multiple regression analysis, the square of the multiple correlation coefficient (R^2) tells us how much of the variation in the independent variable is explained by the dependent variables in the analysis. R^2 of the first model in the regression analysis, which includes only family background, thus tells us that taken together, all of the family background variables included explain 17.1% of the variation in initial engineering self-confidence (R^2 =.171). The most important effect of family background for first-year students is support by significant others for the student's pursuit of engineering (the regression coefficient significant at $p<.05$). Mother's education is also significantly related to engineering self-confidence; however,

[18] There were not enough cases among the first-year students to separate out males and females for a meaningful analysis.

contrary to our expectations, it is an inverse relationship: the higher the mother's education, the lower the self-confidence of the student that they will stay in engineering.

High school background adds 15.2% to the variance explained in first-year engineering self-confidence (R^2 increases from .171 in the first model to .323 in the second model). High school math grades, math SAT scores and the extra-curricular math and science activities the student engaged in during high school all have significant positive relationships with the first year student's confidence that they belong and will stay in engineering.

TABLE IIB-2

MULTIPLE REGRESSION ANALYSIS WITH ENTERING ENGINEERING SELF-CONFIDENCE FACTOR (CONF STAY ENG) AS DEPENDENT VARIABLE, AND FAMILY BACKGROUND, AND HIGH SCHOOL BACKGROUND AS INDEPENDENT VARIABLES FOR FIRST-YEAR STUDENTS,

Unstandardized Regression Coefficients B's (Standardized Regression Coefficients –ß's - in parentheses)

Independent Variable	Model 1	Model 2
Father's Education	.750 (.128)	.290 (.050)
Mother's Education	-.150 (-.259)*	-.159 (-.274)*
Prestige of Father's Occupation	-.028 (-.034)	-.008 (-.020)
Siblings in college	.571 (.028)*	.727 (.036)
Support Index	.157 (.309)*	.129 (.255)*
H.S. science grades		-.112 (-.071)
H.S.math grades		.355 (.221)
Verbal SAT score		.011 (.071)
Math SAT score		.044 (.257)*
EXTRA		.125 (.190)**
Multiple R	.427	.586
R^2	.183	.343

**p < .10 *p < .05

The Relationship between Engineering Self-Confidence and Background Characteristics for Students in All Years of the Program

Background variables are related to engineering self-confidence for all engineering students, but not as strongly as for first-year students. The multiple correlation between background variables and engineering self-confidence for first year students is .568, and for all students is .369 (that is, about 14% of the variance in engineering self-confidence is explained by background characteristics) (Table IIB-3). However, it is only family background characteristics that have an effect on engineering self-confidence for the total group of students; while the student is distanced from their high school experience, family characteristics are current and apparently continue to have an impact on the student's engineering self-confidence. The strongest relationship between background variables and engineering self-confidence is the support the student perceives from significant others for their pursuit of engineering. The father's occupational prestige also has a significant impact on the student's self-confidence: the higher the prestige, the stronger the self-confidence.[19]

We expected that background factors would have less influence on students' engineering self-confidence the longer they had been in engineering at Rowan. However, this expectation was not completely borne out (Table IIB-3). Background factors continue to be related to engineering self-confidence as students start their sophomore year. Family background is more important than high school background, so the effect of high school background has weakened as students distance themselves from the high school experience, but family characteristics continue to have an impact. Father's occupational prestige, education, and the support of significant others for their pursuit of engineering have significant impact on the student's self-confidence in themselves as an engineer. Among the high school factors, it is mainly the student's science grades that continue to have an impact on self-confidence.

[19] It is possible that students whose father's have higher occupational prestige have more self-confidence in whatever they would like to pursue in college; here, we are only focusing on engineering self-confidence.

As juniors begin the third year in the program, none of the background factors have much impact on engineering self-confidence. More than a third of these students have spent the summer in an engineering internship, others have had a job related to engineering, and their family or high school background apparently has less impact on their confidence in themselves as engineers.

TABLE IIB-3

MULTIPLE REGRESSION ANALYSIS WITH ENGINEERING SELF-CONFIDENCE FACTOR (CONF STAY ENG) AS DEPENDENT VARIABLE, AND FAMILY CHARACTERISTICS AND HIGH SCHOOL BACKGROUND AS INDEPENDENT VARIABLES (for Sophomores, Juniors, and Seniors, Separately)

Unstandardized Regression Coefficients B's (Standardized Regression Coefficients –ß's - in parentheses)

Year in Program Independent Variable	TOTAL	SOPHOMORES	JUNIORS	SENIORS
Father's Education	-.070 (-.127)**	-.164 (-.344)*	-.089 (-.153)	-.137 (-.345)
Mother's Education	-.065 (-.114)**	.066 (.115)	-.089 (-.163)	.015 (.026)
Prestige of Father's Occupation	.013 (.170)*	.016 (.242) **	.003 (.039)	.007 (.127)
Siblings in college	.043 (.022)	.184 (.099)	.161 (.077)	-.356 (-.206)
Support Index	.120 (.236)*	.125 (.239)*	.025 (.057)	.157 (.250)
High school science grades	.035 (.022)	.285 (.210)	.197 (.116)	.302 (.212)
High school math grades	.167 (.108)	.526 (.362)*	.149 (.096)	.019 (.017)
Verbal SAT score	.001 (.055)	.002 (.152)	.000 (.029)	.001 (.126)
Math SAT score	.001 (.032)	-.002 (-.113)	-.002 (-.149)	-.000 (-.010)
EXTRA	.053 (.083)	.067 (.134)	-.069 (-.092)	.190 (.309)
Multiple R	.369	.551	.351	.591
R^2	.136	.304	.123	.349

*p<.05 **p<.10

However, the importance of background factors, especially family background, returns as students begin their senior year, and begin to face the end of the program and their projected entry into employment or graduate school. Comparing the unstandardized regression coefficients shows that family support again becomes important to these students' engineering self-confidence, as does father's education. High school math grades and their participation in extra-curricular activities in high school are also related to their self-confidence: perhaps these are indicative of their academic ability, or their inclination to be involved in enrichment activities, as we shall consider below.

In summary, students' family and high school background affect their engineering self-confidence to a greater degree as they enter Rowan in the first year than after they have been at Rowan for two or three years. Of particular impact on first-year students' engineering self-confidence is the extent of support they receive for their pursuit of engineering from significant others, their high school math grades and their extra-curricular high school activities in math and science. The effect of family and high school background seem to diminish until students reach their senior year, when factors outside of Rowan appear to regain importance in how the students see themselves as engineers. As we will see below, female students seem to be particularly affected negatively by such outside influences at the senior level.

GENDER DIFFERENCES IN THE IMPACT OF BACKGROUND CHARACTERISTICS ON ENGINEERING SELF-CONFIDENCE

We suspected that background characteristics might have a different relationship with the engineering self-confidence of men and women, as suggested in the literature and because of the interaction of gender with the high school background factors shown above. Therefore we performed regression analyses for males and females separately, which we will discuss below (Table IIB-4).

Background characteristics are more related to females' engineering self-confidence than to males'. Only about 15% of the variance in male engineering self-confidence is related to background characteristics, while over 27% of the female engineering self-confidence is. For each of the background characteristics we measure, the relationship to engineering self-confidence is stronger for females than for males (comparing the unstandardized regression coefficients for each variable shows that the coefficients for females are larger than for males). For both males and females, the most important of these family characteristics are the positive opinions of family and significant others about the student's pursuit of engineering; however, the importance of this support is nearly double for female students than for males (the unstandardized regression coefficient, B, is .105 for males and .184 for females). In fact, this is the only family characteristic that has statistical significance for the female students.

TABLE IIB-4

MULTIPLE REGRESSION ANALYSIS WITH ENGINEERING SELF-CONFIDENCE FACTOR (CONF STAY ENG) AS DEPENDENT VARIABLE, AND FAMILY CHARACTERISTICS AS INDEPENDENT VARIABLES

(For Total and for Male and Female Students, Separately)

Unstandardized Regression Coefficients B's (Standardized Regression Coefficients –ß's - in parentheses)

	Unstandardized Regression Coefficients (B's)		**Standardized Regression Coefficients (ß's)**	
Independent Variable\Sex	**Males**	**Females**	**Males**	**Females**
Father's Education	-.073**	-.093	-.138**	-.152
Mother's Education	-.023	-.084	-.042	-.135
Prestige of Father's Occupation	.012*	.016	.159*	.189
Siblings have gone to college	.174	-.376	.090**	-.168
Support Index	.105*	.184*	.220*	.300*
High school math grades	.036	.472	.024	.226
High school science grades	.264*	-.305	.182*	-.149
Verbal SAT score	.001	.000	.069	.016
Math SAT score	-.000	.004	-.025	.179
EXTRA	.044	.160	.074	.207
Multiple R	.388	.521		
R^2	.151	.271		

*p<.05 **p<.10

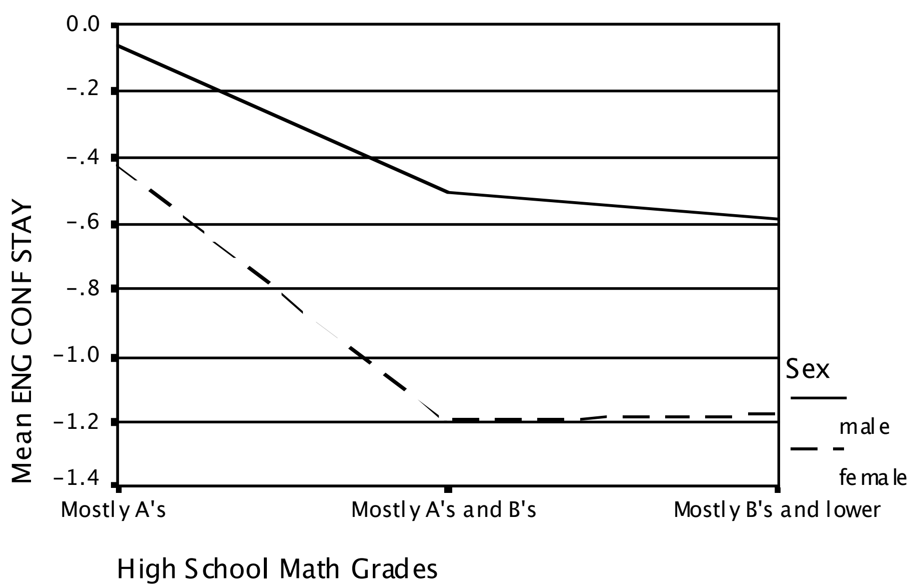
It is interesting to note that females tend to have higher self-confidence if they are the first in their family to go to college (i.e., they do not have siblings who went to college), while males have higher self-confidence when they are following in sibling's footsteps. Perhaps the reason for this is that the women are in a nontraditional major and aspiring to a nontraditional occupation (for females); we would need more information on the major of their siblings to determine this.

In terms of high school influences on self-confidence of females, their high school math grades, and the extent to which they participated in extra-curricular math and science activities before college have the greatest impact. Males are more positively impacted by their high school science grades. Thus, while female students have lower self-confidence than males no matter what their high school math grades were, the self-confidence of females is affected more negatively by lower math grades than is the self-confidence of males; the result is a larger gender gap in engineering self-confidence among the students who had weak math grades in high school than among the students who enter Rowan with a stronger math background (Figure IIB-1).

FIGURE IIB-1

ENGINEERING SELF-CONFIDENCE BY HIGH SCHOOL MATH GRADES BY GENDER

(Mean CONF ENG STAY scores, First Year Students)



Perhaps because of their greater sensitivity to outside factors like family background and support, female students are overall less confident than male students both that they will stay with engineering and that they have the skills and abilities to succeed in engineering (just as we saw for first-year students).[20] However, the gender differences are not statistically significant when the students assess their self-confidence in overall academic ability or their communication skills. This can be seen in Table IIB-5, which presents the mean scores on each of the self-confidence factors for all male and all female students, as well as answers to some of the representative questions having high loading on each factor.

In more detail, on the first factor, males express more self-confidence that they belong in engineering and that they will stay with the major and the career (Table IIB-5). Males express more confidence that engineering is the right major for them, that they are well-suited for the major and the career, and they are very unlikely to drop out before finishing the engineering degree. This finding is not unlike that of other studies, such as the national WEPAN study (Brainard et al 1998), which found that female students have lower self-confidence that engineering is the right major for them. However, it is striking in the Rowan case, given the extent of positive indicators of women's integration into the program that we show below.

On the second factor, males also express more self-confidence in their engineering abilities than do female students (Table IIB-5). Their scores on this factor are significantly higher than female students', reflecting that a higher proportion of the males strongly agree that they are mechanically inclined, technically inclined, and good at designing things.

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[20] The analysis is based on a comparison of factor scores of male and female students, which is allowed because statistical analysis showed that the factor structure of females and males is similar enough to compare scores of the different genders.

Table IIB-5

ENGINEERING SELF-CONFIDENCE BY SEX

Total Students, Fall, 2000

Self-Confidence Indicator/Factor	MALES	FEMALES
CONF STAY ENG factor score (mean)***	**.048**	**-.186**
Well-suited for choice of college major (% strongly agreeing)**	32.3	27.7
Likely to consider dropping out of engineering program before earning degree (% very unlikely)	64.7	54.4
CONF ENG ABIL factor score (mean)****	**.097**	**-.378**
Mechanically inclined (% strongly agreeing)**	36.3	16.7
Technically inclined (% strongly agreeing)**	34.5	20.0
CONF ACAD ABIL factor score (mean)	**-.029**	**.112**
Academic ability (% rating highest 10%)	25.2	25.0
Mathematical ability (% rating highest 10%)	34.5	27.9
CONF COMM SKILL factor score (mean)	**.046**	**-.144**
Communication skills (% rating highest 10%)	19.1	20.6
Speaking skills (% strongly confident)	20.9	20.6

* chi-square significant at p<.10 ** chi-square significant at p<.05

***t-test significant at p<.10 ****t-test significant at p<.05

Communication skills are particularly important in the Rowan program, which emphasizes project presentation every semester and extensive written and oral presentations of their work. Like self-confidence in academic ability, gender differences on the scores for this factor of self-confidence in communication skills were not statistically significant (Table IIB-5). Males and females were equally likely to rate their communication skills in the top 10% compared to other students their age, and to be strongly confident in their speaking and writing skills.

The main gender differences throughout the program, therefore, are related specifically to self-confidence that they belong in engineering and their engineering abilities, perhaps reflecting societal expectations of each gender.

The magnitude of these gender differences in engineering self-confidence varies by year in the program, as we will show below in Chapter II-D. To some extent the gender differences reflect the extent to which characteristics outside the system (such as the support of significant others for their pursuit of engineering) affect engineering self-confidence. Thus we will show that in the senior year, when background variables have as much or more impact than among first-year students, the gender gap in engineering self-confidence is as wide as it was for the first-year students. We suggest that it may be the impact of forces outside of Rowan which is responsible for the wider gender differences in engineering self-confidence: during the middle years of the program, when the students are most influenced by the program itself, gender differences in engineering self-confidence appear to be much smaller.

SUMMARY AND CONCLUSIONS

Engineering self-confidence is made up of a number of different aspects: confidence that the student belongs and will stay in engineering, confidence in specific engineering abilities, and more generalized academic confidence and confidence in communication abilities. The male students enter with more engineering self-confidence in terms of the first two aspects but not in terms of the more generalized academic and communication confidence. The engineering self-confidence with which students enter Rowan is related in part to both their family and high school backgrounds. In particular, in terms of family background it is the support of significant others which is related to stronger engineering self-confidence; and in terms of high school background, both high school achievement in math and science and their extra curricular activities in these areas are related to stronger engineering self-confidence.

The impact of family and high school background are more important influences on engineering self-confidence in the first year than in sophomore or junior years, but in the senior year the impact of family background is again important.

Female students enter Rowan with less confidence that they will stay in engineering and that they have the abilities required in engineering than do males. This gender gap in self-confidence is not generalized to all self-confidence, as women do not show less self-confidence in their overall academic abilities or communication skills. The engineering self-confidence of women is more sensitive to their background influences than that of males, especially among the students with weaker backgrounds.

Perhaps because of the greater influence of background influences on their engineering self-confidence, overall, female students have lower engineering self-confidence than male students. It seems that the engineering self-confidence of the female students is lower when background – or outside—influences are stronger (the freshman and senior years). Below we will explore in more detail how engineering self-confidence changes with time in the program.

CHAPTER II-C

ENGINEERING BEHAVIOR AND PERFORMANCE AND THEIR RELATIONSHIP TO INPUT CHARACTERISTICS

The next step in the student's progress through engineering is their experience during the academic year. A major part of the student's experience is their academic performance in classes; there are also a number of extracurricular activities in which they can participate and which are intended to enhance their progress toward becoming an engineer. The first part of this chapter focuses on the student's academic performance, first showing how first-year students' grades are related to their input of family and high school background and initial engineering self-confidence. The second part of the chapter focuses on the kinds of activities in which students are involved over the course of the academic year. After describing these activities, we show how entering characteristics affect this engineering behavior for first year students, and how background characteristics continue to affect engineering behavior for all students. We then show how initial engineering self-confidence is related to engineering behavior for first-year students, and how engineering self-confidence is related to engineering behavior for all students. Finally, we show how engineering behavior is related to academic performance, with a particular focus on how participation in the Society for Women Engineers affects the female students' experiences and performance.

ACADEMIC PERFORMANCE

Input Characteristics and Academic Performance

We begin this section by looking at the academic performance of first-year students and how it is related to their input characteristics of family and high school background and initial engineering self-confidence. We consider whether it is easier for some students to do well academically than others based on the characteristics they bring with them into Rowan.

In their first semester at Rowan, the input characteristics the students bring with them into Rowan account for about 28% of the variance in the students' overall grade point average (GPA)[21] and in their engineering grades specifically[22] (Table IIC-1). In a multiple regression in which fall GPA is the dependent variable, the only statistically significant effect of family background was father's occupational prestige, which reflects the student's social class as well as how professional their father's occupation was (the higher the father's occupational prestige, the higher the fall grades). Of the high school background factors, high school math grades are related significantly to the students' academic achievement in the first semester. The students' initial engineering self-confidence is not related to their actual academic performance in the first semester. Thus, even students who lack engineering self-confidence may perform well academically (and indeed, as we show below, women's engineering self-confidence is lower than men's, but their academic performance equals or exceeds that of men).

Interestingly, father's occupational prestige has a significant relationship with overall GPA in the first semester, but not with engineering grades per se. High school math grades are significant predictors of both overall and engineering grades in the first semester, but not the spring semester.

As might be expected, by the end of the first year, the input characteristics have even less relationship with academic performance, and only 12% of the variance is explained by these characteristics. None of the regression coefficients of input characteristics predicting spring

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[21] Fall and Spring GPA's are taken from official transcripts of the students' grades.
[22] Engineering GPA was self-reported and referred to the fall semester. For many of the first-year students, the only engineering class they had at this stage was engineering clinic.

grades is statistically significant (Table IIC-1). The regression coefficient (B) of father's occupational prestige goes down from .019 to .010 from Fall to Spring, and the regression coefficient (B) of high school math grades go down from .262 to .188.

When spring grades are predicted with fall grades added to the regression analysis, fall grades are clearly the most important predictor (statistically significant at $p<.00$, with an unstandardized regression coefficient of .943 and a standardized regression coefficient of .777). Therefore the input characteristics have an indirect effect on later academic achievement, but only through their effect on academic achievement in the first semester.

TABLE IIC-1

MULTIPLE REGRESSION ANALYSIS OF ENGINEERING GRADES WITH FAMILY AND HIGH SCHOOL BACKGROUND CHARACTERISTICS AND INITIAL ENGINEERING SELF-CONFIDENCE AS INDEPENDENT VARIABLES, First Year Students

Unstandardized Regression Coefficients (Standardized Regression Coefficients in Parentheses)

Dependent Variable / Independent Variable	Fall 2000 GPA	Engineering GPA	Spring 2001 GPA
Father's Education	-.171 (-.030)	-.038 (-.116)	-.035 (-.075)
Mother's Education	-.027 (-.070)	-.038 (-.112)	.013 (.030)
Prestige of Father's Occupation	.019 (.346)*	.005 (.116)	.010 (.152)
Siblings College-Educated	.135 (.100)	.123 (.103)	.170 (.104)
Support Index	-.033 (-.098)	-.022 (.079)	-.034 (-.085)
High School Science Grades	.100 (.094)	.100 (.096)	.291 (.025)
High School Math Grades	.262 (.249)**	.261 (.277)**	.188 (.147)
Verbal SAT Score	-.000 (.028)	.002 (.179)	-.000 (-.025)
Math SAT Score	-.001 (-.091)	.000 (.005)	-.002 (-.129)
High School Extra-Curricular Math/Science Activities	.031 (.072)	-.066 (-.178)	.023 (.044)
CONF STAY ENG	.125 (.191)	.091 (.155)	.607 (.077)
CONF ENG ABIL	-.105 (-.156)	.078 (-.135)	-.071 (-.009)
Multiple R	.529	.535	.352
R^2	.280	.287	.124

*p<.05 **p<.10.

Relationship of Input Characteristics to Academic Performance for Students at All Levels

Looking at the total group of engineering students, we see that the students' input characteristics have a stronger relationship with the academic performance of females than of male students (Table IIC-2). The input characteristics explain less than 20% of the male students' engineering grades in the first semester, but over half of the female students' engineering grades in the same semester. Comparing the unstandardized regression coefficients shows us that the impact of both father's education and whether the student has a college-educated sibling have stronger impacts on females' engineering grades than on males': these serve both as role models and as support for what the student is doing, and enhance the female students' performance more than the males'.

High school math and science grades also affect the academic performance of the female students more than the males'; in particular, females with better high school science grades do better in their first semester at Rowan, while males with better math grades do better in their first semester at Rowan. While high school grades may be more indicative of academic aptitude than the actual content covered in high school, they may also be indicative of earlier interest in science for the female students, which gives them a boost in their engineering studies. The higher unstandardized regression coefficients for the female students' high school grades as compared to the males' suggests that the grades of female students are more strongly related to their earlier achievement than are the grades of male students.

TABLE IIC-2

MULTIPLE REGRESSION ANALYSIS OF ENGINEERING GRADES WITH FAMILY AND HIGH SCHOOL BACKGROUND CHARACTERISTICS AND INITIAL ENGINEERING SELF-CONFIDENCE AS INDEPENDENT VARIABLES, Total Engineering Students, Males and Females

Unstandardized Regression Coefficients (Standardized Regression Coefficients in Parentheses)

Independent Variable	**Total**	**Males**	**Females**
Father's Education	-.001(-.004)	-.005 (-.024)	.051 (.184)
Mother's Education	-.002 (-.077)	-.002 (-.070)	-.006 (-.195)
Prestige of Father's Occupa	-.000(-.016)	.000 (.005)	-.003 (-.087)
Siblings College-Educate	.074 (.074)	.038 (.038)	.093 (.097)
Support Index	-.034 (-.120)	-.033 (-.115)	-.035 (-.131)
High School Science Grad	.176 (.201)*	.061 (.073)	.695 (.677)*
High School Math Grade	.145 (.179)*	.199 (.263)*	-.269 (-.227)
Verbal SAT Score	.001 (.133)**	.001 (.084)	.019 (.220)
Math SAT Score	.001 (.116)	.001 (.124)	.000 (.081)
High School Extra-Curricu Math/Science Activities	-.024 (-.077)	-.026(-.090)	.009 (.026)
CONF STAY ENG	.054 (.104)	.050 (.088)	.028 (.064)
CONF ENG ABIL	-.011 (-.022)	.003 (.006)	-.178 (-.036)
Multiple R	.458	.422	.760
R^2	.210	.178	.577

*p<.05 **p<.10.

Initial engineering self-confidence does not have a statistically significant relationship with academic performance for males or females. So females' academic performance does not seem to be damaged by their weaker engineering self-confidence (which we saw in the previous chapter).

Overall, female engineering students at Rowan do as well or better in terms of academic achievement than the male students (Table IIC-3). Their overall GPA is slightly higher than men's and their mean GPA in engineering courses is slightly higher than men's. A higher proportion of female students have 4.0 average GPA's in engineering, and female students were more likely to make the Dean's list than were male students. (Table IIC-3) (While not all of the gender differences are statistically significant, almost all of them show the same pattern, of females having higher academic achievement than males.)

TABLE IIC-3

ACADEMIC PERFORMANCE BY YEAR IN SCHOOL AND GENDER

	Year in School				
	Total	**First-year**	**Sophomore**	**Junior**	**Senior**
Mean GPA, Spring 2001 (overall)					
Males	**3.06**	**3.11**	**3.14**	**3.14**	**3.27**
Females	**3.25**	**3.30**	**3.50***	**3.15**	**3.57***
Mean GPA (Engineering)[a]					
Males	**3.41**	**3.59**	**3.24**	**3.31**	**3.44**
Females	**3.50**	**3.64**	**3.56***	**3.13**	**3.57**
% 4.0 GPA (Engineering)[a]					
Males	**16.7**	**49.1**	**2.0**	**2.0**	**5.0**
Females	**26.8***	**50.0**	**11.8**	**18.2***	**9.1**
% Dean's List, Spring 2001					
Males	**31.3**	**32.3**	**20.6**	**40.3**	**43.2**
Females	**42.9***	**42.9**	**40.0****	**46.2**	**38.5**

[a]Self-reported in spring.

* T-Test between the genders significant at p<.05.

** T-Test between the genders significant at p<.10.

Further, the stronger academic performance of the female students holds within almost every major, as can be seen in Table IIC-4. Because of the small numbers in some of the categories, we collapsed the first-year and sophomore students into one "lower division" category; and the juniors and seniors into "upper division." Among lower division students, the gender difference in engineering GPA is found in every major, with females having better engineering GPAs than the male students. Among upper division students in three of the majors (civil/environmental, electrical/computer, and mechanical), however the gender gap – albeit small - is reversed. However, few of these gender differences are statistically significant.

The conclusion is that once year in school and major are controlled, gender differences in academic performance are insignificant. This supports findings by Cerro and Duncan (2002), Felder, et. al. (1993) and Seymour & Hewitt (1997), and some of the results presented by Adelman (1998). Unlike Adelman's findings, women in electrical/computing engineering at Rowan do not perform less well academically than do men; on the contrary, among lower division students, this is one of the few statistically significant differences with women having higher GPA's than men.

TABLE IIC-4

ACADEMIC PERFORMANCE BY MAJOR, YEAR IN SCHOOL AND GENDER

(Mean Engineering GPA [a])

	Total	Lower divisic	Upper divisi
Chemical Engineering Major			
Males	**3.54**	**3.60**	**3.47**
Females	**3.70****	**3.72**	**3.67**
Civil/Environmental Engineering Major			
Males	**3.23**	**3.40**	**3.12**
Females	**3.39**	**3.66**	**2.97**
Electrical/Computer Engineering Major			
Males	**3.42**	**3.44**	**3.39**
Females	**3.62**	**3.93***	**3.15**
Mechanical Engineering Major			
Males	**3.42**	**3.42**	**3.43**
Females	**3.51**	**3.62**	**3.35**

[a] Self-reported in spring.

* T-Test between the genders significant at p<.05.

** T-Test between the genders significant at p<.10.

PARTICIPATION IN EXTRA-CURRICULAR ENGINEERING ACTIVITIES

Measuring Involvement in Engineering Activities

To measure involvement in engineering activities at Rowan, we focused on the extra-curricular engineering activities that are available. These activities are voluntary[23] and therefore reflect the student's interest and intensity of involvement in the engineering program and more generally, the field of engineering. There are two major types of activities: "enrichment" activities, which provide opportunities to learn more about

[23] Since some instructors require study groups, this is the only activity that may not be voluntary.

engineering as a profession and to network with other engineering majors and professionals; and "help" activities, which aid the student in terms of studies, academic and career counseling. These activities can be with other students, with faculty or advisors, or be affiliated with engineers beyond the scope of Rowan (such as internships or professional conferences). We organize the activities by these two facets (see Table IIC-5).

TABLE IIC-5
TYPES OF EXTRA-CURRICULAR ENGINEERING ACTIVITIES STUDIED

	Enrichment Activity	**Help Activity**
With engineering community beyond Rowan	Reading engineering listserv/newsletter Hearing guest speaker outside of class Going on engineering field trip Internship Participation in student chapter of professional engineering organization	(Being tutored[1])
With faculty or advisor at Rowan	Research and/or employment with faculty Job reference from faculty Having supportive relationship with faculty	Talking with faculty about coursework, career, personal problems Academic advising Career counseling
With other students	Residence with other science, engineering, math students	Participation in study group Peer mentoring Tutoring or being tutored[1]

[1]It was assumed that tutoring and being tutored were with other students at Rowan, although outside resources might have been used.

To reduce the number of variables for more complex analyses relating to participation in activities, the 12 items indicating participation in enrichment and help activities were factor analyzed[24] resulting in three factors of involvement:

[24] Varimax rotation was used. Standardized factor scores resulted, each of which had a mean of 0 and a range of approximately –4 to +2.

(1) The first type of involvement resulting from this factor analysis indicated enrichment activities with faculty and with the engineering community beyond Rowan (ACTACAD – for academic enrichment). For example, included were the type of contact students had with faculty outside of class (working with faculty, doing research with faculty, getting a job reference from faculty) and activities such as reading an engineering listserv or newsletter, going on a field trip to industry, listening to a guest speaker outside of class.

(2) The second type of involvement indicated activities relating to counseling help (ACTCOUNS), such as meeting with an academic advisor, receiving career counseling, and receiving peer mentoring during the academic year.

(3) The third type of involvement indicated help activities related to studying (ACTSTUDY), such as frequency of participation in a study group, receiving or giving tutoring.

Higher scores indicated more involvement in this type of activity.

First Year Activities: The Impact of Background Input and Initial Engineering Self-Confidence

Participating in engineering activities is something that develops with time in the program (Table IIC-6). First year students are significantly less involved in enrichment or counseling activities than are more advanced students. For example, while nearly half (46%) of the first-year students did not hear an engineering speaker outside of class during the academic year, 95% of the seniors had; while 35% of the first-year students had never accessed an engineering listserv, almost all (92%) of the seniors had. Similarly, first-year students were less likely to engage in counseling activities: 20% had not met an academic advisor during the year, but nearly all (87%) of the seniors had. Study activities are spread more evenly throughout the program, but only about a third of the first-year students participated in study groups at least once a week compared to 70% of the seniors.

TABLE IIC-6
PARTICIPATION IN ENGINEERING ACTIVITIES BY YEAR IN SCHOOL
(Mean Score on Activity Factors)

	ACTACAD	ACTCOUNS	ACTSTUDY
First-year	-.448	-.423	-.004
Sophomore	-.099	-.143	.056
Junior	.324	.338	-.036
Senior	.470	.478	-.033
Total	.000	.000	.000

To consider the extent to which students' participation in activities during their first year is related to the characteristics with which they enter Rowan, we looked at the relationship between each of the types of activities and the students' input characteristics using multiple regression analysis (Table IIC-7). However, we found that first-year students' participation in engineering activities is not strongly related to their input characteristics. In terms of academic enrichment activities, only about 14% of the variance can be explained by input characteristics, and the only characteristic with a statistically significant impact on participation in these kinds of activities is high school math grades, which may be more indicative of math aptitude in this connection than with a pre-college factor. Students whose parents are more educated, and who have a college-educated sibling, and somewhat more likely to participate in enrichment activities. The students' engineering self-confidence as they enter Rowan is also positively related to participation in enrichment activities, but the relationships are relatively weak (Table IIC-7).

TABLE IIC-7
MULTIPLE REGRESSION ANALYSIS OF ENGINEERING ACTIVITIES WITH FAMILY AND HIGH SCHOOL BACKGROUND CHARACTERISTICS AND INITIAL ENGINEERING SELF-CONFIDENCE AS INDEPENDENT VARIABLES, First Year Students
Unstandardized Regression Coefficients (Standardized Regression Coefficients in Parentheses)

Dependent Variable Independent Variable	ACTACAD	ACTCOUNS	ACTSTUDY
Father's Education	.050 (.115)	-.061 (-.186)	-.085 (-.136)
Mother's Education	.060 (.141)	-.053 (-.162)	.011 (.018)
Prestige of Father's Occupation	-.002 (-.042)	.009 (.211)	.020 (.241)
Siblings College-Educated	.080 (.053)	.024 (.021)	-.231 (-.105)
Support Index	-.022 (-.062)	-.042 (-.154)	.154 (.295)*
High School Science Grades	-.031 (-.023)	.152 (.146)	.060 (.031)
High School Math Grades	.401 (.325)*	-.218 (-.230)	.106 (.059)
Verbal SAT score	.000 (.021)	-.002 (-.177)	-.002 (-.096)
Math SAT score	-.003 (-.212)	-.001 (-.105)	.001 (.051)
High School Extra-Curricular Math/Science Activities	.023 (.048)	.022 (.060)	.166 (.240)**
CONF STAY ENG	.070 (.089)	-.086 (-.144)	.090 (.079)
CONF ENG ABIL	.104 (.138)	-.035 (-.061)	-.385 (-.350)*
Multiple R	.373	.453	.575
R^2	.139	.205	.331

*p<.05 **p<.10.

Somewhat more of the variation in counseling activities is explained by input characteristics (about 20%). Parents' education is negatively related to participation in counseling activities, as are high school math grades and students' initial engineering self-confidence, as might be expected.

About 33% of the participation in study activities is related to input characteristics. Three input characteristics have statistically significant relationships with participation in study activities: the support of significant others (apparently the greater the support, the greater the ease with which the student is integrated into study groups and such); participation in extra-curricular math and science activities in high school, suggesting that the type of student who is active in extra-curricular activities is likely to take advantage of study-related help activities in college; and low confidence in engineering abilities, suggesting that the student feels a need to strengthen their academic performance through study activities. These are not necessarily students who are actually weak in math or science, as their high school grades are positively related to participation in study activities.

The Impact of Input Characteristics and Engineering Self-Confidence on the Activities of Students at All Levels

When we look at the relationships between input characteristics and engineering activities for all students, we see that a few (but only a few) of the input characteristics impact involvement in engineering activities throughout the undergraduate career (Table IIC-8). The most consistent is the relationship between participation in high school extra-curricular activities related to math and science, and participation in extra-curricular activities at Rowan. The connection may be that there are students who become active in extra-curricular activities whatever the setting, or that this indicates a student who is so engaged in math and science that they go above and beyond the requirements out of interest.

Father's occupational prestige impacts participation in counseling activities, either because parents of higher socio-economic status encourage their children to make use of such counseling and advisement, or the students are used to making use of help opportunities made available by the administration or professionals.

Having a sibling who went to college impacts participation in engineering activities, but not always in the expected direction. While siblings seem to act as role models enhancing participation in enrichment activities, it seems to be the students who do not have siblings in college who are more likely to seek help from counseling and study activities. Having the support of significant others for the pursuit of engineering apparently facilitates students bonding with others for the purpose of studying.

TABLE IIC-8

MULTIPLE REGRESSION ANALYSIS WITH PARTICIPATION IN ENGINEERING ACTIVITIES FACTORS AS DEPENDENT VARIABLES, AND BACKGROUND CHARACTERISTICS AS INDEPENDENT VARIABLES

(For Total and for Male and Female Students, Separately)

	Total			Males			Females		
Dependent Variable Independent Variable	**ACTACAD**	**ACTCOUNS**	**ACTSTUDY**	**ACTACAD**	**ACTCOUNS**	**ACTSTUDY**	**ACTACAD**	**ACTCOUNS**	**ACTSTUDY**
Father's Education	.016 (.028)	-.049 (-.091)	.029 (.054)	-.009 (-.016)	-.046 (-.043)	.035 (.064)	.006 (.009)	**-.142(.359)****	.131 (.291)
Mother's Education	.041 (.068)	-.010 (-.017)	.004 (.007)	.040 (.066)	-.011 (-.017)	.012 (.020)	-.011 (-.017)	.025 (.058)	-.051 (-.103)
Prestige of Father's Occupation	.007 (.094)	**.016 (.214)**	.005 (.061)	.008 (.108)	**.014 (.175)**	.005(.062)	.006 (.076_	**.029 (.520)**	-.003 (-.047)
Siblings College-Educated	**-.261 (-.124)****	.172 (.086)	-.121 (-.061)	-.183 (-.089)	.055 (.026)	**-.297(.143)****	**-.639(-.286)****	**.494 (.339)***	**.530 (.321)****
Support Index	**-.079 (-.142)****	.027 (.052)	**.145 (.276)***	**-.097(-.180)***	.042 (.075)	**.150 (.277)***	-.029 (-.049)	-.023 (-.058)	**-.144(-323)****
High School Science Grades	.074 (.041)	-.059 (.035)	.148) (.087)	.087 (.051)	-.064 (-.036)	.101 (.058)	.468 (.228)	-.113 (-.084)	-.048 (-.032)
High School Math Grades	.018 (.011)	-.071 (-.045)	.032 (.020)	-.107 (-.173)	-.057 (-.036)	.191 (.012)	-.401 (-.180)	-.349 (-.240)	.502 (.369)
Verbal SAT score	.000 (.013)	-.000 (-.031)	.000 (.013)	.000 (.018)	-.001 (-.048)	.000 (.001)	-.003 (-.141)	.002(.145)	.004 (.272)
Math SAT score	-.002 (-.098)	.001 (.047)	-.001 (-.030)	-.001 (-.045)	.001 (.035)	-.001 (-.047)	-.003 (-.128)	.001 (.084)	;.003 (-.185)
High School Extra-Curricular SEM Activities	**.103 (.159)***	**.080(.131)****	**.123 (.203) ***	.054 (.089)	.054 (.085)	**.146 (.238)***	**.264(.336)****	**.359 (.700)***	-.050 (-.086)
CONF STAY ENG	**.257 (.239)***	.097 (.096)	-.075 (-.075)	**.297 (.263)***	.169 (.145)	-.063 (-.056)	.189 (.195)	-.077 (-.122)	-.007 (-.010)
CONF ENG ABIL	.028 (.028)	-.057 (-.060)	**-.176 (-.187)***	.065 (.066)	-.076 (-.074)	**-.153(-.154)****	-.060 (-.056)	-.020 (-.029)	**-.221(.281)****
Multiple R	.347	.275	.423	.338	.261	.411	.546	.762	.681
R^2	.120	.086	.179	.114	.068	.169	.298	.581	.463

*p<.05 **p<.10

These background characteristics have more impact on the female than the male students, just as they did on academic performance. The multiple correlation of females' background characteristics with participation in engineering activities is at least double that of the males for each type of activity (Table IIC-8). Comparing unstandardized regression coefficients between males and females, shows that females' participation in engineering activities seem to be much more influenced by whether or not they have a sibling in college, presumably serving as a role model for them, than is males' participation. Further, for women their high school grades and SAT achievement have an impact on their patterns of participating in engineering activities while these same background characteristics do not have an impact on males' participation.

GENDER DIFFERENCES IN PARTICIPATION IN ENGINEERING ACTIVITIES

Given the stronger boost toward participation that females receive from their background characteristics, as well as from engineering self-confidence when it is high, it is perhaps not surprising to find that the female students participate more than the male students in practically every type of activity. Here we go into more detail about these kinds of activities and the gender differences we find.

PARTICIPATION IN "ENRICHMENT" ACTIVITIES

Beyond the Rowan Community

Female students are more involved than are male students in enrichment activities that are linked to engineering beyond the Rowan community (Table IIC-9). They are more likely than the male students to have read an engineering listserv or newsletter on a regular basis, to have heard an engineering guest speaker outside of class, and to have gone on at least one engineering field trip over the course of the academic year. They were at least as likely as men to have had summer or year-round internships in engineering.

Students were also asked which of the five professional organizations on campus[25] they participated in, were members of, and were officers of (Table IIC-9). Since most students participated in and were members only of the discipline-specific organization in their major, responses about membership in each the four discipline-specific student chapters were combined into a single index. Participation and membership in SWE was kept separate, since it pertained mainly to the female students.

Females are more likely than the male students to participate in and be officers of the student chapters of professional engineering societies on campus: high percentages of both males and females participate, 75% of females, and 61% of males (Table IIC-9). Among upperclassmen, the participation rate climbs to 87% for females and 72.5% for males. This does not even include participation in the Society of Women Engineers, which is attended by over half of the women at least occasionally, and over a third of the women are members of SWE (while SWE activities are open to men, few attend and none claim membership).

[25] Chapters of SAE (Society for Automotive Engineers) and of the New Jersey Engineering Honors Society were organized after the year of the survey.

In sum, in terms of enrichment activities sponsored by or reaching out to the engineering community beyond Rowan, the female students are more actively involved than the male students.

TABLE IIC-9

PARTICIPATION IN EXTRA-CURRICULAR ACADEMIC ENGINEERING ACTIVITIES BY GENDER AND YEAR IN SCHOOL
(%'s)

Gender **Enrichment activity**	**Male**	**Female**
% read engineering listserv or newsletter	72.6	**81.2**
% heard engineering speaker outside of class	71.1	**87.2**[*]
% went on engineering field trip	49.8	**64.1**
% had engineering internship during summer and/or academic year	33.3	**37.5**
% participated in student chapter of professional organization[a]	60.9	74.6
% member of student chapter of professional organization[a]	48.8	63.4
% officer of student chapter of professional organization[a]	11.0	22.5
% participated in Society of Women Engineers (SWE)		52.5
% member of Society of Women Engineers (SWE)	--	37.1
% officer of Society of Women Engineers (SWE)		14.8
(n)	(220)	(63)

[*]Chi-square of gender difference significant at p<.05.

[a] American Institute of Chemical Engineers (AIChE), American Society of Civil Engineers (ASCE), Institute of Electrical and Electronic Engineers (IEEE), the American Society of Mechanical Engineers (ASME)

Enrichment Activities with Faculty

Students were asked whether they had worked with a faculty member for pay, worked on research with a faculty member, or received a job reference from a faculty member; and whether any faculty had been particularly supportive of them personally.

Females were more likely than male students to work for pay for a faculty member and/or do research with them (see Table IIC-10). They were also more likely to have received help from a faculty member regarding a job.

TABLE IIC-10

ENRICHMENT ACTIVITIES WITH FACULTY BY GENDER

Gender **Enrichment Activity**	**Male**	**Female**	**Total**
% Worked for faculty member for pay	20.7	**29.7**	22.5
%Conducted research with faculty member	20.0	**32.3**	22.5
%Got job reference or help getting job from faculty member	21.7	**38.6**	25.2

Females are also more likely than males to identify a faculty member as being particularly supportive of them during the academic year (Table IIC-11). Only 18% of the females said there was no particular faculty member supportive of them during the year, compared to 22.4% of the males. While females are more likely to identify a female faculty member in this role, and male students to identify a male faculty member in this role, the majority of students identified both male and female faculty members as particularly supportive.

In sum, in terms of enrichment activities with faculty, female students are more engaged than male students on almost every indicator. As we shall see below, this stands in contrast to other national samples and is indicative of the strong integration of female students into the engineering culture at Rowan.

Table IIC-11
SUPPORT BY FACULTY BY GENDER

(%s)

Have there been particular faculty supportive of you personally this year?	**Male**	**Female**	**Total**
No	**22.4**	18.0	21.5
Yes, female faculty	3.4	**12.5**	5.3
Yes, male faculty	**24.2**	13.3	22.0
Yes, both male and female faculty	49.9	**56.3**	51.2

Enrichment Activities with Other Students

Residential arrangements have received a great deal of attention regarding students' retention in a college in general (Tinto, 1993), and women's retention in engineering, in particular. Some of the programs geared to enhancing the persistence of women in engineering have established living communities for women in science, math, and engineering, with the rationale that women involved in these disciplines can provide a supportive network for each other to a greater extent than women in other disciplines (Hathaway, et. al., 2000; Seymour & Hewitt, 1997). While Rowan has no formal program of the kind, many of the engineering and other math and science students do room together. Therefore, another aspect of student life at Rowan that was explored was whether the students were living with other students in the fields of engineering or related math and science majors.

When asked about their living arrangements for the academic year, 36.7% of all engineering students indicated that they were living with other science, math and engineering students; 36.7% indicated that they were living with students in other disciplines; and 26.6% indicated that they were not living with students (the majority of these are commuters who live with their parents or other relatives). A slightly higher proportion of males than females live with other science, engineering and math (SEM) students, as might be expected given that there are fewer female students majoring in these fields (Table IIC-12); a higher proportion of women are living with non-SEM students.

TABLE IIC-12

LIVING WITH ROOMMATES WHO ARE SCIENCE, ENGINEERING, AND MATH (SEM) MAJORS BY PARTICIPATION IN ENRICHMENT ACTIVITIES AND GENDER

	ROOMMATES OF MALES			**ROOMMATES OF FEMALES**		
Enrichment activity	**SEM**	**NOT SEM**	**NOT STUDENTS**	**SEM**	**NOT SEM**	**NOT STUDENTS**
Beyond Rowan community % read engineering listserv/newsletter	69.9	70.8	**80.0**	66.7	**85.2**	**90.9**
% heard engineering speaker outside class	**74.0**	62.7	66.4	81.0	**92.3**	81.8
% went on industrial field trip	**53.4**	45.5	38.2	**61.9**	**63.0**	54.5
% participation in student chapter of professional organization	**62.8**	57.5	54.5	71.4	**78.6**	**76.9**
% member of student chapter of professional organization[a]	**53.5**	48.8	39.4	52.4	**67.9**	**69.2**
% participation in Society of Women Engineers (SWE)	**--**	--	--	**71.4**	40.0	55.6
% member of Society of Women Engineers (SWE)	**--**	--	--	**42.9**	28.0	**50.0**
% internship	**53.4**	20.9	25.5	**52.4**	25.9	**54.4**
With Faculty % visited faculty outside classroom	97.3	97.0	98.2	100	98.3	100.0
% supportive faculty	**82.2**	65.7	**90.9**	**90.5**	81.5	72.7
% worked for pay for faculty	**24.7**	14.9	13.0	**33.3**	22.2	9.1
% did research with faculty	**23.6**	10.8	14.8	19.0	**33.3**	**27.3**
% got help for job from faculty	18.1	18.2	**27.3**	28.6	**44.4**	27.3
(n)	(86)	(80)	(66)	(21)	(28)	(13)
% of Total	37.1	34.5	28.4	33.9	45.1	21.0

For males, living with other science, engineering and math (SEM) majors seems to tie them in to the engineering activities more actively. Males with SEM roommates are more likely to be involved in enrichment activities both outside the Rowan engineering community and with Rowan faculty. They are more likely to have heard an engineering speaker outside of class, gone on an industrial field trip, be members of professional organizations, have internships, and have more research contact with faculty. For females, the pattern is much less clear. While women living with SEM majors are more likely than the other female students to be active in SWE and to have worked for pay for a faculty member, they are not more likely to have done research with faculty, to be members of other professional organizations, hear engineering speakers, read engineering listservs, and the like. Since these are not the kind of intentional living communities set up in other programs for women in engineering, perhaps they do not have the same kind of effect that has been found in other places for women.

PARTICIPATION IN EXTRA-CURRICULAR ENGINEERING "HELP" ACTIVITIES

"Help" Activities with Faculty

High proportions of Rowan students consult with faculty about a variety of concerns. Almost all students had visited faculty outside the classroom over the academic year, and over half of the students talked to faculty about coursework once a week or more (Table IIC-13). Almost half had talked to faculty about personal concerns other than their courses or careers.

While females are consistently more likely to consult with faculty on all matters, the gender differences are not large in terms of having contact or not (Table IIC-13). However, female students made more frequent contact with faculty (41.4% of female students vs. 31.9% of male students visited faculty outside the classroom "often", and 64.8% of female students vs. 54.3% of male students talked to faculty about coursework at least once a week). The female students were also more likely to have seen an academic advisor over the course of the year, although a higher proportion of the male students had received career counseling (Table IIC-13).

TABLE IIC-13

HELP FROM FACULTY BY GENDER

(%'s)

	Males	**Females**	**Total**
Help Activity During Academic Year			
% who visited faculty outside classroom	96.4	**97.7`**	96.7
% who talked to faculty about coursework	96.4	**99.2**	97.0
% who talked to faculty about courses to take	77.4	**85.0**	78.9
% who talked to faculty about career	65.9	**67.2**	66.2
% who talked to faculty about personal concerns	45.7	**47.2**	46.0
% met academic advisor at least once a semester	76.3	**84.4***	77.6
% received career counseling at least once a semester	**29.8**	22.4	27.9

*Chi-square of gender difference significant at $p<.05$.

Help Activities with Other Students

Women are also more likely than the males to have been involved in study activities with other students, including participating in study groups, tutoring, and being tutored over the course of the year (Table IIC-14). While males are slightly more likely to have received peer mentoring, the gender difference is not statistically significant.

TABLE IIC-14
PARTICIPATION IN HELP ACTIVITIES WITH OTHER STUDENTS BY GENDER

Gender **Help Activity with Other Students**	**Males**	**Females**
% participated in study group once a week or more	57.7	**68.8**
% tutored another student at least once a semester	28.9	**43.7***
% received tutoring at least once a semester	26.3	**40.6***
% received peer mentoring at least once a semester	**22.8**	19.7
(n)	(220)	(63)

*Chi-square of gender difference significant at p<.05.

In summary, females are more likely than males to be involved in help activities over the course of the academic year, both receiving and getting help,, whether the help is from faculty or giving or receiving help from other students.

VARIATION IN LEVEL OF ACTIVITY BY YEAR IN PROGRAM

Generally, activity level is higher the longer a student has been in the engineering program at Rowan. This occurs for two reasons: the students most alienated from the program may drop out, especially in the first two years of the program; and the students who remain are more familiar with the opportunities and services available and therefore can make more use of them. They are also more comfortable with the environment and may get more involved for that reason. Also, some opportunities, such as internships, are geared primarily toward upper division students. The interesting question for us is whether this variation by year in the program is similar for males and for females.

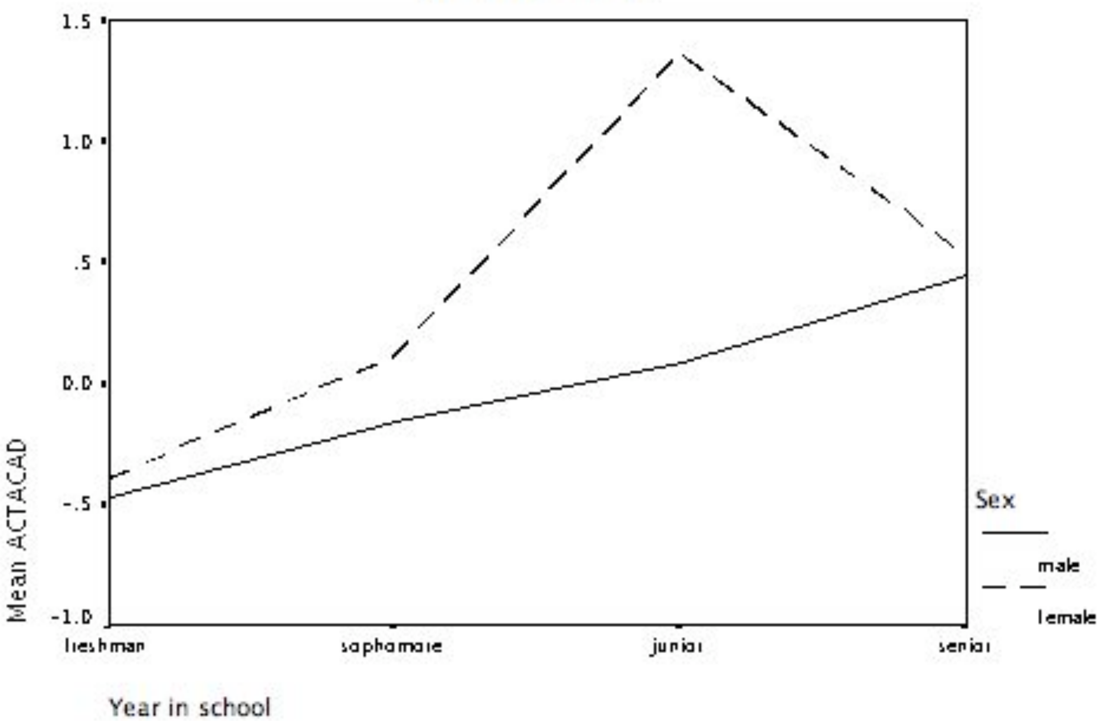
We look first at the three activity factors: enrichment activities, counseling activities, and study activities.

With regards to enrichment activities, upper division males and females show more involvement than lower division students (Figure IIC-1). However, junior females show a spurt of activity that is much greater than among junior males, and hence there is a much wider gender gap, with females doing more participation than males at the junior level. Seniors, like first year and sophomore students show much fewer gender differences in this respect.

FIGURE IIC-1

ACADEMIC ACTIVITIES BY GENDER AND YEAR IN SCHOOL

(Mean ACTACAD)

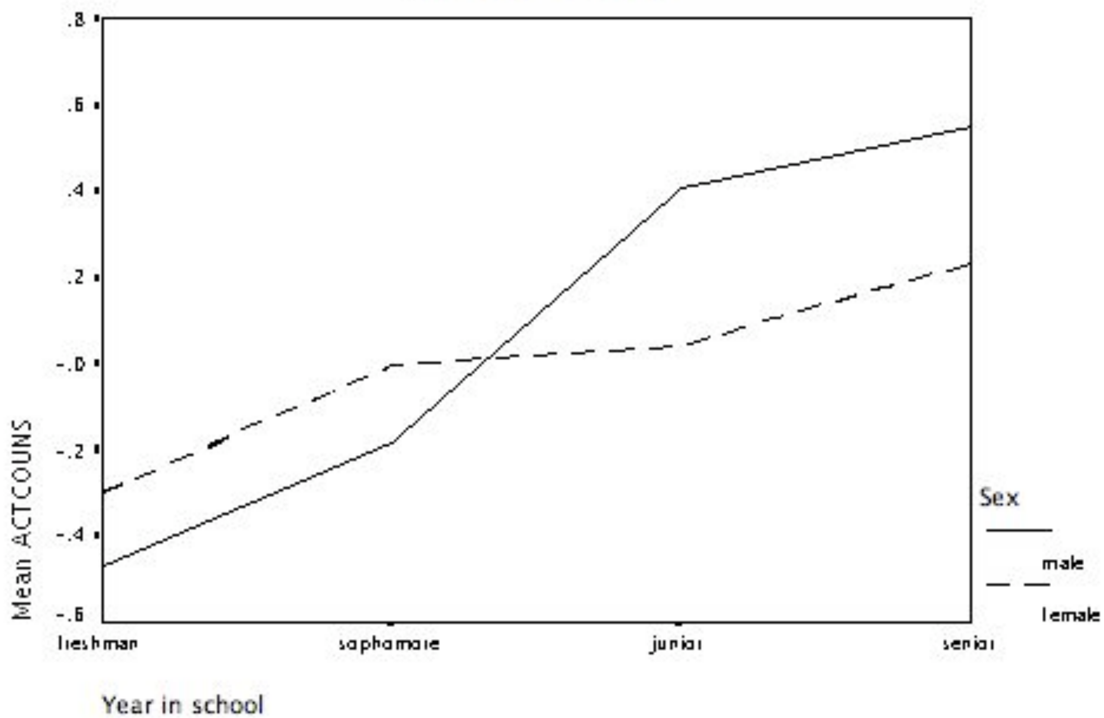


With regard to counseling types of activities, again upper division students (both male and female) show more participation than lower division students (Figure IIC-2). However, it is the upper division males who are very different from the lower division males, pushing them above the level of activity of junior and senior females. It is primarily the male's career counseling and peer mentoring which is greater than the females at the junior and senior levels.

FIGURE IIC-2

COUNSELING ACTIVITIES BY GENDER AND YEAR IN SCHOOL

(Mean ACTCOUNS)

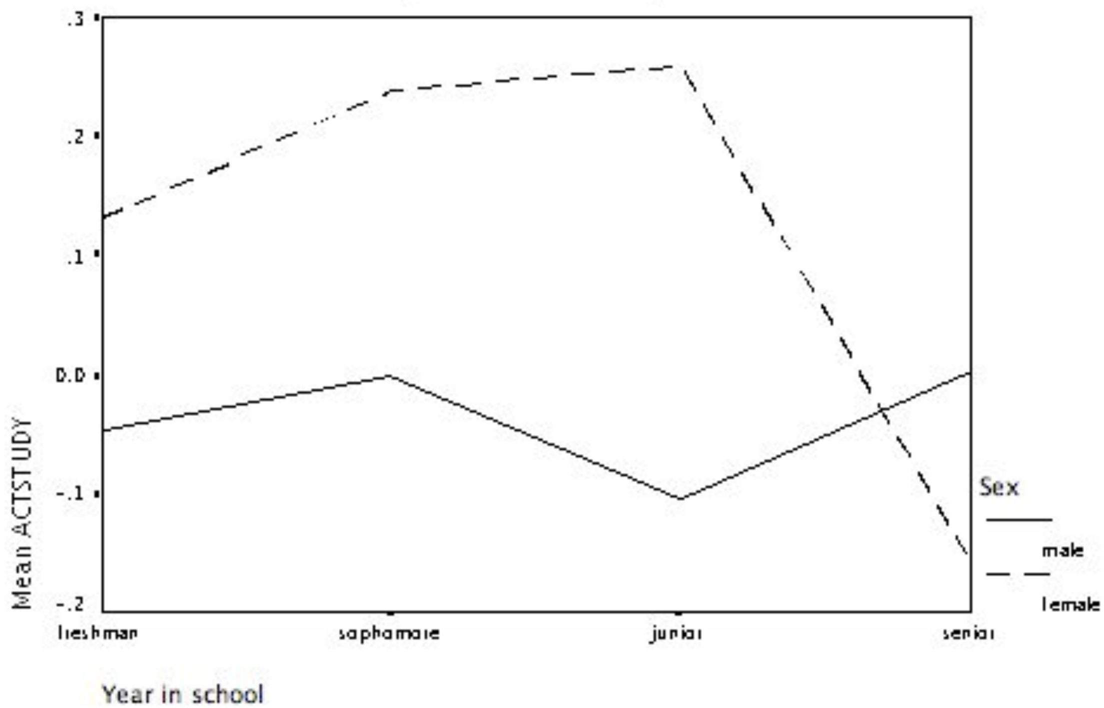


Participation in study activities does not follow the same pattern as the other activities. Among males, study activity varies little by year in the program (Figure IIC-3). It takes a slight dip in the junior year, but is fairly stable, somewhat below the mean. Females, on the other hand, are much more involved in study activities – being in a study group, tutoring and being tutored. Only in the senior year do females engage in much less of these kinds of activities, so that among seniors there is less of a gender gap, and it is reversed (senior males engage in more of these study activities than senior females).

FIGURE IIC-3

STUDY ACTIVITIES BY GENDER AND YEAR IN SCHOOL

(Mean ACTSTUDY)



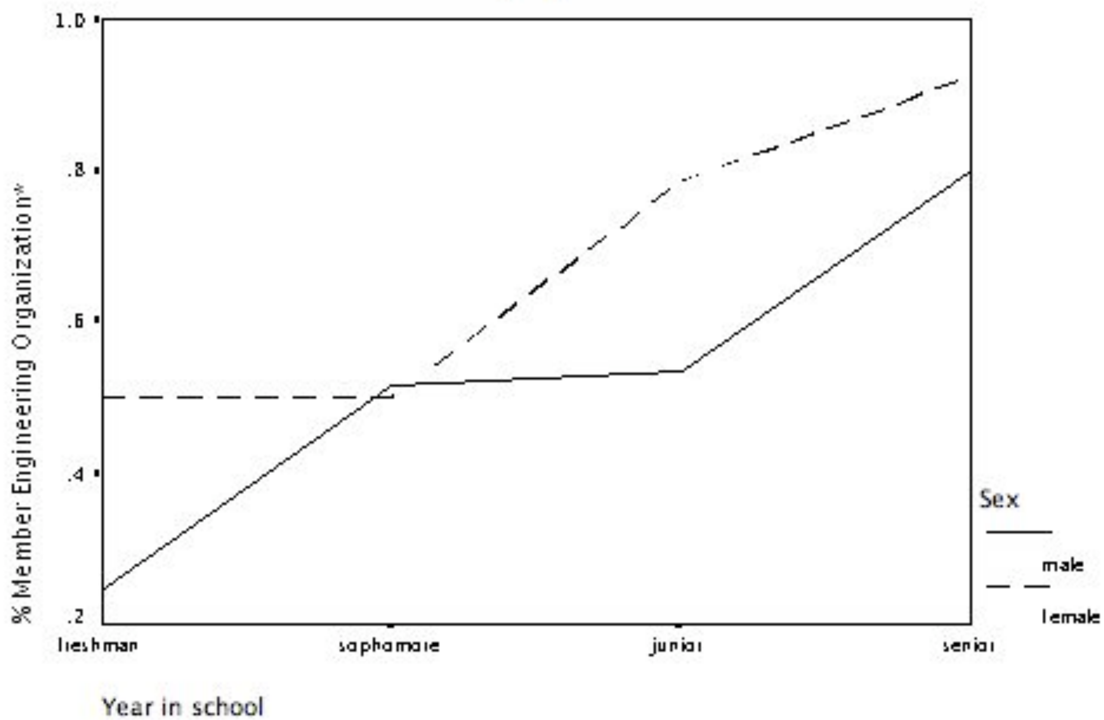
So, interestingly, among seniors there tends to be a convergence between males and females in terms of enrichment activities and study activities, while the counseling gap remains wide among upper division students.

Looking at organizational membership (Figure IIC-4), we see that the level of membership is higher for upper division than lower division students, and highest for senior students. Females are more involved in the professional organizations in every year except sophomore. As for the other enrichment activities, there is somewhat of a convergence among male and female seniors, as senior male students participate much more than junior or lower level students.

FIGURE IIC–4

ORGANIZATIONAL MEMBERSHIP BY GENDER AND YEAR IN SCHOOL

(%'s)

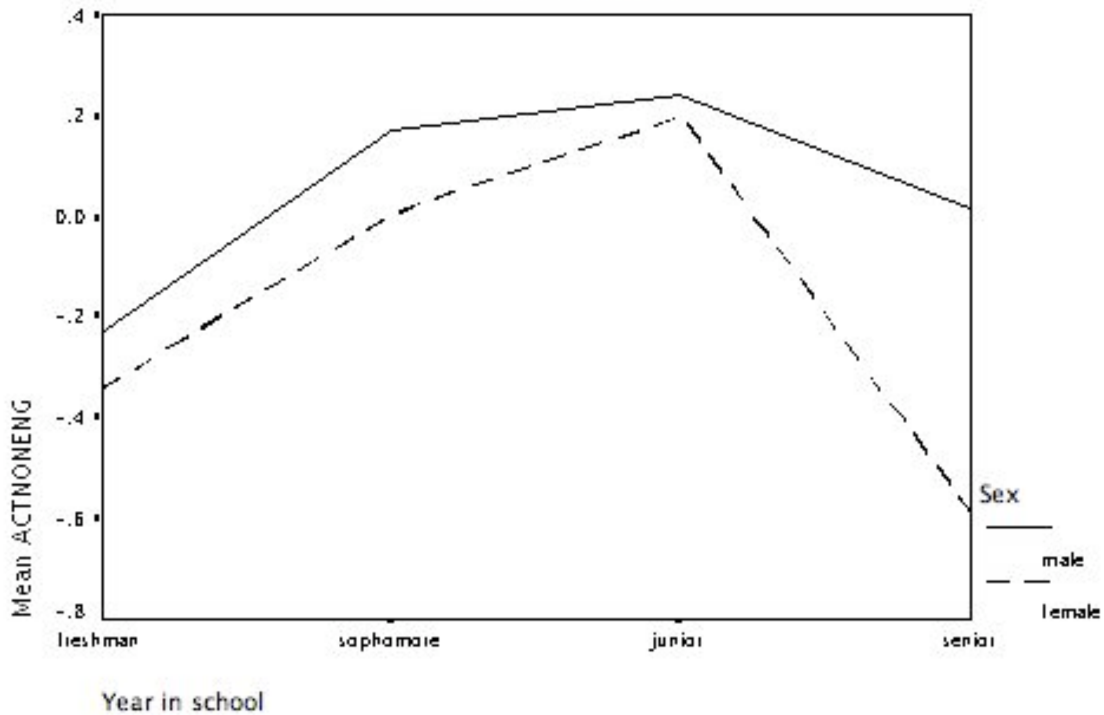


Finally, involvement in non-engineering activities shows a different pattern: involvement is lower for senior students, especially among females, who have considerably less involvement than senior males (Figure IIC-5). This was reflected in focus group discussions, where the female students indicated that they felt the need to spend almost all of the their time in the engineering building, on engineering projects and work. This even suggests a reversal of the "geek mentality" that Margolis and Fisher (2002) found among computer science students, with males displaying "non-geek" behavior more than females.

FIGURE IIC-5

NON-ENGINEERING ACTIVITIES BY GENDER AND YEAR IN SCHOOL

(Mean ACTNONENG)



SWE MEMBERSHIP: WHAT DOES IT ADD?

Membership in women's organizations raises some controversy: some believe that it isolates and marginalizes the women, while others see it as an enriching network (see, for example, Ross, 1994; Seymour and Hewitt, 1997). In focus groups, Rowan women were also divided over the benefits that participation in SWE (the Society for Women Engineers): some felt it was an enriching and comforting network, others felt it might brand them as marginal or feminist; they felt that it called attention to the female students as women, emphasizing their "otherness" (although they did not use that term).

It is worthwhile, therefore, to see whether SWE membership adds to the benefits of participating in student chapters of discipline-specific professional engineering societies.

The Rowan engineering females fall into three main groups: About a third (34%) belong to both SWE and a discipline-specific organization; 39% belong to a discipline-specific organization but not SWE; and 27% belong to neither a discipline-specific organization nor SWE. (Almost all SWE members belong to discipline-specific organizations as well, so there were not enough cases to analyze those belonging to SWE only.)

It should be noted that while there is some tendency for engineering majors to join discipline-specific organizations only after their first-year (perhaps because some of them had not chosen a discipline-specific major until then), SWE membership is distributed evenly across all four years of the program.

Membership in discipline-specific organizations as well as SWE appears to enhance engineering involvement. Women who are members of one or both of these types of organizations are more likely to have engaged in enrichment activities both outside the Rowan community and with faculty: they are more likely to have read an engineering listserv or newsletter, heard an engineering speaker outside of class, gone on an engineering field trip, had an engineering internship, conducted research with or worked for pay for a faculty member) (Table IIC-15). The women who are both SWE members and members of discipline-specific organizations were especially likely to have worked with or done research with a faculty member. They also were more likely to have gone on an engineering field trip. Thus, the additional SWE membership seems to have enhanced relationships with faculty and outside exposure. Since there were hardly any females who had joined SWE but not a discipline-specific organization, there is no evidence that SWE isolates or marginalizes Rowan women.

TABLE IIC-15

PARTICIPATION IN DISCIPLINE-SPECIFIC PROFESSIONAL ORGANIZATION, SOCIETY FOR WOMEN ENGINEERS, AND ENRICHMENT ACTIVITIES

(Females Only)

Organizational Participation / **Enrichment Activity**	**0 NEITHER**	**1 ORG NOT SWE**	**2 ORG AND SWE**	**TOTAL**
Beyond Rowan community				
% read engineering listserv or newsletter	63.6	**85.7**	**94.7**	80.6
% heard engineering speaker outside of class	81.3	**91.3**	**100.0**	91.5
% went on engineering field trip	50.0	65.2	**85.0**	67.7
% who had engineering internship during summer and/or academic year	27.3	**33.3**	**47.4**	35.5
Help Activity				
% met academic advisor at least once a semester	81.8	75.2	**94.7**	83.9
% received tutoring at least once a semester	45.5	28.6	**47.4**	40.3
% participated in study group once a week or more	68.2	66.7	**68.4**	67.7
% tutored another student at least once a semester	45.5	32.9	**57.9**	45.2

In terms of help activities, there is little difference in terms of the proportion who participated frequently in a study group, reflecting the extent to which this is encouraged and even formalized by some instructors. SWE membership is related to more involvement in getting and giving tutoring, and with meeting an academic advisor. This suggests that the SWE membership is related to participation in these "help" activities, either because the women who join SWE are more active help seekers (SWE being another reaching out for help in the form of networking) or because SWE encourages such activities (indeed forming a supportive "help" network).

Lest there be speculation that the women who join SWE need more help than the other women (and hence perhaps are motivated to join SWE), we see in Table IIC-16 that both SWE and discipline-specific organization members tend to have higher GPA's than women involved in neither type of organization, and there is some tendency for SWE members to have slightly higher GPA's than women in discipline-specific organizations only. In any case, there is no evidence that SWE members seek out SWE because they are in greater need of help or in any sense in a status of weakness vis-à-vis engineering.

TABLE IIC-16

PARTICIPATION IN DISCIPLINE-SPECIFIC PROFESSIONAL ORGANIZATION, SOCIETY FOR WOMEN ENGINEERS, AND ACADEMIC ACHIEVEMENT

(Females Only)

Organizational Membership	Mean GPA Fall 00	Mean GPA Spring 01
Neither	2.89	3.22
Discipline-specific organization only	3.28	3.39
Discipline-specific organization and SWE	3.34	3.36

SUMMARY AND CONCLUSIONS

First year students' academic performance and participation in engineering activities are somewhat influenced by their input characteristics of family and high school background and initial engineering self-confidence. However, over the course of the academic year, much of this influence is weakened at least in terms of academic performance. The impact of input family and high school background characteristics is, however, greater for the female students than the male students, especially on academic performance. The impact of engineering self-confidence is, however, not related to academic performance for the females although it is for the males.

Throughout the undergraduate years, females are more involved in the extra-curricular activities than are males, and their academic performance is almost always equal to if not beyond that of what males achieve.

SWE appears to enhance the involvement of the female students, at least in terms of study activities. It is not the weaker students who are involved in SWE, but rather those with better grades, suggesting the helping resources of SWE are effective.

CHAPTER II-D

CHANGES IN ENGINEERING SELF-CONFIDENCE OVER THE COURSE OF THE ACADEMIC YEAR

After students have been in the Rowan program for at least a year, their orientations to engineering are often modified. Their engineering self-confidence may be enhanced or diminished, depending on how well they have met their own expectations or exceeded them, the connections they have made in the school and beyond in the field of engineering, as well as their initial levels of self-confidence. In order to better understand the changes in engineering self-confidence taking place from the beginning of the academic year to its end, we looked at two indications of change in engineering self-confidence. First we looked at differences in self-confidence over the years in the program. Second, we looked at the change in responses to individual questions about engineering self-confidence that were repeated in both the fall and the spring surveys.[26]

DIFFERENCES IN ENGINEERING SELF-CONFIDENCE BY YEAR IN THE PROGRAM

To begin to assess the effect of the Rowan program on self-confidence, we compared the students at the various stages in the engineering program. It should be noted that in this section, because we are not examining panel data but cross-sectional data, we are not looking at the change in satisfaction of the same student from one year to the next, but only a comparison of students at different levels at a particular point in time. Therefore we can only infer changes over the undergraduate career from the cross-sectional differences we find between cohorts at this one point in time. Since almost all of the engineering students started out in this program as first-year students, year in the program

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[26] In this report we present only within-year changes. The change will be followed year to year with a longitudinal study, currently in progress.

does reflect for the most part the number of years of exposure to the Rowan program. It does not, however, control for changes in the program that may have occurred at various stages of these years, and thus is a very rough proxy for more precise measurement of changes over the course of the undergraduate career. Further, the differences between cohorts (in terms of actual students and differences in the program that they experienced) may explain some of the differences between students at different levels in the program rather than changes in their development as they progress through the program. We will return to this point below, when we do look at how students change over the course of the academic year.

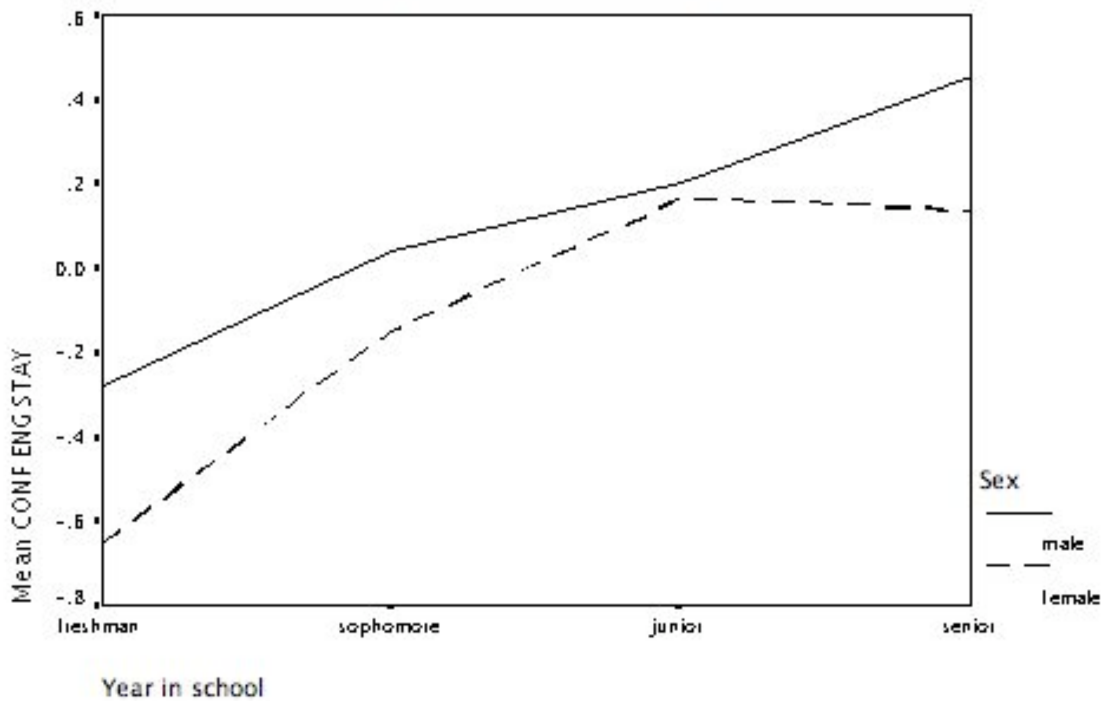
Confidence to Stay in Engineering

The longer a student has been in the engineering program at Rowan, the more confident he or she is that they will stay with engineering as a major and as a career (Figure IID-1). To some extent this is because some of the students who lack this confidence drop out of engineering; those who remain with the program have a greater investment in succeeding and are more likely to believe they will.

FIGURE IID-1

ENGINEERING SELF-CONFIDENCE (CONF ENG STAY)

BY GENDER AND YEAR IN SCHOOL



However, there is a gender difference in this pattern (Figure IID-1). The self-confidence of males that they will stay in engineering is greater with each year that they are in the program: sophomores have more confidence than first-year males; juniors have more confidence than sophomore males; and senior males the highest self-confidence of all – as might be expected if we think of each successive year seeing themselves as "survivors" from the previous year. Among females, a similar pattern is seen in comparing first-year, sophomore, and junior females: engineering self-confidence is greater with each year in the program. The difference between years in the program is even greater than the differences found for males, perhaps because they start out with less self-confidence than males, and as a result, the gender gap in self-confidence that they will stay in engineering is narrower for sophomores than for first-year students, and practically non-existent for juniors. That females start out with less self-confidence than males is similar to findings in previous studies (Dresselhaus, 1985; McIlwee and Robinson, 1992); what is notable is the narrowing of the gender gap in later portions of the undergraduate program, as women's self-confidence appears to increase.

However, this pattern does not continue for the seniors. Senior females do not have more confidence than junior females; in fact, their confidence that they will stay in engineering is a little lower than that of junior females. As a result, among seniors the gender gap in confidence that they will stay in engineering is again wide for seniors – almost as wide as it was for first-year students.

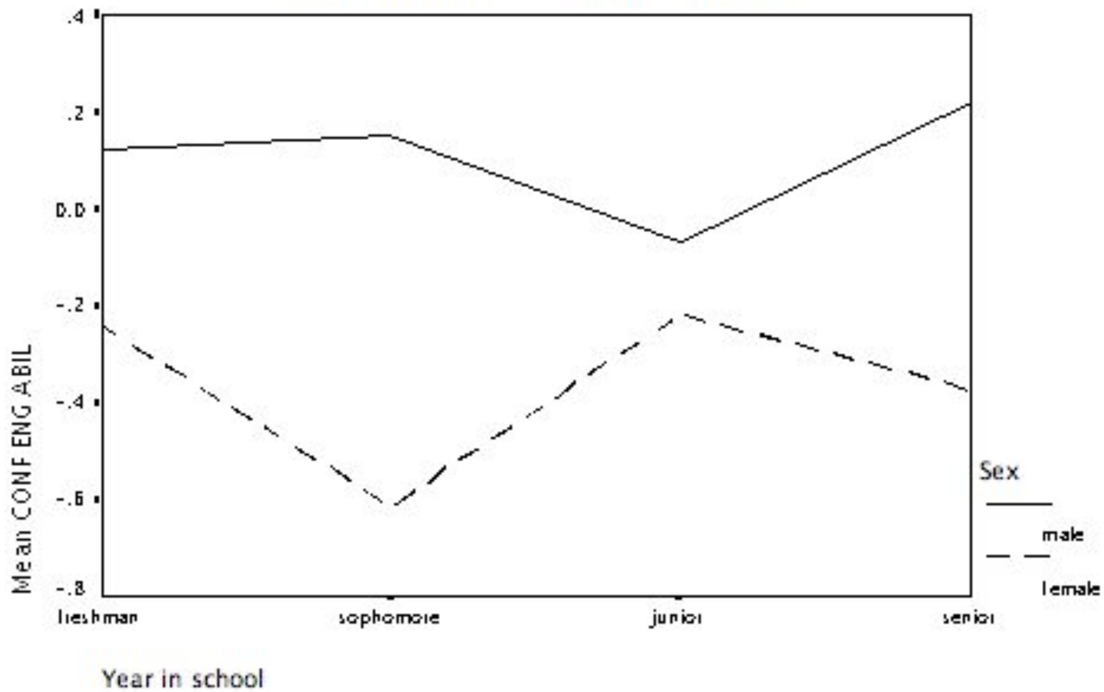
Confidence in Engineering Abilities

Self-confidence in engineering abilities does not follow the same pattern. Self-confidence does not vary linearly by year in the program for either males or females, and the gender gap fluctuates from one year to the next, widest in the sophomore year and again in the senior year (Figure IID-2).

FIGURE IID-2

CONFIDENCE IN ENGINEERING ABILITY

BY GENDER AND YEAR IN SCHOOL

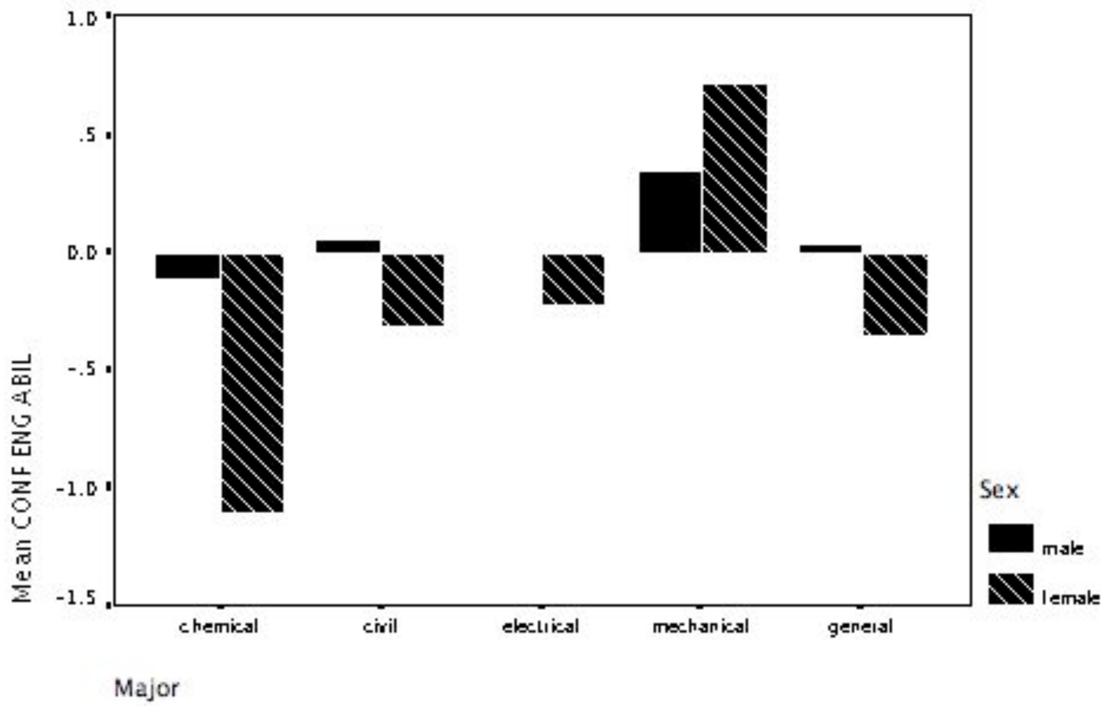


Considering the possibility that not all majors value mechanical, technical, and design abilities equally (as suggested by some of the students), we looked at the difference in self-confidence in these abilities by major (Figure IID-3). Indeed, there are great variations in self-confidence in these abilities by major for the female students: females majoring in mechanical engineering have much higher self-confidence in their mechanical, technical and design abilities than do female students in other majors. For males, however, major makes much less of a difference. In fact, the gender gap in this kind of self-confidence is reversed for mechanical engineering majors – the females in this major have higher self-confidence in their abilities than do the males; but for all other majors, the males have higher self-confidence in their abilities. The small numbers of females in some of these majors precluded our following how this varies over year in the program.[27]

FIGURE IID-3

SELF-CONFIDENCE IN ENGINEERING ABILITY

BY GENDER AND MAJOR



Confidence in Academic Ability

Self-confidence in overall academic ability shows a different pattern of gender difference over the four years of the engineering program (Figure IID-4). First-year females enter Rowan with a stronger sense of academic self-confidence than do first-year males, even though there were few significant gender differences in high school

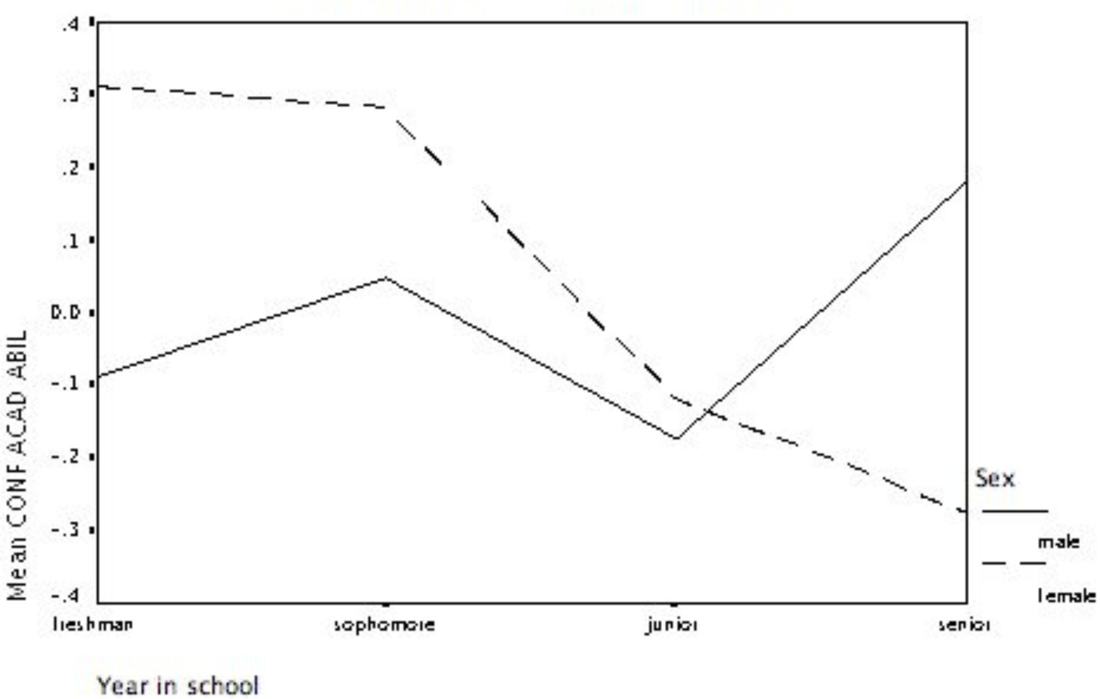
[27] It is possible that these results could have been created by two statistical factors: (1) as a second factor extracted, its eigenvalue is much lower and therefore the variations between males and females could have caused this lack of clear pattern; (2) the second statistical factor is the smaller number of cases with each successive year, which may make the pattern less clear.

achievement. Academic self-confidence is higher for sophomore females than males, also. However, the academic self-confidence of junior females is considerably lower than that of first-year or sophomore females, and that of seniors is even lower than that of juniors. The academic self-confidence of male seniors, on the other hand, is considerably higher than any of the previous years. As a result, the gender gap in academic self-confidence is virtually absent in the junior year, and is reversed in the senior year, with male seniors having stronger academic self-confidence than female seniors. It should be noted that this self-confidence in academic ability does not reflect actual achievement, as we show below: in the senior year, as in most other years, females have higher grade point averages than males.

FIGURE IID-4

CONFIDENCE IN ACADEMIC ABILITY

BY GENDER AND YEAR IN SCHOOL



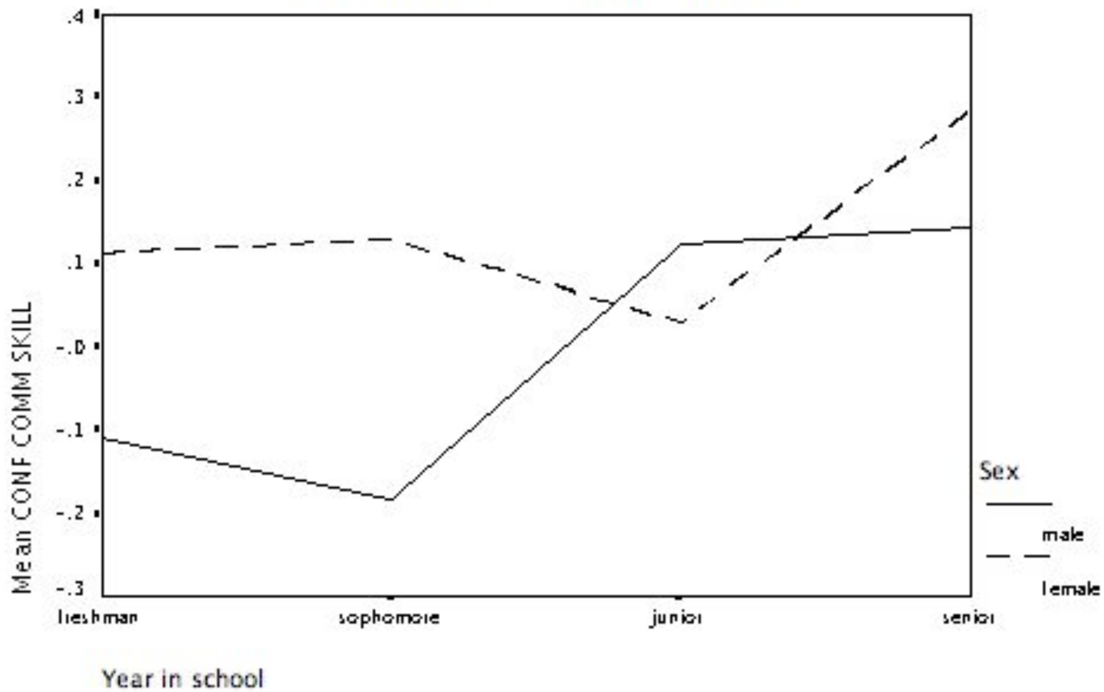
Confidence in Communication Skills

As mentioned above, Rowan's engineering program integrates communication skills into its required engineering clinic in the sophomore year, thus making a concerted effort to minimize advantages of any student over the other in terms of being able to make coherent and professional presentations of their work. The data on self-confidence in communication skills at the various level of the program suggests that they are successful in this endeavor (Figure IID-5). It is fairly well accepted that female students tend to have stronger verbal and written communication skills than male students, and this is reflected in the stronger communication self-confidence of female first-year students as they enter Rowan, compared to males. This stronger self-confidence is apparent at the beginning of the sophomore year, as well. However, after most students have had sophomore clinic, where communication skills are emphasized, the gender gap is much smaller: juniors and seniors have much smaller gender differences in this respect than in the earlier years. At the beginning of their senior year, females have slightly more communication self-confidence than males, but the gap is much smaller than in the first or second years of the program.

FIGURE IID-5

CONFIDENCE IN COMMUNICATION SKILL

BY GENDER AND YEAR IN SCHOOL



While the four self-confidence factors show different patterns of variance over the years of the program, they do share one pattern in common: whatever gender gap first year students start out with, by the junior year the gender gap has been narrowed. However, in the senior year traditional gender gaps of males having more self-confidence than females are seen in the first three self-confidence factors (only confidence in communication skills is higher for women among seniors). It will be remembered that engineering self-confidence among first-year students and senior students is affected most by characteristics the student inputs into Rowan (as opposed to the experiences of the Rowan program). The traditional gender gaps we see may be a result of the outside society's norms about women in engineering. It seems that the impact of Rowan while students are in the program (rather than looking toward graduation and employment or graduate school) is to narrow the gender gap in self-confidence, which reflects the inclusive nature of the program.

To better explore the effect of Rowan on the students' self-confidence, we looked at how engineering self-confidence changes from the fall to the spring semester of our study.

CHANGE IN ENGINEERING SELF-CONFIDENCE OVER THE COURSE OF THE ACADEMIC YEAR

To represent change in confidence that they belong in the major, we looked at the change in agreement with the statement, "I am confident that engineering is the right major for me." To represent change in confidence about engineering abilities, we looked at the change in agreement with the statement, "I am mechanically inclined." If the response in the Spring was more confident than in the Fall, students were considered to have increased their self-confidence; if the response in the Spring was less confident than in the Fall, students were considered to have decreased their self-confidence; if the response was the same for the two points in time, students were considered stable in their self-confidence.

Over the course of the academic year, the majority (about 60%) of the students did not change their self-confidence that engineering was the right major for them or that they were mechanically inclined. However, nearly 20% did increase their self-confidence on each of these indicators; and over 20% lowered their self-confidence in these respects.

We separated our analysis by year in the program in order to focus on when in the program changes occurred.

CHANGE IN SELF-CONFIDENCE BY YEAR IN PROGRAM AND GENDER

Looking first at the change in self-confidence that engineering is the right major, we can see that during the first year in the program, more students increase their confidence that engineering is the right major for them than decrease their confidence, and this is true for both males and females (Figures IID-6 and IID-7). We also see that a higher proportion of first-year female students increase their self-confidence than do male students, and a smaller proportion of first-year female students go down in self-confidence compared to males.

FIGURE IID-6

CHANGE IN CONFIDENCE ABOUT MAJOR FROM FALL TO SPRING

BY YEAR IN SCHOOL (Males)

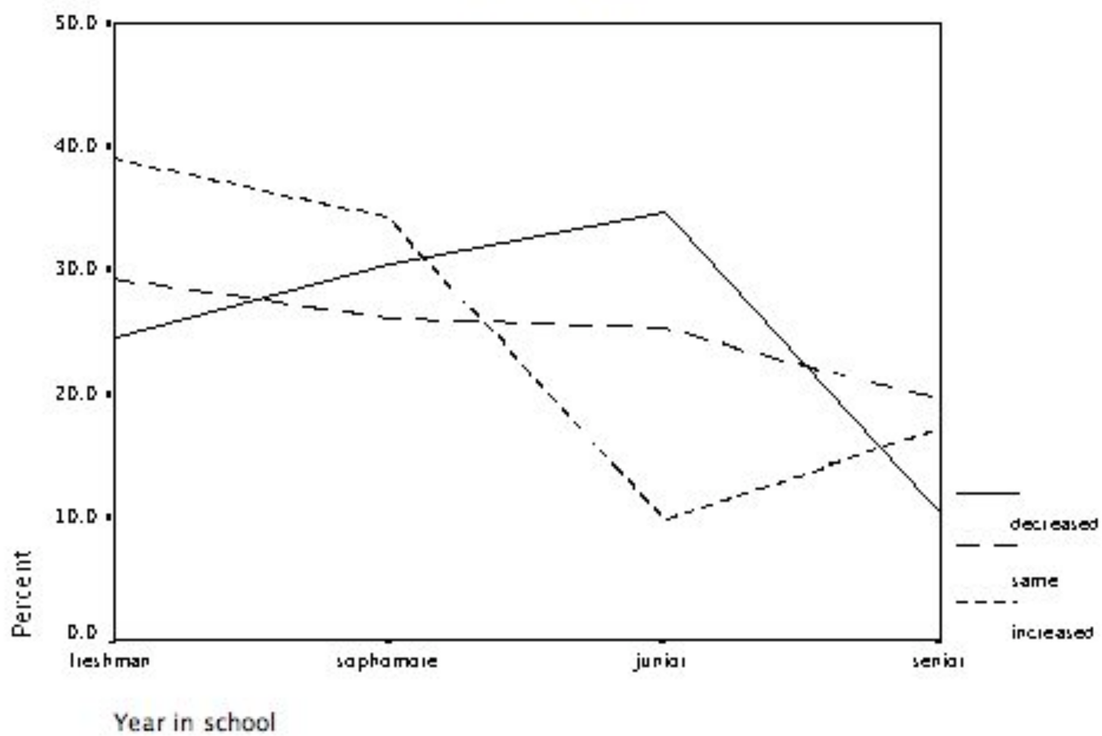
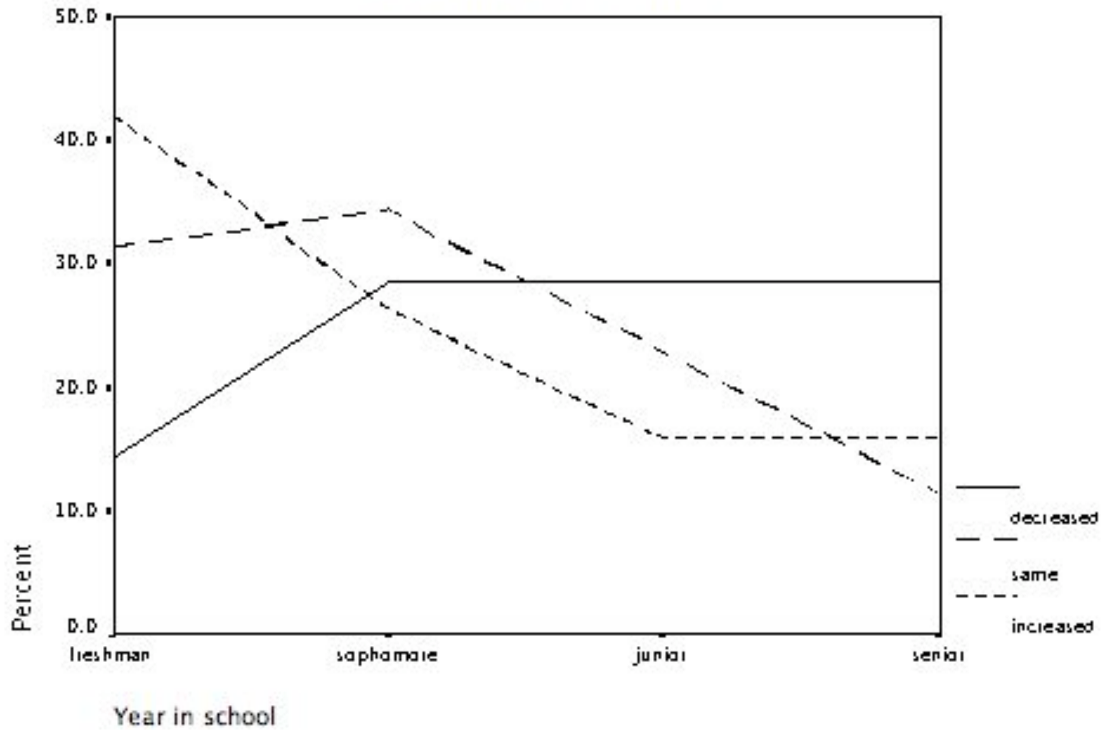


FIGURE IID-7

CHANGE IN CONFIDENCE ABOUT MAJOR FROM FALL TO SPRING

BY YEAR IN SCHOOL (Females)



Among sophomores, the proportion of male students increasing their self-confidence in engineering as the right major for them is not quite as high as in the first year of the program, while the proportion of males whose self-confidence has gone down is higher than in the first year. As a result, nearly the same proportion of males increase their confidence as decrease it. The same is true for females, although a higher proportion of sophomore females' self-confidence is steady from the beginning of the year to the end of the year.

For males, a higher proportion of juniors lose confidence over the course of the academic year than increase self-confidence – the gap is wide. This corresponds to some of the faculty's perception that the junior year is the most difficult of the program.

Similarly, for junior females, a higher proportion lose confidence during the course of the year than increase self-confidence.

It is in the senior year that we see a different pattern of male and female students. Among males, the proportion losing self-confidence is much lower than at any other time in the program, while the proportion increasing self-confidence is greater than among juniors. Thus overall the male self-confidence that engineering is the right major for them is strengthened during the senior year. This is not true for the females. The proportion whose self-confidence is lowered during the academic year remains as high as among juniors, and is a much higher proportion than those whose self-confidence increases or stays the same. Thus, overall, the self-confidence of female students that engineering is the right major for them, decreases during the senior year.

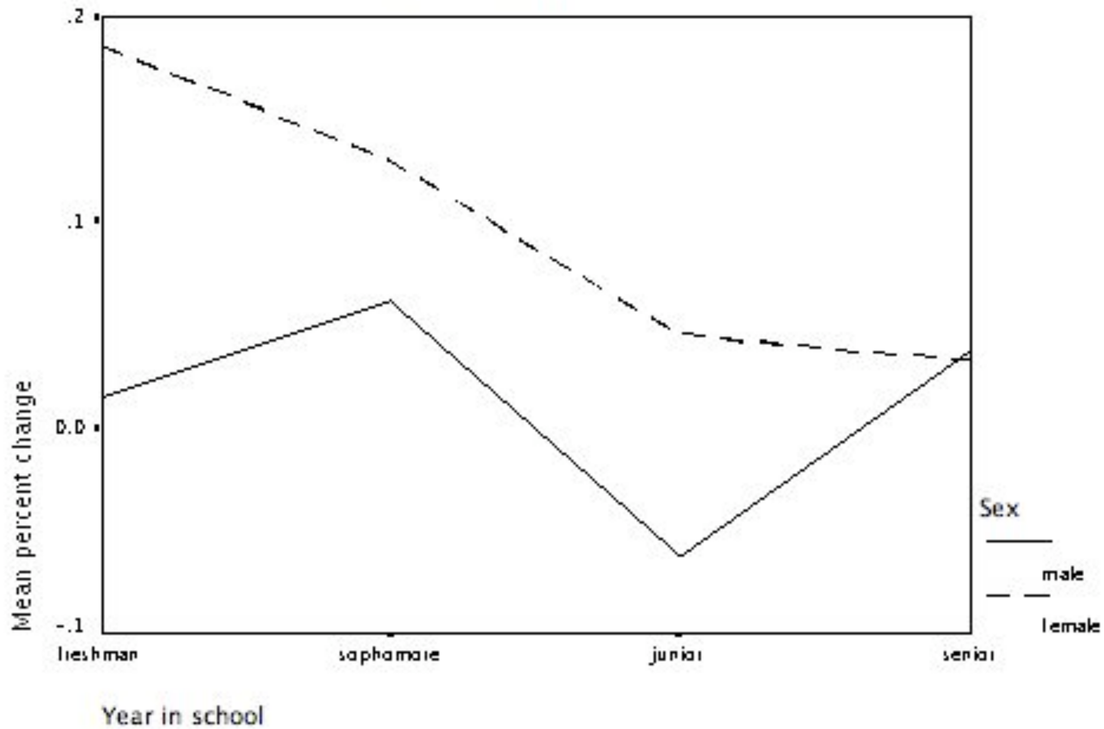
We can also look at *how much* change there was in this self-confidence. This was calculated by subtracting the Fall answer from the Spring answer, and dividing by the Fall answer. This standardized the percentage of change in responses, with the higher the percentage, the greater the improvement in self-confidence, and the lower the percentage, the greater the decrease in self-confidence from Fall to Spring.

We can see that in the first three years of the program, the self-confidence of females that engineering is the right major for them increased to a greater extent than did that of males (Figure IID-8). However, in the senior year, the change in self-confidence was of the same magnitude for males and females; in other words, the strengthening of self-confidence during the course of the academic year is greater for females for every year except the senior year.

FIGURE IID-8

PERCENT CHANGE IN ENGINEERING SELF-CONFIDENCE ABOUT MAJOR

BY GENDER AND YEAR IN SCHOOL

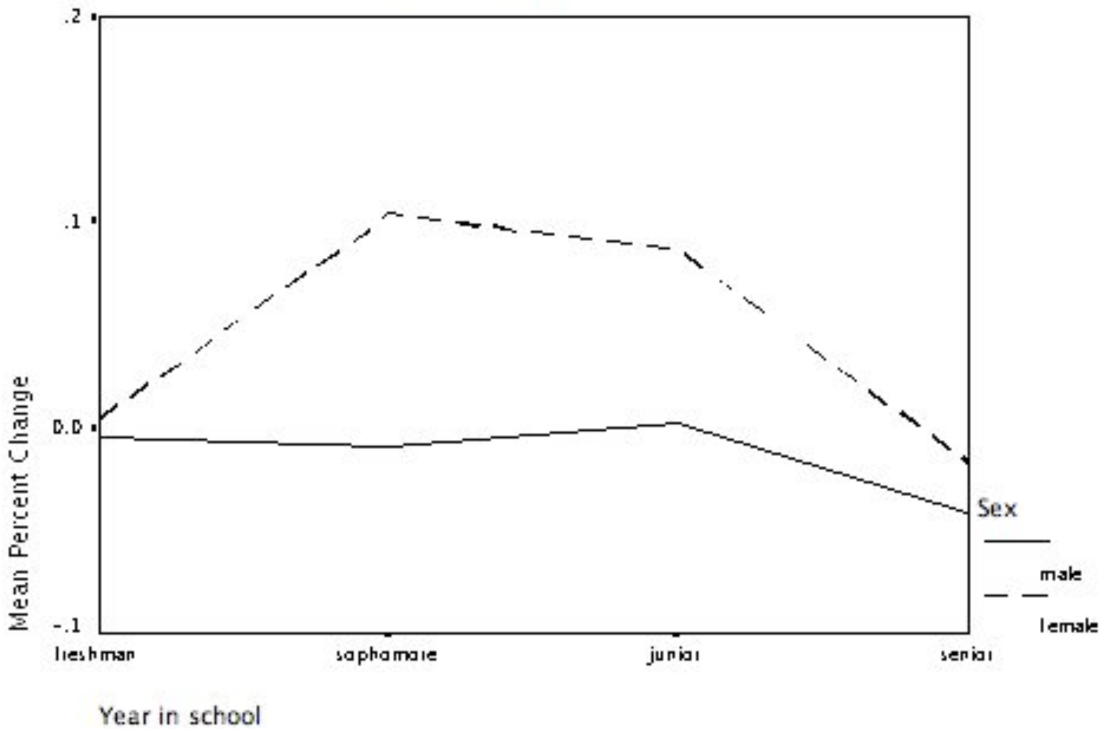


With respect to engineering abilities, represented by how mechanically inclined the student feels they are, females' confidence in this respect increases to a greater extent than males' in the sophomore and junior years, but increases the same amount in the first year and the senior year (Figure IID-9). Thus it seems that the middle years of the program are particularly supportive of women in bolstering their confidence in their engineering abilities.

FIGURE IID-9

PERCENT CHANGE IN CONFIDENCE THAT MECHANICALLY INCLINED

BY GENDER AND YEAR IN SCHOOL



In summary, we can see that over the course of the academic year, self-confidence that engineering was the right major for them was strengthened for a much higher proportion of female students than male students (Table IID-1). Almost a third of the females increased their self-confidence in this respect from the beginning of the academic year to the end of it, compared to less than 20% of the male students. In contrast, 23% of the male students decreased their agreement with the statement, compared to 11.5% of the female students. Similarly, self-confidence in their engineering abilities was strengthened for a higher proportion of female than male students, while self-confidence in this respect was undermined for a higher proportion of male than female students.

TABLE IID-1

CHANGE IN ENGINEERING SELF-CONFIDENCE OVER THE COURSE OF THE ACADEMIC YEAR BY GENDER

Gender	**Confidence that engineering right major for me**	**Consider myself mechanically inclined**
% Increased Self-Confidence		
Total	21.9	19.4
Male	19.2	18.4
Female	31.1	23.0
% Self-Confidence Stayed Same		
Total	57.7	57.9
Male	57.7	56.6
Female	57.4	62.3
% Decreased Self-Confidence		
Total	20.4	22.7
Male	23.0	25.0
Female	11.5	14.8

These results were reinforced by students' self-assessment in the Spring of whether several of their abilities had changed during the academic year. In many respects, students felt their abilities had improved over the course of the year. Over half of the students felt their overall academic ability had improved over the course of the academic year, that their critical thinking skills had improved, that their problem solving skills had improved, their computer skills, their speaking skills and their mathematical ability (Table IID-2).

In most of these areas, the percentage of females assessing an improvement was about the same as that of males. Females were more likely than males to see an improvement in their computer skills and in their speaking skills; males were more likely than females to see an improvement in their mathematical ability.

TABLE IIH-2

PERCEIVED INCREASE IN ABILITY OR SKILL OVER ACADEMIC YEAR BY GENDER

(% perceiving increase)

Ability or Skill	Males	Females	Total
Computer skills	66.9	79.1	69.6
Mathematical ability	63.0	49.3	60.0
Overall academic ability	58.0	61.2	58.7
Problem-solving skills	54.4	56.7	54.9
Critical thinking skills	51.7	55.2	52.5
Speaking skills	50.0	58.2	51.8
Writing skills	38.2	38.8	38.4

Thus, we can see that generally the engineering self-confidence of women in engineering at Rowan is strengthened by their time at Rowan at least as much if not more than that of male students, with the exception of the senior year, during which female's self-confidence that engineering is the right major for them is more likely to decline.

CHANGE IN ENGINEERING SELF-CONFIDENCE AND BACKGROUND FACTORS

In this section we look at the changes in engineering self-confidence by background factors, to consider whether students with particular background characteristics are empowered more than others during the course of the academic year. While background factors were related to self-confidence at the beginning of the year, the relationship was stronger for first-year students than for most of the other students, and therefore we did not expect background factors to have strong relationships with changes in self-confidence. Because of the relatively small number of cases, we were unable to analyze these relationships by year.

For the most part, the relationships are indeed weak between change in confidence that engineering is the right major, and family background factors (Table IID-3). The only statistically significant relationships are for females, between change in confidence and having siblings who went to college (p=.01) and support by significant others for their pursuit of engineering (p=.08). The pattern with regard to parents' education and father's occupational prestige is that students whose parents have less education or occupational prestige are more likely to increase their self-confidence over the course of the year, while the students whose parents are most highly educated are more likely to lose self-confidence over the course of the year. It may be that the latter come in with unrealistic expectations of the ease with which they will acquire the profession, while the latter come in more apprehensive; the experience over the course of the year tends to equalize their self-confidence. Similarly, it is the women with the lowest support from outside the university for their pursuit of engineering whose self-confidence is raised the most over the course of the year. On the other hand, women who have siblings in college are less likely to lose self-confidence, perhaps because they have role models to help them over any obstacles. The impression we get is that the Rowan experience tends to reduce the disparities in engineering self-confidence between students of differing family backgrounds, empowering the students with weaker family role models and support, and not unduly capitalizing on the advantages students with stronger family role models and support might have.

TABLE IID-3

CHANGE IN SELF-CONFIDENCE THAT ENGINEERING IS RIGHT MAJOR FROM FALL TO SPRING BY FAMILY BACKGROUND AND GENDER

(%'s)

Gender	Change in Confidence that Engineering Right Major	% Father's with college education	% Mothers with College Education	Father's mean occupational prestige	Mean number of siblings	% whose siblings went to college	Support of significant others for engineering[a]
Males	Decreased	61.2	47.9	52.9	2.1	43.0	6.51
	Same	46.3	41.0	53.4	2.0	43.0	6.74
	Increased	51.2	41.5	52.5	1.8	30.0	6.59
Females	Decreased	85.7	85.7	55.7	1.7	0	7.00
	Same	48.6	60.0	52.0	1.8	62.0	6.97
	Increased	52.6	52.6	49.7	2.2	53.0	5.73

[a]The support index is explained above in Chapter IIB.

With regard to changes in confidence in mechanical ability, there are no statistically significant differences by family background characteristics for males, and no clear patterns of relationship (Table IID-4). For the females, however, it is the women whose fathers have higher education and higher occupational prestige whose self-confidence in their mechanical ability increases the most (anova significant at p=.03 and p=.02, respectively). It is also the women who had more siblings in college whose confidence in their mechanical ability increases the most. So it is possible that these role models and/or socio-economic status enhance women's self-confidence in their mechanical abilities, beyond the influence of the school environment.

TABLE IID-4

CHANGE IN SELF-CONFIDENCE IN MECHANICAL ABILITY FROM FALL TO SPRING BY FAMILY BACKGROUND AND GENDER

Gender	Change in Confidence in Mechanical Ability	% Fathers with College education	% Mothers with College Education	Father's mean occupational prestige	Mean number of siblings	% whose siblings went to college	Support of significant others for engineering
Males	Decreased	51.6	50.0	52.4	2.1	34.0	7.12
	Same	50.5	41.3	53.1	1.8	46.0	6.26
	Increased	48.8	34.2	53.6	2.2	36.0	7.07
Females	Decreased	28.6	64.3	41.5	2.0	50.0	6.44
	Same	54.6	57.6	53.9	2.0	44.0	6.67
	Increased	78.6	64.3	55.5	1.6	52.0	6.62

With regard to high school background, none of the relationships with change in self-confidence are statistically significant, and the patterns are even more obscure than with family background, both for males and for females (not shown here). Apparently, changes in self-confidence result not from background influences but more in terms of experiences over the course of the year.

CHANGES IN SELF-CONFIDENCE AND PARTICIPATION IN ENGINEERING ACTIVITIES

Next we considered whether involvement in the extra-curricular engineering activities offered at Rowan affected students' engineering self-confidence. For males, involvement in the various kinds of enrichment activities, counseling, study and organizational activities is not significantly related to changes in self-confidence (Table IID-5). Apparently students who are more involved in non-engineering activities have lowered their confidence that they belong in engineering (but, of course, it is not clear which comes first – the lowered confidence, or the pull to be involved outside of engineering). For the women, there is a clearer pattern that the women whose self-confidence in engineering as the right major for them decreased, were less involved in both counseling and studying activities, and were more involved in non-engineering activities. They were also less likely to belong to SWE than the women whose confidence increased.

TABLE IID-5

CHANGE IN SELF-CONFIDENCE IN ENGINEERING AS RIGHT MAJOR FROM FALL TO SPRING BY ENGINEERING ACTIVITIES AND GENDER[a]

Gender	Change in Confidence that Engineering Right Major	Mean score on ACTACAD	Mean score on ACTCOUNS	Mean score on ACTSTUDY	Mean score on ACTNONENG	% Member of professional organization	Member of Society for Women Engineers
Males	Decreased	.063	-.157	.091	.136	59.2	Na
	Same	-.134	-.056	-.124	.035	52.0	Na
	Increased	-.068	-.073	-.012	**.008**	**61.0**	Na
Females	Decreased	.404	-.491	-.179	.049	85.7	29.6
	Same	.120	**.090**	.135	-.207	60.0	36.4
	Increased	**.471**	**-.076**	**.172**	-.152	68.4	**44.5**

[a]Activity factors are explained above in Chapter II-B.

Involvement in counseling and study activities, and lack of involvement in non-engineering activities, are related to increased self-confidence in mechanical ability for both males and females. Females whose self-confidence in their engineering abilities did not decrease are also more active in academic enrichment activities (ACTACAD) (Table IID-6). SWE membership does not have the same effect on increasing confidence in mechanical ability as it did on confidence that the women belonged in engineering.

So involvement in engineering activities, especially study and counseling activities, are related to increased self-confidence for women especially, although the relationships are fairly weak.

TABLE IID-6

CHANGE IN SELF-CONFIDENCE IN MECHANICAL ABILITY FROM FALL TO SPRING BY ENGINEERING ACTIVITIES AND GENDER[a]

Gender	Change in Confidence that Engineering Right Major	Mean score on ACTACAD	Mean score on ACTCOUNS	Mean score on ACTSTUDY	Mean score on ACTNONENG	% Member of professional organization	Member of Society for Women Engineers
Males	Decreased	-.043	-.143	.102	.206	54.8	na
	Same	.014	-.098	-.241	.031	54.1	na
	Increased	-.358	**.036**	**.232**	**-.117**	58.5	na
Females	Decreased	.056	.031	-.014	-.155	64.3	64.3
	Same	**.349**	-.146	.076	-.092	66.7	29.1
	Increased	**.264**	**.192**	**.321**	**-.342**	64.3	30.8

[a]Activity factors are explained above in Chapter II-B.

CHANGES IN SELF-CONFIDENCE AND ENGINEERING GRADES

It is reasonable to expect that the change in engineering self-confidence is related to academic performance during the same academic year, with those who perform less well lowering their self-confidence and those who perform better increasing their self-confidence (Table IID-5). In terms of confidence to stay in engineering, however, this is true for males but not for females. Males who decreased their self-confidence had lower grades in their engineering classes than did males whose self-confidence increased or stayed the same over the course of the academic year. However, academic performance does not seem to explain changes in engineering self-confidence for women in the program.

TABLE IID-5

MEAN GRADE POINT AVERAGE IN ENGINEERING COURSES BY CHANGE IN CONFIDENCE THAT ENGINEERING IS RIGHT MAJOR FROM FALL TO SPRING AND GENDER

Change from Fall to Spring in Self-Confidence "Engineering is right major for me."	Males	Females
Decreased	3.21	3.51
Same	3.43	3.50
Increased	3.50	3.50

On the other hand, women's self-confidence in their mechanical abilities is related to better academic performance (Table IID-6), as it is for males. Those whose confidence in their mechanical abilities decreased from the Fall to the Spring have the lowest engineering grade point averages, while those whose confidence increased have the highest engineering GPA's.

TABLE IID-6

MEAN GRADE POINT AVERAGE IN ENGINEERING COURSES BY CHANGE IN CONFIDENCE IN MECHANICAL ABILITY FROM FALL TO SPRING AND GENDER

Change from Fall to Spring in Self-Confidence that "I am mechanically inclined."	Males	Females
Decreased	3.23.	3.43
Same	3.47	3.47
Increased	3.50	3.66

SUMMARY AND CONCLUSIONS

We have shown that over the course of the academic year, experience in the Rowan engineering program strengthens the engineering self-confidence of many of the women in the first three years of the undergraduate program, and that this strengthening of self-confidence is a process that happens more to the female students than to the male students. The role of the school in increasing women's self-confidence is strengthened by the greater effect that participation in enrichment and help activities has for women than for men. Males, in contrast, tend to lose self-confidence during the course of the year, except in their senior year. These contrasting patterns may well reflect the gender differences in participation in "support" activities, relationships with faculty and peers. However, in their senior year, males' gains in self-confidence result in their having a much higher level of self-confidence than females at the end of their senior year.

In spite of the fact that they come with considerably less self-confidence in themselves as engineers at the beginning of the freshman year, the integration of the female students into the program is paralleled by their gains in general engineering self-confidence at every level of the program. With regard to confidence in engineering abilities, the picture is somewhat different. In almost all cases, both males and females lose self-confidence in their engineering skills in the course of the academic year, presumably as they encounter the difficulty of the program. However, the senior year appears to be a main parting of the genders. Males' self-confidence increases over the course of the academic year; females' self-confidence decreases. Therefore, at the end of the senior year, we find the largest gap in self-confidence of all, as we did on the first factor.

The males who lose self-confidence over the course of the year have lower engineering grades than their fellow male students who do not lose confidence. Women who lose confidence that they belong in engineering, however, do not usually have lower grades; their loss of confidence appears to be related more to their involvement in extra-curricular activities. This finding reinforces the perception that the Rowan environment contributes to women's self-confidence over the course of the academic year. Loss of confidence in their engineering abilities is related to poor academic performance for both males and females.

CHAPTER II-E

SATISFACTION WITH THE ROWAN ENGINEERING PROGRAM

In this chapter we focus on student satisfaction with various aspects of the Rowan engineering program at various levels of their undergraduate career. Students were asked how much they agreed with both positive and negative statements about the program's offerings, special features, structure, work load, faculty-student relationships, camaraderie with fellow students and the like.[28] Their opinions are our window on how students respond to various aspects of the program—which they like, which they are less comfortable with. Since one of the reasons students leave programs is their dissatisfaction, attention to their satisfaction and dissatisfaction is of great importance. Women's attrition in particular is of concern in engineering, so we devote part of this chapter to assessing and understanding gender differences in satisfaction. Further, since elements of the Rowan program appear to be "female-friendly" as a by-product rather than targeting women per se, it is important to assess whether women are indeed satisfied with these elements of the program, and whether men are satisfied as well--or whether these "female-friendly" measures are difficult for men even if they help women.

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[28] Survey questions were developed and worded both to reflect aspects of the Rowan program and to include questions comparable to other surveys (see comparisons in Chapter IIH). We recognize that the list may not be exhaustive of all aspects of the program. In addition, sometimes the wording does not exactly expression satisfaction, but is a more neutral kind of assessment. For example, we ask how much the student agrees that: "The clinic system provides realistic experiences like in the work world," and infer that agreement indicates satisfaction, even though the student is not asked whether this is a good thing or a bad thing. The creation of the indices through factor analysis, as we describe below, shows that the phrasing of this question (and others like it) does indeed fit into the general concept of satisfaction objectively; in factor analysis, a question that did not indicate satisfaction would not have had enough commonality with other survey items to be included in an index of satisfaction.

The programmatic elements of most interest to us were those special to the Rowan program: especially the emphasis on teamwork and the Engineering clinic. Because Rowan is one of the few programs to institutionalize the teamwork pedagogy so widely for all of its students, it provides us an opportunity to ascertain the contribution of teamwork to the engineering education environment for female as compared to male students. Group work is supposed to be a pedagogy that women prefer, since it involves collaborative rather than competitive learning, interactional negotiations which women enjoy, a peer setting for confidence building and a safer environment for error correction for those unsure of their skills. Further, it promotes a feeling of equality among all contributors, and also provides the opportunity to learn from each other's strengths. The experience of males and females in groups may, however, differ (Tannen, 1993; Felder, et. al., 1995). This chapter enables us to address some of the issues which have been raised about the pedagogy of group work: whether it is valid to assume that women really prefer to work in groups rather than to work individually, and whether women are more satisfied or at least as satisfied with group work than are men.

Another important feature of the Rowan program is the extensive lab work that permeates each semester. In other programs, women have been alienated because they feel at a disadvantage with lab work, being less familiar with it and feeling less comfortable in the lab setting. With greater opportunities for lab experience, it was important to assess whether females were satisfied with the lab work and whether they were as satisfied as males.

Personal student-faculty interaction is another of the hallmarks on which Rowan prides itself: it was important to assess whether students perceive this to be accurate, and whether the gender of the student affects their satisfaction in this respect. Because a feeling of belonging is integral to remaining in a major, students' assessment of peer relationships and their sense of community in engineering were also important to assess.

Finally, we also asked the students about satisfaction with course load, opportunities offered, how the program was run, and advisement.

In this chapter, after describing our indicators of satisfaction with the Rowan program, we analyze each type of satisfaction to determine which type of student is most satisfied or dissatisfied with that aspect of the Rowan program. We consider the extent to which the input students bring from family and pre-college preparation influences their satisfaction with the Rowan engineering program. A critical question is whether the program satisfies only the most highly qualified students, or whether it caters to students who have less strong preparation; whether students who had the greatest chance of acceptance into another engineering program are more or less satisfied with the Rowan program.

Many would say that satisfaction is closely related to academic performance, those who do better being more satisfied, those doing worse, less satisfied. We look at the relationship between academic performance and satisfaction. To get an idea of what kinds of involvement in the Rowan program might lead to more or less satisfaction with the program, we also relate the student's involvement in extra-curricular activities to their levels of satisfaction.

We then consider how engineering self-confidence is related to satisfaction with the various aspects of the program. While we recognize that the two may affect each other, we start out by looking at how levels of self-confidence measured in the fall semester are related to satisfaction at the end of the academic year. We then show how satisfaction is related to the change in engineering self-confidence from fall to spring.

In the last part of the chapter, we look at gender differences in satisfaction, and how the satisfaction of males and females is related to their background characteristics, engineering self-confidence, academic performance and involvement in activities at Rowan.

THE MEASUREMENT OF SATISFACTION WITH THE PROGRAM

Some 30 items asked the students to express their satisfaction with these various elements of the program and climate in engineering. These items were factor analyzed to determine the major dimensions of satisfaction with the program according to the students.[29] Initially, three main factors were discerned, each reflecting a content area of satisfaction. The first content area of satisfaction related to the more general programmatic elements of the program and its structure, reflecting attitudes about the scheduling of courses, advising, coursework load, and research opportunities.

The second content area of satisfaction reflected satisfaction with the more specific applications of the program, such as the way laboratory work is conducted, team work, and the engineering clinic program.

The third content area of satisfaction related to the interpersonal climate, including faculty-student and peer relationships.

[29] The factors were created using principle-components varimax rotation factor analysis. On each of the factor analyses, the items included showed high communality (.5 or higher) and together explained at least 50% of the variance of the items.

Because each of these content areas encompassed many indicators, a second stage of factor analysis was performed separately on each of the content areas. The result was that the first content area of programmatic elements was separated into two factors; the second content area of program application was separated into three factors; and the third content area of interpersonal climate was separated into two factors. In sum, there were seven factors indicating satisfaction with an aspect of the program; that is, each student received scores on seven factors[30]. A more detailed description of each of these factors follows.

I. Programmatic Elements:

IA. Satisfaction with classwork demands (SATCLASS)

The indicator SATCLASS relates to the extent to which students perceive coursework to be too demanding or difficult. Giving voice to many of the familiar complaints about courses that are heard on college campuses and in engineering programs in particular, it is based on the extent to which students agreed (on a scale of 1 to 5) with the following items: "The pace of learning in many of the required courses is too fast", "The workload for engineering students is too heavy and difficult", "Many of my classes are too large", "Engineering professors expect students to have better developed computer skills than they actually have", and "Not enough attention is given to different styles of learning in engineering classes."

IB. Satisfaction with choices available (SATCHOIC)

[30] The resulting scores on each factor are standardized with a mean of 0 and a standard deviation of 1. The range of scores for each factor is about –4 to +3, the lower the score, the less satisfied.

The second indicator of satisfaction with the content of the program relates to the extent to which students are satisfied with the choices they are offered regarding classes and internship opportunities. It includes the extent to which they agreed (on a scale of 1 to 5) that: "I can usually get the classes I need in the semester that I need them", "Departmental advisors do a good job", "There are ample opportunities for students to do independent research at Rowan," and "There are ample opportunities offered for student internships in engineering".

II. Program Applications

IIA. Satisfaction with labwork (SATLAB)

The indicator SATLAB relates to the extent to which students were satisfied with their laboratory experiences. The items with high loading on this factor included how strongly the student agreed (on a scale of 1 to 5) that "Lab work adds a lot to my understanding of course material," "Expectations for lab work are explained well," and "More lab experience would be worthwhile."

IIB. Satisfaction with teamwork (SATTEAM)

The score on the second indicator of program applications reflects satisfaction with the teamwork required. It includes the extent to which students agreed (on a scale of 1 to 5) with many of the familiar complaints against group work: that they "do not enjoy working in assigned groups in class", that "usually not everyone does their fair share," that teamwork "slows down the learning process" in the clinic setting, that their experience in the engineering clinics has made them "more negative about working in groups/teams," and that "too much group work is required in engineering classes."

IIE. Satisfaction with engineering clinic (SATCLINIC)

The third factor of program applications is the extent to which students are satisfied with the engineering clinic system. It includes the extent to which students agreed (on a scale of 1 to 5) that the clinic system: provides "realistic experiences like in the work world," provides "useful hands-on experience in engineering," enables students "to connect things from different disciplines," "unifies engineering students in the same class but from different majors," has students "spend time on learning material or approaches irrelevant to their major," and that "too much work is expected for the amount of credit given in the clinics" (a frequent complaint that was voiced in the focus groups).

III. The Interpersonal Climate:

IIIA. Satisfaction with peer relationships (SATPEERS)

The first indicator of interpersonal climate reflects satisfaction with peer relationships in the Engineering College. The items with high loading on this factor included: agreement (on a scale of 1 to 5) that engineering students at Rowan usually "care about me as an individual," "listen to me when I am troubled," "show that they respect me," "support and encourage each other," "are friendly," "help each other out on coursework, projects & ideas," "are approachable," and "feel a sense of community in the Engineering College."

IIIB. Satisfaction with faculty-student interaction (SATFAC)

The last indicator reflects satisfaction with faculty-student interaction. It included how strongly the student felt that the faculty "are approachable," "are available… outside of classroom hours", "are friendly," "listen when I am troubled," "support and encourage me", "respect me", "care about me as an individual," and "care whether I learn the course material."

SATISFACTION WITH THE ENGINEERING PROGRAM

Satisfaction with Programmatic Elements

Level of Satisfaction with Programmatic Elements

The first type of satisfaction reflected in the satisfaction factors is how satisfied Rowan students are with the opportunities afforded by the engineering program, and they appear to be quite satisfied. For example, nearly 90% agree that they can get the classes they need when they want them, 76% agree that departmental advisors do a good job, and nearly half are satisfied that there are ample opportunities to do independent research (Table IIE-1). As we show below in Chapter IIH, Rowan students tend to be more satisfied with many aspects of their program than students in other engineering programs. Satisfaction with this aspect of the program seems to grow as the students progress through the program[31], as might be expected: more opportunities are offered to more advanced students, on the one hand, and less satisfied students will transfer out, on the other.

[31] Again, we remind the reader that we are using cross-sectional data of one year in time, so that the differences between the years confound the effect of cohort differences and changes over time in the program (see above, where discussed in Ch. IID).

TABLE IIE-1

SATISFACTION WITH PROGRAMMATIC ELEMENTS BY YEAR IN SCHOOL

(% "agree" and "strongly agree")

Year in School / Satisfaction Item	First-Year	Sophomore	Junior	Senior	Total
I can…get classes I need in semester I need them	78.3	86.5	86.3	100.0	87.0
Advisors do a good job	79.5	70.5	78.9	75.4	76.0
There are ample opportunities for students to do independent research at Rowan	30.1	41.0	46.3	64.9	43.8
SATCHOIC (mean score)	-.328	-.051	.054	.478	.000

The second factor of satisfaction with the program reflects opinions about the coursework load. Agreement with the individual statements contributing to this factor indicated dissatisfaction, while disagreement indicated satisfaction[32]; some of these items are illustrated in Table IIE-2. For example, few students agree that Rowan classes are too large (the largest classes are capped at 35), but a third agree that the pace is too fast, and nearly half find the workload too heavy and difficult. Unlike satisfaction with the programmatic structure, satisfaction with the coursework load is lower in the sophomore and junior years (when many of the faculty claim the load is in fact most difficult).

[32] For purposes of presentation, the factor scores were aligned with the other factors of satisfaction, so that greater satisfaction was indicated by a higher score.

TABLE IIE-2

SATISFACTION WITH COURSEWORK BY YEAR IN SCHOOL

(% "agree" and "strongly agree")

Satisfaction Item \ Year in School	First-Year	Sophomore	Junior	Senior	Total
Many of my classes are too large	8.4	11.3	15.1	3.5	10.0
The pace…in many of the required courses is too fast	25.3	33.0	34.9	43.3	34.0
The workload for engineering students is too heavy and difficult	30.5	54.5	62.0	43.9	48.1
SATCLASS (mean score)	.309	-.190	-.302	.263	.000

In the following sections, we will look at what kinds of students are more or less satisfied with the programmatic elements of SATCHOIC and SATCLASS. First we will look at selected family and high school background characteristics as they are related to students' satisfaction scores; then we will look at students' academic performance and participation in extra-curricular activities and how they are related to satisfaction.

Satisfaction with Programmatic Elements and Background Characteristics

To explore whether students with certain kinds of backgrounds are more or less satisfied with the programmatic elements, we begin by looking at the relationship between selected family characteristics and the satisfaction scores. We consider parents' education, father's occupation, how much support students perceive by significant others for their pursuit of engineering. We expected that the effect of background characteristics would become weaker during the undergraduate career as they get more involved in their undergraduate education and satisfaction would depend more on their school experience.

Since we therefore expected family characteristics to affect first year students more than more advanced students, we looked at first-year students separately from students at all levels.

Satisfaction with the programmatic elements of SATCHOIC and SATCLASS does tend to be higher among first year students whose parents are college-educated; however, the differences are small and statistically significant only for satisfaction with coursework (SATCLASS) (Table IIE-3). More advanced students whose fathers are in engineering, science or math and students who have more support from significant others for their pursuit of engineering are more satisfied with the coursework load, but family background is not significantly related to their satisfaction with the program structure or offerings (SATCHOIC).

TABLE IIE-3

SATISFACTION WITH PROGRAMMATIC ELEMENTS BY FAMILY CHARACTERISTICS AND YEAR IN SCHOOL

(Mean scores on SATCHOICE and SATCLASS)

	Year in School:	**First Year**		**Students of All Levels**	
Family characteristic	**Satisfaction Factor:**	**SATCHOIC**	**SATCLASS**	**SATCHOIC**	**SATCLASS**
Father's Ed	College ed	-.29	.50*	-.04	.12
	Less than college	-.39	.20	.04	-.02
Mother's Education	College ed	-.33	.38	.00	.10
	Less than college	-.36	.33	-.02	.02
Sibling's Education	College ed	-.40	.20	.04	.00
	Not college ed	-.33	.44	-.07	.13
Father's occupation	Sciences/engineering	-.81*	.45	-.04	.25**
	Other	-.25	.34	-.01	.00
Support for Engineering Pursuit	Strong	-.30	.39	.03	.13**
	Mild	-.30	.21	-.08	-.09

*T-test of difference in mean score on satisfaction factor significant at $p<.05$.
** T-test of difference in mean score on satisfaction factor significant at $p<.10$.

Considering high school background characteristics, we expected that students with higher high school grades in engineering-related subjects and greater participation in extra-curricular activities related to math and science might be better prepared for the engineering program and hence more satisfied with it, at least at the beginning.[33]: In their first year at Rowan, satisfaction with the coursework (SATCLASS) is higher for students who got higher grades in math and science in high school. However, satisfaction with the program structure and opportunities (SATCHOIC) is not significantly higher at any level of the program for students with stronger high school math and science backgrounds, nor is satisfaction with coursework at higher levels.

TABLE IIE-4

SATISFACTION WITH PROGRAMMATIC ELEMENTS BY HIGH SCHOOL BACKGROUND AND YEAR IN SCHOOL
(Mean scores on SATCHOICE and SATCLASS)

	Year in School:	**First Year**		**Students of all Levels**	
High School Background	**Satisfaction Factor:**	**SATCHOIC**	**SATCLASS**	**SATCHOIC**	**SATCLASS**
High school math and science grades	Mostly A's and B's	-.277	.588*	.076	.132
	Mostly B's or lower	-.387	-.198	-.059	-.004
Extra-Curricular math and Science Activities	More	-.230	.201	.003	.037
	Less	-.455	.370	-.015	.034

To see the overall effect of the background characteristics on satisfaction with these programmatic elements, we ran a multiple regression analysis with SATCHOIC and

[33] For example, almost all students had gone to co-ed high schools, so we could not look at this high school characteristic.

SATCLASS being the dependent variables, and family and high school background characteristics being the independent variables. The multiple correlations (and their squares) resulting from these regression analyses, performed for first-year students separately and then for all students, are presented in Table IIE-5.

We can see that background variables have a much stronger effect on the satisfaction of first-year students than on students at more advanced levels. The square of the multiple correlation tells us how much of the variation in the dependent variable can be explained by all of the background characteristics taken together. For first year students, more than a quarter of the variation in satisfaction with the program offerings (SATCHOIC) can be explained by these background characteristics. Among more advanced students, however, less than 7% of the variation is explained by family and high school background; at more advanced levels, involvement in the program itself is more important than the background with which the student enters the program. Similarly, among first-year students, background characteristics explain 17% of the variation in satisfaction with class work (SATCLASS), but only 4% of the variation among more advanced students. Among more advanced students, satisfaction with coursework is more strongly related to their achievement at Rowan, as we will see below.

TABLE IIE-5

MULTIPLE CORRELATIONS RESULTING FROM MULTIPLE REGRESSION ANALYSIS OF SATISFACTION WITH PROGRAMMATIC ELEMENTS WITH FAMILY AND HIGH SCHOOL BACKGROUND AS INDEPENDENT VARIABLES
for First-Year and All Students, Separately
(R^2 in parentheses)

Satisfaction Factor (Dependent Variable) \ Year in School	First Year	Students at All Levels
SATCHOIC	.529 (.279)	.256 (.066)
SATCLASS	.417 (.174)	.202 (.040)

Independent Variables in Multiple Regression Analysis: Mother's education, father's education, Occupational prestige of father, whether had sibling who went to college, support for engineering index, math and science high school grades, math SAT score, verbal SAT score, participation in high school extra-curricular activities in math and science.

Academic Performance and Extra-Curricular Activity and Satisfaction with Programmatic Elements

In this section we look at whether the kinds of activities the students engage in at Rowan and their academic performance during the year are related to the extent of satisfaction with the programmatic elements of the engineering program. It is reasonable to expect that better students will tend to be more satisfied with the program, as would students who are more fully integrated into the extra-curricular engineering-related activities offered. Identifying which activities are linked to higher satisfaction may also give a handle on how to increase the satisfaction of students with the program.

To study this we used multiple regression analyses with each of the satisfaction factors as a dependent variable (SATCHOIC and SATCLASS), and the independent variables being the factors of participation in various types of engineering activities at Rowan (these factors are explained in detail in Chapter II-C above): participation in academic enrichment activities and contact with faculty (ACTACAD), participation in counseling and mentoring activities (ACTCOUNS), participation in study activities (ACTSTUDY), participation in student chapters of professional organizations (ORGMEM); and grade point average for the spring semester (SPRING GPA). The results are presented in Table IIE-6.[34]

First we see that students who participate more in academic enrichment activities are more satisfied with the opportunities of the program and how it is structured (SATCHOIC). Students who take advantage of more counseling opportunities are also more satisfied in this respect. Participation in study activities is not related to this kind of satisfaction—perhaps because the study groups are such a well entrenched facet of the program that all students use them, whether they are satisfied or not. The lack of relationship between grades and SATCHOIC should also be noted: it is not only the best students who are satisfied with the opportunities the program offers.

Not surprisingly, on the other hand, students who get better grades are more satisfied with the coursework load. These are the students who do not find the course work too demanding and are able to meet the pace and challenge of the courses. Participation in activities is not related to this type of satisfaction (although, as we will show below, women who participate in SWE are more likely to be satisfied with the coursework load than women who do not participate).

So, in this respect, promoting participation in enrichment and counseling activities might increase satisfaction with the program structure. However, they would be unlikely to affect satisfaction with course work load.

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[34] The results for first-year students are not presented separately from all students, because the regression results were very similar for both groups of students.

TABLE IIE-6
MULTIPLE REGRESSION ANALYSES WITH SATISFACTION FACTORS AS DEPENDENT VARIABLES AND ENGINEERING ACTIVITIES AND ACADEMIC ACHIEVEMENT AS INDEPENDENT VARIABLES
for First Year Students and Students at All Levels
Unstandardized regression Coefficients, B's (standardized regression coefficients, β's, in parentheses)

	SATCHOIC	SATCLASS
ACTACAD	**.247** **(.246)***	.095 (.101)
ACTCOUNS	**.182** **(.180)***	-.079 (-.083)
ACTSTUDY	-.085 (-.079)	.003 (.003)
ORGMEM	.194 (.094)	.133 (.069)
Spring GPA	.073 (.045)	**.279** **(.183)***
Multiple R	.368	.255
R^2	.135	.065

* $p<.05$.

SATISFACTION WITH PROGRAM APPLICATIONS

The next type of satisfaction recognized by the students was satisfaction with specific program applications: lab work, teamwork, and engineering clinic.

Level of Satisfaction with Program Applications

Most of the students agree or strongly agree with many of the positive statements about these program applications. For example, nearly 80% think lab work adds to their understanding of course material, 70% disagree that teamwork slows down the learning process, and over 80% agree that engineering clinic gives useful teamwork experience. The mean scores on each of the three factors expressing satisfaction with lab work, teamwork, and engineering clinic are presented in Table IIE-7, along with a few of the individual items contributing to each of the factors.

TABLE IIE-7

SATISFACTION WITH PROGRAM APPLICATIONS BY YEAR IN SCHOOL

(% "agree" and "strongly agree")

Satisfaction Item \ Year in School	First-Year	Sophomore	Junior	Senior	Total
Labwork adds…to my understanding of course material	80.7	78.4	76.3	84.2	79.6
Expectations for lab work are explained well	77.3	61.4	57.6	75.4	77.6
SATLAB (mean score)	.178	-.133	-.118	.111	.000
Teamwork slows down the learning process in the clinic setting	69.9	71.6	62.6	78.9	70.1
Too much group work is required in engineering classes	57.8	51.2	47.9	52.7	43.5
SATTEAM (mean score)	.006	-.027	-.103	.167	.000
Clinic projects provide useful hands-on experience	68.6	67.0	65.9	75.4	68.8
The clinic experience… gives good teamwork experience	84.3	78.1	78.5	87.7	81.7
SATCLINIC (mean score)	-.187	.089	-.082	.228	-.004

Satisfaction with these aspects of the program does not seem to vary linearly by time in the program. Satisfaction with lab work, for example, is highest in the freshman year, but as the lab work gets harder and more complex, satisfaction goes down. Satisfaction with both team work and engineering clinic is highest in the senior year, but satisfaction with team work is lowest in the junior year, and satisfaction with engineering clinic is lowest in the freshman year. So satisfaction with each of these aspects of the program varies by year in the program, but it is not just a matter of spending time in the program, as it was for the programmatic elements presented above; rather it seems to be related more to the nature of the particular application in question at that level of the program.

Satisfaction with Program Applications and Background Characteristics

With respect to family characteristics and satisfaction with lab work, teamwork, and engineering clinic, most of the differences in satisfaction between students of more supportive family backgrounds or families with stronger role models, are not statistically significant, (Table IIE-8).[35]

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[35] Since there was little difference between first-year students and more advanced students in the relationship between background characteristics and satisfaction with program applications, we do not present the separate analysis for first-year students.

TABLE IIE-8
SATISFACTION WITH PROGRAM APPLICATIONS BY FAMILY CHARACTERISTICS
(Mean scores on SATLAB, SATTEAM, SATCLINIC)

Family characteristic \ Satisfaction Factor		SATLAB	SATTEAM	SATCLINIC
Father's Education	College ed	-.079	-.020	-.083
	Less than college	-.000	.008	.049
Mother's Education	College ed	-.096	-.061	-.096
	Less than college	.031	-.068	.031
Sibling's Education	College ed	-.062	.012	-.083
	Not college ed	.024	-.030	.053
Father's occupation	Sciences/ engineering	.020	.043	-.150
	Other	-.045	-.019	.013
Support for Engineering Pursuit	Strong	-.017*	.100	.069
	Mild	-.020	-.088	-.195

High school background seems to have little relationship to satisfaction with labwork, teamwork or engineering clinic, and this is true for first year as well as more advanced students (Table IIE-9).

TABLE IIE-9

SATISFACTION WITH PROGRAM APPLICATIONS BY HIGH SCHOOL CHARACTERISTICS AND YEAR IN SCHOOL

(Mean scores on SATLAB, SATTEAM, SATCLINIC)

	Year in School:	**First Year**			**Students of all Levels**		
High School Background	**Satisfaction Factor:**	**SATLAB**	**SATTEAM**	**SATCLINIC**	**SATLAB**	**SATTEAM**	**SATCLINIC**
High school math and science grades	Mostly A's and B's	.189	.052	-.317	-.069	.001	.004
	Mostly B's or lower	.142	-.073	-.105	-.004	-.011	-.035
Extra-Curricular math and Science Activities	More	.222	.129	-.179	-.109	-.057	.014
	Less	.107	-.163	-.214	.013	.022	-.032

Using all of the background characteristics as independent variables in a multiple regression analysis with the satisfaction factors as dependent variables shows us the extent to which the background characteristics taken together are related to satisfaction with the program applications. As shown by the squares of the multiple correlations (resulting from these multiple regression analyses), we see that the background variables, taken all together, actually explain little about the satisfaction of the students with the program applications (Table IIE-10). Less than 5% of the satisfaction with teamwork or engineering clinic and only 9% of the variation in satisfaction with lab work is related to background characteristics, suggesting that students' satisfaction with these parts of the program is not confined to students of any particular family or high school background. Even among first year students (not presented here), only about 7% of the variation in satisfaction is explained by these background variables.

This suggests these features of the Rowan program do not cater to one type of student over another, but rather that satisfaction is distributed fairly evenly among students with all sorts of backgrounds and input characteristics.

TABLE IIE-10
MULTIPLE CORRELATIONS RESULTING FROM MULTIPLE REGRESSIONS ANALYSIS OF SATISFACTION WITH PROGRAM APPLICATIONS FACTORS WITH FAMILY AND HIGH SCHOOL BACKGROUND AS INDEPENDENT VARIABLES

Dependent Variable	Multiple R	R^2
SATLAB	.308	.095
SATTEAM	.225	.051
SATCLINIC	.144	.021

Academic Performance and Extra-Curricular Activity and Satisfaction with Program Applications

To explore how academic performance and participation in extra-curricular activities over the academic year were related to satisfaction with the program applications of lab work, teamwork, and engineering clinic, we performed multiple regression analyses with each of the satisfaction factors as dependent variables, and the activities and grade point average as independent variables. The results are presented in Table IIE-11. We see that participation in enrichment activities is related to higher satisfaction with teamwork, perhaps because students are more integrated with their peers and hence get along better in their teams – or students who are more satisfied with their teams are also more likely to join their peers in enrichment activities. Students who participate in counseling activities are also more likely to be satisfied with the teamwork – perhaps the counseling gives them pointers on how to make the most of their team members. Participation in study activities is not related to satisfaction (or dissatisfaction) with these parts of the program (perhaps because the study activities are so widespread among the students). Also, students do not need to be involved in the professional organizations to be satisfied with these program applications, nor are students with better grades more satisfied with these parts of the program.

TABLE IIE-11
MULTIPLE REGRESSION ANALYSES WITH SATISFACTION WITH PROGRAM APPLICATION FACTORS AS DEPENDENT VARIABLES AND ACADEMIC PERFORMANCE AND ENGINEERING ACTIVITIES AS INDEPENDENT VARIABLES
(Unstandardized regression Coefficients, B's; standardized regression coefficients, ß's, in parentheses)

Dependent Variable / Independent Variable	SATTEAM	SATCLIN	SATLAB
ACTACAD	**.129 (.069)****	.040 (.039)	-.022 (-.023)
ACTCOUNS	**.204 (.205)***	.091 (.090)	.104 (.106)
ACTSTUDY	.010 (.010)	.037 (.035)	.055 (.053)
ORGMEM	.020 (.010)	-.013 (-.006)	-.100 (-.050)
Spring GPA	-.050 (-.032)	-.123 (-.075)	-.059 (-.037)
Multiple R	.242	.118	.130
R^2	.059	.014	.017

*Significant at p<.05 ** Significant at p<.10

SATISFACTION WITH THE INTERPERSONAL CLIMATE

The final type of satisfaction discerned by the students was satisfaction with the interpersonal climate – faculty-student relationships and peer culture.

Level of Satisfaction with the Interpersonal Climate

Rowan students are very positive about the interpersonal climate, and their satisfaction with the climate tends to be higher the longer they have been in the program (the most satisfied in these respects are the seniors). Table IIE-12 presents some of the individual items making up each of the factors, as well as the factor scores, by year in school. (We present the percentage who "strongly agree" with the individual items, because if we included those who "agree" as well as "strongly agree", we would have nearly all the students.) High percentages of students feel the faculty are approachable, respect them, and support and encourage them.

With respect to the interpersonal climate among students, high percentages of students feel a sense of community among engineering students, see fellow students as friendly and as helping each other out for coursework, projects and ideas. Only about a quarter of the students think their peers are very competitive.

There is some tendency for satisfaction with the interpersonal climate to be lowest for first-year students and higher for more advanced students, although the relationship does not seem to be linear; that is, once beyond the first year, satisfaction does not necessarily increase with each year in the program and may be more dependent on the particular group of students involved.

TABLE IIE-12

SATISFACTION WITH INTERPERSONAL CLIMATE BY YEAR IN SCHOOL

(% "strongly agree")

Satisfaction Item / Year in School	First-Year	Sophomore	Junior	Senior	Total
Faculty are approachable	65.1	61.4	72.5	84.2	69.5
Faculty respect me	41.0	46.6	48.1	61.4	48.2
Faculty support and encourage me	28.9	39.8	43.8	57.9	41.2
SATFAC (mean score)	-.198	.058	.119	.087	.000
Engineering students at Rowan feel a sense of community	38.6	66.3	48.2	70.2	54.8
Engineering students at Rowan help each other out	38.6	43.2	44.3	57.9	45.0
Engineering students at Rowan are friendly	30.1	33.0	28.7	40.4	32.5
SATPEERS (mean score)	-.136	.109	-.089	.153	.000

Satisfaction with Interpersonal Climate and Background Factors

Satisfaction with peer relationships has little relationship with family background characteristics. The only significant relationship among first-year students seems to be an inverse relationship between support from significant others for the engineering pursuit and satisfaction with peer relationships; that is, first year students with less support from significant others seem to reach out more to their peers for the support they are lacking from significant others, probably integrating them more into the peer culture and therefore making them more satisfied with it.

With regard to satisfaction with faculty-student relations, students whose fathers are not in engineering are more satisfied—again, perhaps these students forge stronger links to faculty when the family does not provide role models, or the students are particularly grateful for faculty guidance and attention, which increases their satisfaction.

TABLE IIE-13

SATISFACTION WITH INTERPERSONAL CLIMATE BY FAMILY CHARACTERISTICS AND YEAR IN SCHOOL

(Mean scores on SATCHOICE and SATCLASS)

	Year in School:	**First Year**		**Students of all Levels**	
Family characteristic	**Satisfaction Factor:**	**SATPEERS**	**SATFAC**	**SATPEERS**	**SATFAC**
Father's Ed	College ed	.067	.312	.117**	-.049
	Less than college	-.299	.207	-.095	.038
Mother's Education	College ed	-.129	.399	.042	.036
	Less than college	-.091	.130	-.023	-.033
Sibling's Education	College ed	-.249	.175	-.045	-.065
	Not college ed	-.005	.332	.115	.019
Father's occupation	Sciences/engineering	-.370	-.071	-.017	-.457*
	Other	-.058	.313	.008	.098
Support for Engineering Pursuit	Strong	.037**	.281	.110	.002
	Mild	.318	.407	-.065	.064

**T-test of difference in mean scores on satisfaction factor significant at p<.10.

With regard to high school background, while it seems that students with stronger high school math and science backgrounds tend to be more satisfied both with the student-faculty relationships and with their peers (Table IIE-14), the differences in satisfaction between students with stronger and weaker high school background are not statistically significant.

TABLE IIE-14

SATISFACTION WITH INTERPERSONAL CLIMATE BY HIGH SCHOOL BACKGROUND AND YEAR IN SCHOOL
(Mean scores on SATPEERS and SATFAC)

	Year in School:	**First Year**		**Students of all Levels**	
High School Background	**Satisfaction Factor:**	**SATFAC**	**SATPEERS**	**SATFAC**	**SATPEERS**
High school math and science grades	Mostly A's and B's	.373	.044	.031	.056
	Mostly B's or lower	.180	-.217	-.034	-.019
Extra-Curricular Math and Science Activities	More	.440	.035	.086	.000
	Less	.115	-.275	-.054	.004

When we put together the family and high school background variables as independent variables in a multiple regression analysis where SATFAC and SATPEERS are the dependent variables, we see that students' satisfaction with student-faculty relations has little relationship to background characteristics for both first-year and more advanced students. Apparently the faculty make an effort to connect to students with both stronger and weaker backgrounds. We also see that background characteristics are related to the first-year students' satisfaction with peers more than they are for students at more advanced levels, among whom family and high school background have hardly any impact on how satisfied they are with either faculty or peers (the R^2 shows us that less than 5% of the variance in SATPEERS and SATFAC is explained by background characteristics among students at all levels).

TABLE IIE-15

MULTIPLE CORRELATIONS RESULTING FROM MULTIPLE REGRESSION ANALYSIS OF SATISFACTION WITH INTERPERSONAL CLIMATE WITH FAMILY AND HIGH SCHOOL BACKGROUND AS INDEPENDENT VARIABLES
for First-Year and All Students, Separately
(R^2 in parentheses)

Year in School / Satisfaction Factor (Dependent Variable)	First Year	Students at All Levels
SATFAC	.264 (.070)	.183 (.034)
SATPEERS	.437 (.191)	.219 (.048)

Independent Variables in Multiple Regression Analysis: Mother's education, father's education, Occupational prestige of father, whether had sibling who went to college, support for engineering index, math and science high school grades, math SAT score, verbal SAT score, participation in high school extra-curricular activities in math and science.

Satisfaction with Interpersonal Climate and Academic Performance and Participation in Extra-Curricular Activities over the Academic Year

In their first year at Rowan, students' satisfaction with their peers is related positively to their involvement in academic enrichment activities as well as their receiving guidance in some sort of counseling activity (Table IIE-16). Such involvement is not related to their satisfaction with student-faculty relationships, nor their satisfaction with either factor of the interpersonal climate at later stages. In fact, at later stages in their undergraduate career, student involvement in counseling activities is related to negative opinions about student-faculty relations, perhaps reflecting the student's difficulties in a particular class or with a particular faculty member.

TABLE IIE-16
MULTIPLE REGRESSION ANALYSES WITH SATISFACTION WITH INTERPERSONAL CLIMATE FACTORS AS DEPENDENT VARIABLES AND ACADEMIC PERFORMANCE AND ENGINEERING ACTIVITIES AS INDEPENDENT VARIABLES
For First Year Students and Students at All Levels
(Unstandardized regression Coefficients, B's; standardized regression coefficients, ß's, in parentheses)

	First Year Students		Students at All Levels	
Dependent Variable: Independent Variable:	**SATFAC**	**SATPEERS**	**SATFAC**	**SATPEERS**
ACTACAD	-.122 (-.085)	**.323** **(.256)***	-.046 (-.046)	.203 (.215)
ACTCOUNS	.253 (.141)	**.482** **(.311)***	**-.129** **(-.126)****	.175 (.184)
ACTSTUDY	-.027 (-.025)	.063 (.073)	.074 (.066)	.061 (.060)
ORGMEM	.145 (.064)	-.183 (-.098)	.057 (.027)	-.073 (-.038)
Spring GPA	.193 (.109)	-.000 (.000)	.088 (.051)	.133 (.088)
Multiple R	.208	.335	.153	.296
R^2	.043	.112	.023	.088

*Significant at p<.05 ** Significant at p<.10

ENGINEERING SELF-CONFIDENCE AND SATISFACTION WITH THE ROWAN PROGRAM

It was reasonable to expect that students who show more engineering self-confidence would be happier with the program in its various aspects – the structure of the program and what it offers, the coursework load, the specific program applications of lab work, teamwork, and engineering clinic, and interpersonal relations – and vice versa: students who are more satisfied with the program will be more confident that they are in the right place (as suggested also by Zeldin and Pajares, 2000).

Whatever the direction of influence, we find that students who have higher self-confidence that they belong in engineering and will stay in the major, are more satisfied with most of the features of the program (Table IIC-17). Students who are satisfied with the program's structure and offerings, with the lab work, team work, and fellow students are those more likely to feel they belong in engineering.

Satisfaction with engineering clinic is not related to engineering self-confidence, nor is satisfaction with student-faculty relationships. The latter findings reinforce the perception of inclusiveness of these parts of the program – the faculty reaching out to students less sure of themselves; the clinic setting intended to be inclusive.

No type of satisfaction is significantly related to confidence in their engineering abilities. Apparently the students separate out their own abilities from their evaluations of the program.

TABLE IIC-17

PEARSON CORRELATIONS BETWEEN SATISFACTION WITH THE ENGINEERING PROGRAM AND ENGINEERING SELF-CONFIDENCE

SELF-CONFIDENCE FACTOR:	CONF STAY ENGIN	CONF ENG ABILITIES
SATISFACTION FACTOR:		
SATCHOIC	**.210****	.046
SATCLASS	**.182****	-.041
SATLAB	**.112****	.070
SATTEAM	**.122***	.000
SATCLIN	.017	.056
SATFAC	-.018	-.022
SATPEERS	**.319***	.048

*p<.05 **p<.10

Changes in Engineering Self-Confidence and Satisfaction with the Rowan Program

We had expected a relationship between dissatisfaction with the various components of the Rowan program and decreased self-confidence that one should be an engineer – or greater satisfaction among those whose self-confidence increased over the course of the academic year. It could also be that the causal direction is that satisfaction with the program increases self-confidence in oneself as an engineer. In Table IIC-18 we show the mean scores on each of the satisfaction factors for students whose self-confidence that "engineering is the right major for me" had decreased from the fall to spring semester, stayed the same, or increased; and similarly, for self-confidence in the student's mechanical ability. We see that indeed for almost every satisfaction factor, the lowest satisfaction scores are found among students whose self-confidence that engineering is right for them decreased and whose self-confidence in their mechanical abilities decreased. (The numbers in bold in the table support this finding.)

On the other hand, students whose self-confidence increased are not necessarily more satisfied than students whose self-confidence remained stable. The numbers in italics show the few cases in which students whose self-confidence increased were the most satisfied. Therefore it seems that satisfaction is not necessarily a reflection of increased self-confidence; however, dissatisfaction is related to decreased self-confidence or perhaps, a generalized disenchantment with engineering, both for themselves and more generally.

TABLE IIC-18

SATISFACTION WITH ROWAN ENGINEERING PROGRAM BY CHANGE IN SELF-CONFIDENCE THAT "ENGINEERING RIGHT MAJOR FOR ME" AND IN MECHANICAL ABILITY FROM FALL TO SPRING

(Mean Factor Scores)

	Change in Self-Confidence that "Engineering Right Major for Me"			**Change in Self-Confidence in Mechanical Abilities**		
Satisfaction Factor:	Decreased	Same	Increased	Decreased	Same	Increased
SATCHOIC	**-.244**	-.018	*.204*	**-.143**	.028	*.041*
SATCLASS	**-.115**	.161	.080	.118	.071	.113
SATTEAM	**-.151**	.029	-.034	**-.084**	-.027	*.055*
SATCLINIC	.102	-.090	.038	**-.203**	.031	-.009
SATLAB	**-.367**	.048	.010	**-.292**	.035	.012
SATFAC	-.039	-.032	-.037	.082	-.010	-.280
SATPEERS	**-.216**	.025	*.145*	**-.119**	-.024	*.246*

GENDER DIFFERENCES IN SATISFACTION WITH ROWAN'S ENGINEERING PROGRAM

In this section we focus on the gender differences in satisfaction with the engineering program. Previous studies have suggested that women's disproportionate attrition from undergraduate engineering is caused in part by their dissatisfaction with many aspects of traditional programs. It was therefore important to assess the gender differences in satisfaction with the Rowan program, especially since so many features were expected to be female friendly.

Generally we find that female students are as or more satisfied with the program than are the male students. On almost all of the satisfaction factors, female students have significantly higher scores than male students. On no factor with a statistically significant gender difference are female students less satisfied. The mean scores on all 7 factors are presented in Table IIE-19 by gender.

TABLE IIE-19
SATISFACTION WITH VARIOUS ASPECTS OF ROWAN'S ENGINEERING PROGRAM BY GENDER
(Mean Factor Scores)

SATISFACTION FACTOR	GENDER	
	MALE	FEMALE
Programmatic Issues: SATCLASS**	-.051	.181
SATCHOICE*	.071	.253
Program Applications: SATLAB	.021	.086
SATTEAM*	-.066	.230
SATCLINIC**	.018	.188
Interpersonal Climate: SATPEERS*	.081	.277
SATFAC	.007	-.021
(n)	(246)	(67)

*T-test of gender difference in means significant at p<.05.
**T-test of gender difference in means significant at p<.10.

In the following we look more closely at gender differences in each of the different factors of satisfaction.

I. Programmatic Elements

On the first two programmatic elements, dealing with satisfaction with the coursework load and the amount of choice available in the program, female students are more satisfied than male students.

a. Satisfaction with classwork demands (SATCLASS)

Female students are more satisfied with classwork issues than are male students. The mean score for females was .181 compared to -.051 for males, the t-test showing a significance of p<.10. (Table IIE-16). As an example of the responses to individual items with high loading on this factor, we can consider student's satisfaction with the pace in required courses: while 29.3% of the male students disagreed that the pace in required courses is too fast, 44.8% of the women disagreed.

b. Satisfaction with choices available (SATCHOICE)

The female students are significantly more satisfied than are the males with the amount of choice available in the engineering program. Their mean score on this indicator is .253, compared to males' .071 (the t-test showed significance at p<.05). More specifically, we can look at two of the questions with high loading on this factor: 62.7% of the female students agreed they could get the classes they needed in the semester they wanted, compared to only 46% of the male students; 38.8% of the female students strongly agreed that ample internship opportunities were offered, while only 22.9% of the male students strongly agreed with this. [36]

II. Program Applications:

With regard to the applied aspects of the program, females are more satisfied on two of the three indicators; on the third, there is no significant gender difference.

[36] It should be noted that while we do not have data on the actual opportunities and choices offered to male and female students, there is no indication that differential opportunities are actually available. The only indication that we have is in terms of proportion actually having summer internships among upper division students, and we showed above that there is no significant gender difference in this (Chapter II-C). (It is, of course, possible that fewer females are looking for internships, or particular classes that are hard to get; but we have no evidence that this would be the case.)

a. Labwork (SATLAB)

There is no gender difference in satisfaction with laboratory work. The mean score for males is .024, and for females, .087 (not a statistically significant difference). While females are more likely to feel that lab work adds a lot to their understanding of course material, that expectations for labwork are explained well, and also that more lab experience would be worthwhile (Table IIE-20), not all of the differences are statistically significant; hence, gender differences on the overall lab factor are not.

TABLE IIE-20
SATISFACTION WITH LABWORK (INDIVIDUAL ITEMS) BY GENDER
(% " agree" and "strongly agree")

	Total	Male	Female
Lab work adds a lot to my understanding of course material	79.2	77.5	85.1
Expectations for lab work are explained well*	67.3	64.4	77.6
More lab experience would be worthwhile	48.2	47.0	52.3

* Chi-square significant at $p < .05$.

b. Teamwork (SATTEAM)

In their evaluations of teamwork and group work, female students were more satisfied than male students. Their mean score on this factor was .230, compared to males' mean score of -.066 (the t-test was significant at $p<.05$).

More specifically, responses to one of the questions with high loading on this factor show that less than a third of the female students thought too much group work was required in engineering classes, compared to over half of the male students (Table IIE-21). Female students are also more likely than male students to say that working in assigned teams helps them understand the material in class, and to disagree that teamwork slows down the learning process in the engineering clinics.

TABLE IIE-21
SATISFACTION WITH TEAMWORK (INDIVIDUAL ITEMS) BY GENDER
(% " disagree" and " strongly disagree")

	Total	Male	Female
I do not enjoy working in assigned groups in class	57.1	55.5	62.7
Teamwork slows down the learning process in clinic*	70.0	66.1	83.6
Too much group work is required in engineering classes**	52.3	48.5	65.6
% clinic made me more positive about working in teams	62.8	63.2	61.2

Chi-square significant at p< .05. ** Chi-square significant at p<.10.

As mentioned above, previous research has suggested that women in particular respond favorably to cooperative learning and group work in class (Felder et. al., 1995; Seymour and Hewitt, 1997; Treisman, 1992); while the differences are small, our findings reinforce this notion.

c. Satisfaction with the engineering clinic (SATCLINIC)

Female students are more positive in their appraisal of the clinic system than are the male students. Their mean score on this indicator is .188, compared to males' .018 (the t-test was significant at p<.05). Considering some of the specific indicators included in this assessment of the clinic system: over a third of the female students strongly agree that clinic projects provide useful hands-on experience in engineering, compared to 1/5 of the male students (Table IIE-22). Over a third of the females strongly agree that the clinic projects give good teamwork experience, compared to 27.2% of the males.

TABLE IIE-22

SATISFACTION WITH ENGINEERING CLINIC (INDIVIDUAL ITEMS) BY GENDER
(%“agree” and “strongly agree”)

	Total	**Males**	**Females**
Clinic provides realistic experiences	69.8	66.4	77.6
Clinic provides useful hands-on experience*	87.8	86.4	92.5
Interdisciplinary nature of clinic enables me to connect things from different disciplines	74.4	63.6	79.1
Too much work expected for credit given in clinic**	13.5	13.3	11.9
Clinic unifies students in same class but different major*	70.1	69.4	84.1
Interdisciplinary nature of clinic means a lot of time learning material/approaches irrelevant to my major**	36.9	34.5	39.3

* Chi-square significant at p<.05.

**Answers presented are % “disagree” and “strongly disagree”.

III. Interpersonal Climate

With regard to the engineering climate, females are more satisfied than males are with their peer relationships, but there is no significant difference in satisfaction with faculty-student relationships.

a. Satisfaction with peer relationships (SATPEERS)

Female students are more satisfied with their peer relationships than are males: their mean score on the SATPEERS factor is .277, compared to males’ .081 (the t-test is significant at p<.05).

To make this more concrete, we look at some of the questions with high loading on this factor: while 53% of the males are proud to be engineering students and 50% strongly agree that students feel a sense of community in the Engineering College, 73.1% and 71.6% of the female students do, respectively (Table IIE-23). While 40% of the males strongly agree that students help each other on coursework projects and ideas, 62.7% of the female students do. While about 30% of the males feel that fellow students are approachable and friendly, over 40% of the female students do.

TABLE IIE-23

SATISFACTION WITH PEER RELATIONSHIPS (INDIVIDUAL ITEMS) BY GENDER

(%"agree" and "strongly agree")

% "agree" and "strongly agree" that peers usually:	**Total**	**Males**	**Females**
Are approachable	32.6	29.6	**43.3**
Support and encourage each other	28.9	27.4	**34.3**
Are friendly	32.5	29.9	**41.8**
Listen to me when I am troubled	16.7	16.0	**19.4**
Help each other on coursework projects, ideas	45.0	40.0	**62.7**
Respect me*	23.4	21.2	**31.3**
Care about me as individual	21.1	20.3	**23.9**
Feel sense of community in Engineering College*	54.8	50.0	**71.6**
Are proud to be engineering students	57.7	53.3	**73.1**
(n)	(308)	(241)	(67)

*chi-square significant at p<.05.

The literature points out that satisfactory peer relationships may be the "single most potent source of influence on growth and development during the undergraduate years" (Astin & Astin, 1993:398), and the importance of a community of fellow engineering students has been seen as critical in reducing female attrition from science and engineering fields (Hathaway, et. al., 2000; Seymour, 1995; Strenta, et. al., 1994). Female satisfaction with their peer relationships is therefore an important finding.

From the survey questions we do not know whether most women are referring to peer relationships with women or men or a mixture. However, the focus group interviews indicated that there does not seem to be a consistent pattern: some women associate mainly with other women, while others associate with both genders, and a few associate mainly with male students.

b. Faculty-Student Relationships (SATFAC)

In terms of satisfaction with faculty-student relationships, there is no gender difference. With a mean score of -.021, female students are not significantly different in this respect from males, whose mean score is .007.

The individual questions show, for example, that faculty are equally perceived by females and males as likely to listen to them when they are troubled, show them respect, and give them helpful feedback (Table IIE-24). The faculty have undertaken to be very dedicated to undergraduate education and very accessible to students (as stated in faculty interviews with the principal investigator); it appears that they are perceived as such by male and female students alike.

TABLE IIE-24
SATISFACTION WITH FACULTY-STUDENT RELATIONS BY GENDER
(%'s)

% strongly agreeing that faculty usually:	**Total**	**Males**	**Females**
Are approachable	67.3	67.1	78.1
Are friendly	64.8	64.9	81.3
Support and encourage me	40.4	37.7	51.6
Show they respect me	47.0	46.1	56.3
Show they care about me as an individual	38.2	36.8	51.6
Listen to me when I am troubled	35.2	37.9	39.1
Care whether I learn the course material	54.4	51.8	65.6
Give helpful feedback on papers, projects, ideas	41.5	39.6	50.0
Are available outside of class	54.5	52.2	67.2
(n)	(284)	(220)	(64)

GENDER DIFFERENCES IN ENGINEERING SATISFACTION BY YEAR IN THE PROGRAM

There are a number of reasons to expect gender differences to vary according to year in the program. The WEPAN Climate Pilot study found, for instance, that gender differences regarding the fast pace and heavy workload in engineering classes were smallest for seniors (Brainard, et. al., 1998). On the other hand, Felder et. al. (1995) found that experiences with teamwork became more negative for women over several semesters, whereas their experiences were more positive in the first semester. We therefore were prompted to examine whether gender differences in satisfaction with these various elements of the Rowan program remain constant in the different years of the program. As we have seen above, women's satisfaction with the program seems to be more related to their experiences in the program, and therefore the variation in their satisfaction over year in the program may reflect how positive or negative these experiences are.[37]

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[37] We should again remember that because at this point we are not examining panel data but cross-sectional data, our analysis of change throughout the program is somewhat limited. We do not follow the change in satisfaction of the same student from one year to the next, but only a comparison of students at different levels at a particular point in time. We can only infer changes over the undergraduate career from the cross-sectional differences we find between cohorts at this one point in time. Since almost all of the engineering students started out in this program as first-year students, however, year in the program does reflect for the most part the number of years of exposure to the Rowan program. It does not, however, control for changes in the program that may have occurred at various stages of these years, nor does it take account of differences between cohorts which may affect gender differences indirectly; thus, this analysis is a very rough proxy for more precise measurement of changes over the course of the undergraduate career. The longitudinal study underway will address these concerns.

I. Programmatic Elements

a-b. Satisfaction with classwork demands (SATCLASS) and choices available (SATCHOICE)

In terms of the programmatic elements of both program demands and choices, the gender difference in satisfaction is greater for upper division students, particular for juniors (Figures IIE-1 and IIE-2). In fact, the gender differences on these factors are not statistically significant among lower division students (t-tests of gender differences among lower division students are not significant for either factor). For both males and females, satisfaction with these aspects of the program is higher at the end of the program than in the earlier years of the program. Among upper division students, females are significantly more favorable in their opinions about these aspects of the program than are males, and the graph shows us that this is especially true during the junior year. Junior males are not as satisfied as first-year males in terms of coursework, and are just as satisfied but not more with regard to the choice factor. In contrast, junior and senior females are much more satisfied with both programmatic aspects than are lower division females. As a result, the gender difference in satisfaction, with females being more satisfied than males, is greatest for the junior year.

FIGURE IIE-1

SATISFACTION WITH COURSEWORK BY GENDER AND YEAR IN SCHOOL

(Mean Score on SATCLASS Factor)

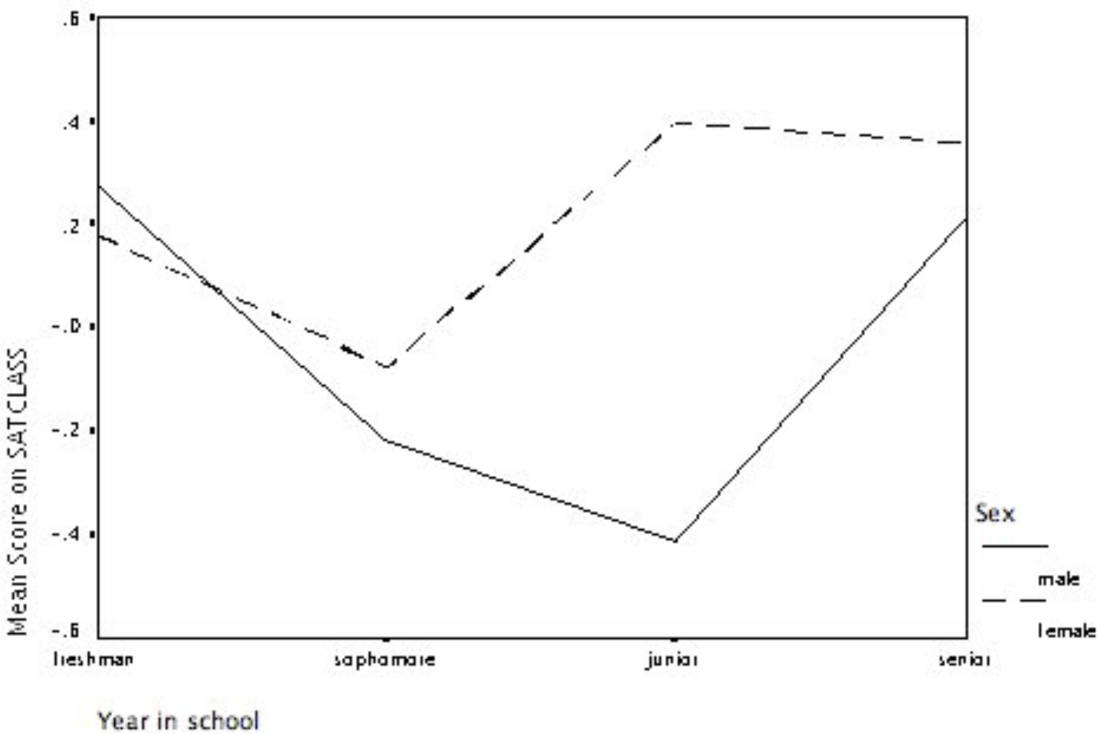
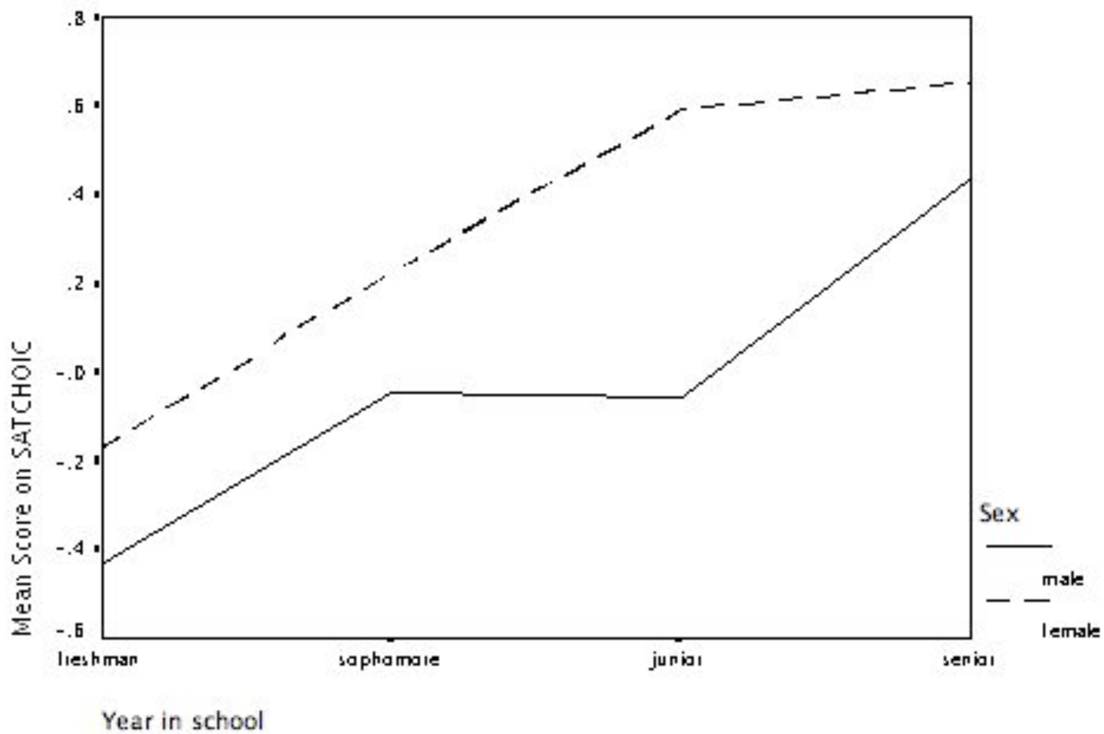


FIGURE IIE-2

SATISFACTION WITH OPPORTUNITIES BY GENDER AND YEAR IN SCHOOL

(Mean Score on SATCHOIC Factor)



II. Satisfaction with Applied Aspects of the Program (SATLAB, SATTEAM, AND SATCLINIC)

a. SATLAB

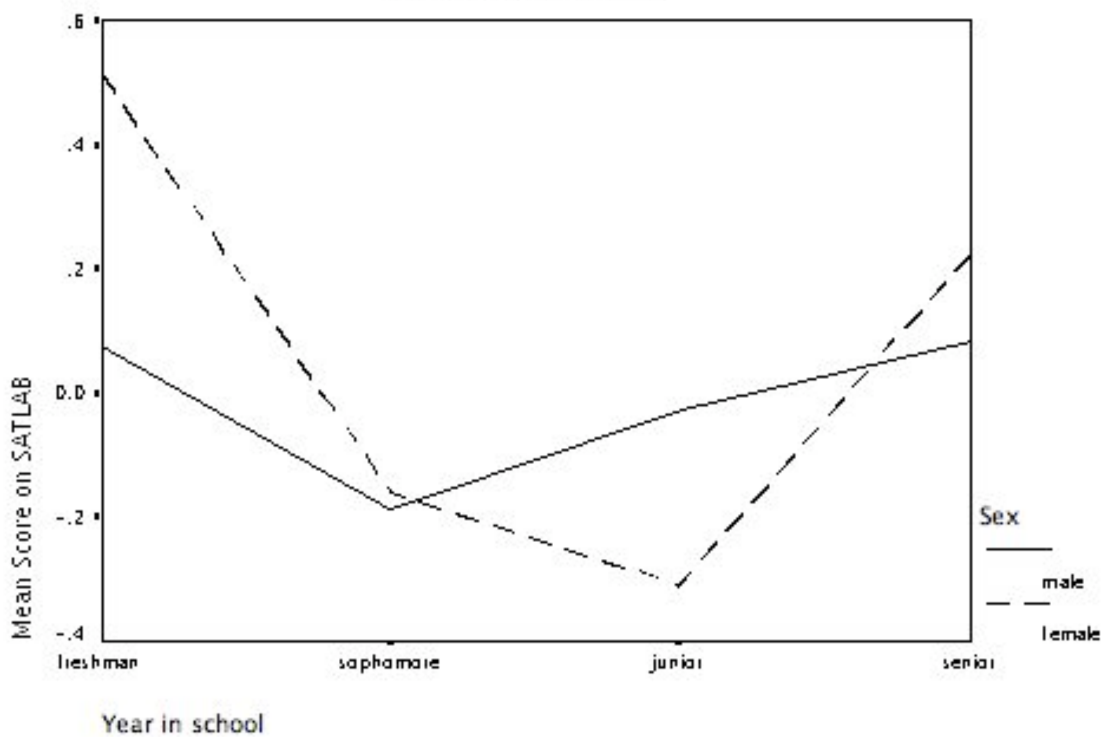
While overall there is no gender gap in satisfaction with lab work, we can see that the overall mean camouflages considerable differences among the students (Figure IIE-3). Female variation in level of satisfaction with lab work is much greater than among male students: there is a curvilinear relationship with year in the program for females, showing that first-year students and senior students are more satisfied with lab work, while sophomore and junior students are the least satisfied. Among males, there is less difference in satisfaction between the different years of the program.

Both male and female sophomores are less satisfied with lab work than are first-year students, and this change is especially great for female students, who are comparatively well satisfied with the lab work encountered in the first year. This lack of satisfaction in the sophomore year is intensified among females in the junior year, where the level of satisfaction in this respect is at its lowest. Junior males, on the other hand, seem to have “recovered” from the sophomore “shock”, and have a level of satisfaction similar to the first-year and senior year. Thus, in the sophomore year, gender differences disappear; but in the junior year, females are considerably less satisfied with lab work than are the male students; and in the senior year, there is again little gender difference.

FIGURE IIE-3

SATISFACTION WITH LABWORK BY GENDER AND YEAR IN SCHOOL

(Mean Score on SATLAB Factor)



This fluctuation in satisfaction with the lab work could be related to the type of lab work required in these various years, or differences in the way lab work is administered during the different years of the program; it might be related to the particular mix of majors or other characteristics in any of these cohorts. Additional research will be necessary to explain this finding.

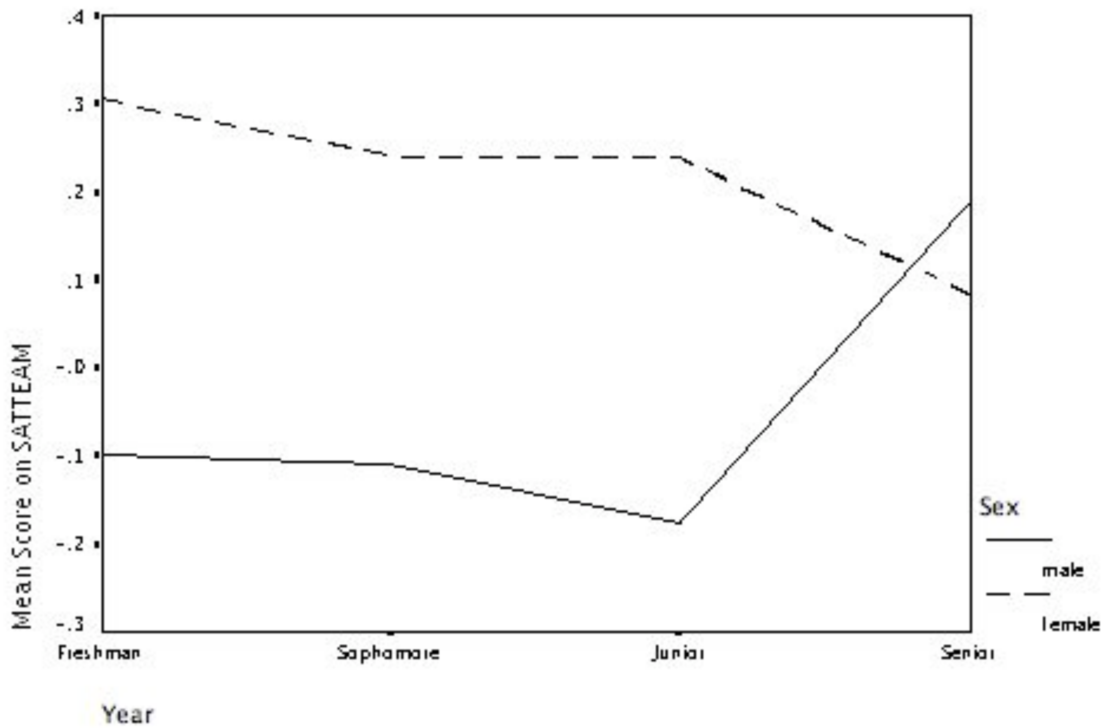
b. SATTEAM

Females are more satisfied than males with team work up until the senior year (Figure IIE-4). Female satisfaction with teamwork does decrease slightly with each year in the program, but until the senior year is at a significantly higher level than that of males; however, senior males seem to be much more favorable toward teamwork than males at other years, so there is virtually no gender difference during the senior year. The reason for this difference will be interesting to explore, as it may give a clue as to how to improve the teamwork experience for males at other levels of the program.

FIGURE IIE-4

SATISFACTION WITH TEAMWORK BY GENDER AND YEAR IN SCHOOL

(Mean Score on SATTEAM Factor)



It should be noted that these findings lend mild support to those of Felder et. al. (1995), who, in their longitudinal study of cooperative learning among engineering students, found that females became less enamored with group work as time went on. In our sample, the level of satisfaction with teamwork is lower for each successive year, but the differences are quite small.

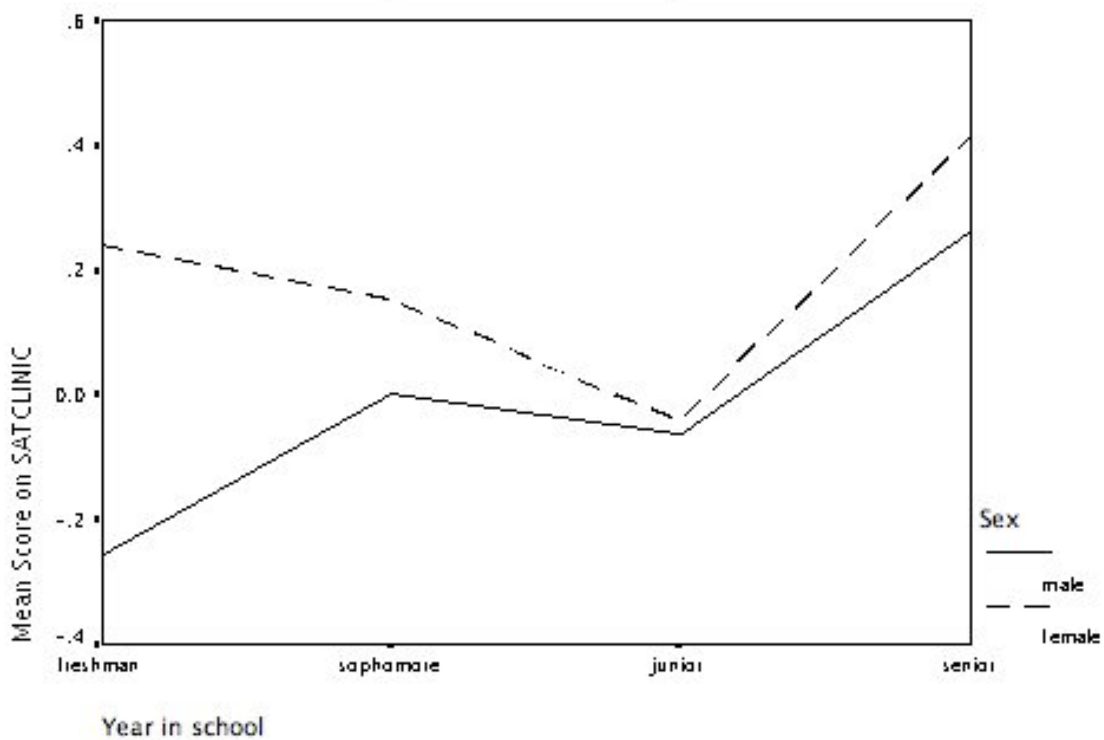
c. SATCLINIC

Gender differences in satisfaction with the clinic system are mainly among first-year students (Figure IIE-5). The greater satisfaction of females with the clinic system is considerably less among sophomores and practically nonexistent among juniors and seniors. Among females, satisfaction with clinic is lowest for juniors, and considerably higher among seniors. For both males and females, seniors express the most satisfaction with the clinic system.

FIGURE IIE-5

SATISFACTION WITH ENGINEERING CLINIC BY GENDER AND YEAR IN SCHOOL

(Mean Score on SATCLINIC Factor)



Summarizing our findings about the gender differences in satisfaction with applied aspects of the Rowan program over the different years of the program, we found that gender differences in satisfaction exist even after we control for year, and quite a bit of variation is found in those gender differences over the years. While the patterns of difference vary over the three factors, this much they have in common: for all three indicators, the gender differences are greater among lower division students, and least among senior students. However, the fluctuation of satisfaction is quite considerable for females when it comes to lab work, and for males when it comes to team and clinic work.

III. Interpersonal Climate

a. Satisfaction with Peer Relationships (SATPEERS)

The female students are more satisfied with peer relationships than the male students are at every level of the program except senior, when the gender differences are not statistically significant (Table IIE-25). Peer relationships are particularly satisfactory for females in the junior year; among the females, the lowest satisfaction with peer relationships is for seniors.

TABLE IIE-25
MEAN SATISFACTION WITH PEER RELATIONSHIPS (SATPEERS)
BY GENDER AND YEAR IN SCHOOL

GENDER YEAR IN SCHOOL	MALE	FEMALE
Freshman	-.264	.113
Sophomore	.020	.297
Junior	-.185	.734*
Senior	.203	-.002

*T-test significant at p<.05.

b. Satisfaction with Faculty-Student Interaction (SATFAC)

With regard to satisfaction with faculty-student interaction, there is relatively little gender difference over the course of the undergraduate years (Table IIE-26). First-year students seem to be somewhat more satisfied than other students, among both males and females, and in the sophomore year, females appear to perceive particularly less satisfactory faculty-student relations than in other years. Whether this is a one-time occurrence or a pattern that will repeat itself is something that further analysis will address.

TABLE IIE-26
MEAN SATISFACTION WITH FACULTY-STUDENT INTERACTION BY GENDER AND YEAR IN SCHOOL
(Mean Scores on SATFAC)

GENDER YEAR IN SCHOOL	MALE	FEMALE
Freshman	.232	.526
Sophomore*	-.076	-.574
Junior	-.118	.054
Senior	-.066	-.143

*T-test significant at p<.10.

THE EFFECT OF BACKGROUND CHARACTERISTICS ON THE SATISFACTION OF MALE AND FEMALE STUDENTS

Background characteristics have a stronger relationship with the satisfaction of female students in all of these respects than they have with the satisfaction of male students (Table IIE-27). For females, family and high school background characteristics explain 16-31% of the satisfaction with the various aspects of the engineering program compared to less than 12% of the variance being explained for males. The stronger relationship between females' background characteristics and the various aspects of satisfaction suggests that they may be more vulnerable to outside influences (this reinforces a point made above when we discussed changes in engineering self-confidence over the course of the academic year, which appears to be influenced negatively by outside influences, especially in the first and senior years).

TABLE IIE-27

MULTIPLE CORRELATION (R) AND R^2 RESULTING FROM MULTIPLE REGRESSION ANALYSIS OF INPUT CHARACTERISTICS ON FACTORS OF SATISFACTION WITH ENGINEERING

(Male and Female Students, Separately)

Unstandardized Regression Coefficients, B's (Standardized Regression Coefficients, β's, in parentheses)

Dependent Variable	Males	Females
Programmatic Elements: SATCHOIC	.352(.124)	**.479(.230)**
SATCLASS	.230(.053)	**.400(.160)**
Program Applications: SATTEAM	.278(.078)	**.467(.218)**
SATCLINIC	.251(.063)	**.465(.217)**
SATLAB	.316(.100)	**.567(.321)**
Interpersonal Climate: SATFAC	.237(.056)	**.536(.288)**
SATPEERS	.275(.076)	**.560(.314)**

[b]Independent variables: Mother's and father's education, father's occupational prestige, sibling went to college, support index; high school math/science grades, verbal SAT score, math SAT score, extra-curricular math and science activities in high school

ENGINEERING SELF-CONFIDENCE AND SATISFACTION WITH THE ENGINEERING PROGRAM BY GENDER

The literature suggests that strong contributors to women feeling a lack of fit in engineering is a perceived "chilly climate" for women: teaching methods which are not comfortable, colleagues and faculty who are not supportive, too much pressure with heavy course loads and lab work with which they do not feel comfortable. Our satisfaction indicators measure how well women feel in Rowan's engineering program, and suggest that most women do not perceive a "chilly climate" in any of these ways. However, women on the average had lower engineering self-confidence than the male students. Clearly satisfaction with the engineering program and engineering self-confidence do not show the same patterns of gender difference. The question was raised, therefore, as to whether the relationship between satisfaction with the program and engineering self-confidence was similar for males and females. As we showed above (Ch. II-D) students who felt they belonged in engineering and were confident they would stay in engineering, tend to be more satisfied with most aspects of the program. Presumably there may be a two-way influence, that students who were satisfied with the program would have stronger self-confidence that they would stay in engineering and that their engineering abilities were adequate for their studies.

Looking at the interrelationships between satisfaction and engineering self-confidence by gender, we find that for both males and females, confidence about staying in engineering (CONF STAY ENG) is indeed related to satisfaction with the programmatic elements of the program (SATCHOIC, SATCLASS), and with peer relationships (SATPEERS) (Table IIE-28). Males and females who are satisfied with these aspects of the program are more confident they will stay in engineering. However, among females there is no relationship between engineering self-confidence and how satisfied they are with the program applications (SATLAB, SATTEAM, SATCLIN). This suggests that the personal self-confidence of female students is triggered less by their reaction to these parts of the program than by other factors (for example, their participation in extra-curricular activities, as we show below).

Students' satisfaction with student-faculty relationships is not related to their personal self-confidence for males nor for females. This suggests that positive student-faculty relationships are not confined to those who are most confident in their future in the program but rather are spread among the entire engineering student body.

TABLE IIE-28

PEARSON CORRELATIONS BETWEEN SATISFACTION WITH THE ENGINEERING PROGRAM AND ENGINEERING SELF-CONFIDENCE

Males and Females Separately

SELF-CONFIDENCE FACTOR:	**CONF STAY ENGIN**		**CONF ENG ABILITIES**	
SATISFACTION FACTOR:	**Males**	**Females**	**Males**	**Females**
SATCHOIC	**.269***	**.271***	**-.017**	**-.141***
SATCLASS	**.169***	**.265***	-.048	.077
SATLAB	**.158***	.072	.076	.147
SATTEAM	**.290***	.040	.102	.069
SATCLIN	-.068	-.151	.185	.128
SATFAC	-.089	-.057	.077	.059
SATPEERS	**.357***	**.370***	.026	**.290***

*p<.05

Confidence in engineering abilities has little relationship with most of the satisfaction factors. Again, this suggests that the program appeals on a wide basis to students and not just to the stronger students. In fact, for females there is an inverse relationship between confidence in engineering abilities and satisfaction with the opportunities offered in the program.

Interestingly, women's satisfaction with peer relationships is significantly related positively both to confidence of staying in engineering and confidence in engineering abilities. Women who get along well with their peers, feel a sense of community and perceived positive peer relations, are more confident in themselves as engineers, both in terms of ability and that they will stay in the field (or the women who feel they belong in engineering are also more satisfied with their colleagues in the field). This reinforces previous research, which suggests the importance to females of a strong personal network and a sense of community in order to feel confidence that they belong in engineering.

The lack of relationships between satisfaction with student-faculty relationships and either of these self-confidence factors suggests the inclusiveness of the faculty orientation, not concentrated only on the stronger students in either gender.

THE RELATIONSHIP BETWEEN THE SATISFACTION OF MALES AND FEMALES AND THEIR ACADEMIC PERFORMANCE AND PARTICIPATION IN ENGINEERING ACTIVITIES

The satisfaction of neither males nor females is strongly related to their academic achievement (Table IIE-29). For men, grades are related to their satisfaction with the coursework (SATCLASS), and their satisfaction with peers (males who get better grades are more satisfied with their peer relationships). Females who make better grades are more satisfied with the opportunities the program offers (SATCHOIC). But the rest of the correlations are not statistically significant.

TABLE IIE-29

PEARSON CORRELATION COEFFICIENTS BETWEEN SPRING GRADE POINT AVERAGE AND SATISFACTION FACTORS BY GENDER

Satisfaction Factor	Males	Females
SATCHOIC	.024	.289*
SATCLASS	.199*	.173
SATLAB	-.032	-.149
SATTEAM	.026	.001
SATCLINIC	-.060	-.110
SATFAC	.012	.038
SATPEERS	.150*	-.131

*Pearson correlation significant at $p<.05$.

To study the effect of the academic year's experiences on the satisfaction of male and female students, we did a multiple regression analysis of each satisfaction factor, using the spring grades, the three factors indicating types of extra-curricular activities (academic enrichment, counseling, and study activities), and the index of participation in a professional organization chapter, for males and females separately. The multiple correlations resulting from the analyses is presented in Table IIE-30.

We find that women's satisfaction is affected more by their experience over the academic year than is males' satisfaction. Women seem to respond to the experience in the program more than males do. This reinforces our perception that women's self-confidence that they belong in engineering is enhanced by their experience at Rowan, countering the negative attitudes that may affect them from the outside society for choosing a non-traditional professional direction; here we see that their satisfaction is also enhanced by their experience during the academic year to a greater extent than is males', whose satisfaction may be more stable and dependent on longer term socialization supporting the career choice.

TABLE IIE-30
MULTIPLE CORRELATIONS OF ENGINEERING ACTIVITIES WITH SATISFACTION FACTORS[a] AND GENDER

Satisfaction Factor (Dependent Variable)	Males	Females
SATCHOIC	.371	**.451**
SATCLASS	.223	**377**
SATTEAM	.277	**.359**
SATCLIN	.147	**.231**
SATLAB	.147	**.318**
SATFAC	.150	**.236**
SATPEERS	.325	**.352**
(n)	(222)	(64)

[a]Based on multiple regression analyses for males and females separately, with each of the satisfaction factors being a dependent variable, and the independent variables being year in school, ACTACAD, ACTCOUNS, ACTSTUDY, ORGMEM and Spring GPA (see definition of indices in text).

WOMEN'S PARTICIPATION IN SWE AND SATISFACTION WITH THE ENGINEERING PROGRAM

It will be recalled that among the female students, as shown in Chapter II-C, there were some benefits to participating in Society for Women Engineers in addition to other discipline-specific organizations: female students involved in SWE as well as another professional organization were more active in enrichment activities, especially field trips and with faculty, and were more likely to engage in "help" activities. Below we can see how participation in SWE and the other organizations are related to the satisfaction of the female students. Female students who participate in the engineering organizations tend to be more satisfied with almost all aspects of the Rowan program and climate (Table IIE-31). Although not all of the differences are statistically significant, the consistent trend indicates that the women who participate in organizations are more likely to be satisfied with the program's offerings, coursework demands, faculty-student relationships, peer relationships, and the teamwork in classes. There are no differences in satisfaction with Rowan's engineering clinic.

SWE seems to add to the satisfaction with classwork demands, but not to satisfaction with the other aspects of the program. This may be related to the greater participation of SWE members in "help" activities that we saw above (in Chapter II-C).

TABLE IIE-31

ORGANIZATIONAL MEMBERSHIP BY SATISFACTION WITH ENGINEERING AT ROWAN

(Mean Factor Scores)

Organizational Membership Satisfaction Factor	NEITHER	ORG NOT SWE	ORG AND SWE	TOTAL
SATCHOICE*	-.20	**.49**	**.32**	.25
SATCLASS*	-.16	**.07**	**.72**	.23
SATFAC	-.47	**.22**	**-.09**	-.06
SATPEERS	.12	**.43**	**.46**	.36
SATTEAM	.07	**.30**	**.23**	.22
SATCLINIC	.14	.16	.15	.15
SATLAB	**.37**	-.03	-.03	.07

*anova statistically significant at $p<.05$.

SUMMARY AND CONCLUSIONS ABOUT SATISFACTION

In this chapter we showed that students' satisfaction with the engineering program is multifaceted, made up of opinions about the programmatic structure and offerings; the program applications of lab work, teamwork and engineering clinic; and the interpersonal climate. We showed how satisfaction with the programmatic structure and offerings seems to grow on the students the longer they have been in the program; other aspects of satisfaction stay fairly stable or decline from the first-year to the senior.

We analyzed the extent to which satisfaction with the various aspects of the program was evenly spread throughout the students in the program, which would fit the inclusiveness to which the program aspires, or whether certain types of students were more satisfied with the program than others. Considering family characteristics, we found few significant differences in satisfaction between students of different socio-economic backgrounds (as indicated by parents' education, father's occupation, and sibling's education), few differences in satisfaction between students with strong or weak role models for engineering in the family, and only a few differences in satisfaction between students with stronger or weaker support from significant others for their pursuit of engineering. The few differences we found suggest that students with who enter the program fewer engineering role models in the family or weaker support may actually be more satisfied in their first year with faculty-student relations and peer relations, their weaker support system outside the university perhaps pushing them to establish interpersonal support within the engineering program at Rowan. Students with stronger high school backgrounds in math and science are somewhat more satisfied in their first year with the course work load. However, their these background differences become less important influences on satisfaction as students progress through the program. The conclusion is that the program does not cater to any particular type of student more than others, and indeed manages to be inclusive of students from different backgrounds and preparation.

A second question that we asked was whether students who were doing better academically were the most satisfied with the program. Students who got better grades during the academic year of the survey were more satisfied with the coursework load; however, grades had little relationship to any of the other satisfaction factors. So the Rowan program does not just appeal to the stronger – or the weaker—students. This was important to ascertain, because the emphasis on teamwork and engineering clinic are innovations which appeal is not something that can be assumed a priori. It is important that better students are not dissatisfied with the program applications and structure, just as it is important that weaker students are satisfied.

Our analysis gave us a clue as to which, if any, activities during the academic year were related to satisfaction (or dissatisfaction). We found that students who are involved in academic enrichment activities and counseling or mentoring felt that the program had a lot to offer, their peers were supportive and that they were part of a community, and that teams worked well. On the other hand, satisfaction with lab work, with engineering clinic, or with coursework was not dependent on involvement in extra-curricular activities. Nor was satisfaction with faculty-student relations. Apparently the faculty reach out to students even if they are not involved in extra-curricular or organizational activities.

Students' satisfaction with many aspects of the program gives us a clue about how committed a student is to staying in the major and in the career. There was a significant relationship between a student's engineering self-confidence and their confidence with how the program is structured, how hard the coursework is, the program applications (especially lab work and teamwork), and their satisfaction with their peers. Students who have lost confidence over the course of the year are also more disenchanted with the program itself. So satisfaction can give us a clue as to what the student's frame of mind is about staying in engineering.

As to gender differences in satisfaction, according to our results, the program, its delivery and the interpersonal climate are indeed female friendly: female students are as satisfied or more satisfied than the male students with the programmatic elements of choice and opportunity, classwork load, with the delivery of lab work, teamwork, and the Engineering Clinic, and with peer and student-faculty relationships. However, this does not mean that the males are dissatisfied. Especially notable is the lack of gender difference in satisfaction with the lab work, whereas in other engineering programs, lab work has been a bone of contention for women in particular; and women's positive appraisal of the engineering clinic and the teamwork involved in the program indicates their comfort-level with this pedagogy. In these program applications, women's greater satisfaction than males occurs mainly at the beginning of the program; by the upper division years, there is virtually no gender difference in satisfaction with these features, which reinforces their widespread appeal.

Females' satisfaction is affected more than is males' by factors outside the Rowan system (as indicated by the family background characteristics and high school characteristics in the first year). Their satisfaction is also enhanced more than is males' by their participation in extra-curricular engineering activities over the course of the year. Participation in SWE enhances female students' satisfaction primarily with the coursework demands, apparently offering a help network for the women participating in it. Thus females seem to be especially sensitive to the efforts of the program to involve them. This ties in well with the empowerment female students receive over the course of the academic year (their engineering self-confidence more likely to increase than that of males'). For females, the institution can make a difference, and this program has a positive effect on its female members.

Perhaps the ultimate act of dissatisfaction is attrition. In the next chapter we will see which students stay with the program and which do not, and how their retention is related to their satisfaction, engineering self-confidence, and active involvement in the various kinds of activities offered in the program.

CHAPTER II-F

RETENTION OF ENGINEERING MAJORS

The most objective criterion of success in undergraduate engineering, both from the institutional and the individual student's perspective, is whether a student stays in the major and completes an engineering degree. In this chapter we discuss the retention of students in Rowan's engineering program and some of the factors related to retention or early exit in this context.

The literature has pointed out several reasons for leaving engineering: poor academic performance, lack of engineering self-confidence, lack of pre-college experience and knowledge in engineering, complaints of poor teaching, inappropriate reasons for choosing the major, inadequate advising, loss of interest, curriculum overload, lack of female peers and role models for women, feeling uncomfortable as women in the major, lack of participation in support activities, and perceiving a different major to offer better education or was more interesting (the only prominent "pull" factor) (Adelman, 1998; Goodman et al, 2002; Seymour & Hewitt, 1997) . Astin & Astin (1993) contribute the insight that interaction with engineering faculty may actually backfire and prove to be negative influences on persistence in the major. Adelman (1998) further refines the insight by showing that compared to students who stay in engineering, students who leave engineering display a higher degree of dissatisfaction with academic and work preparation aspects of their experience.

Our study lends insight into these issues because of the nature of the Rowan program and its apparent effect on women in the program. Unlike what has been found in more traditional programs, we have shown that the women coming into the Rowan program do not exhibit poorer pre-college preparation than do the men. We have also shown that once they are in the engineering program they exhibit as much or more satisfaction with the engineering program as men, and they perceive their contact with faculty and peers as positively or more so than do male students. They are as active or more in enrichment and help activities related to engineering. Further, gender gaps in engineering self-confidence are often wider than what was found at Rowan, and at Rowan are narrowed over the course of the academic year for most of the levels of the program. In this chapter we attempt to link up these special qualities of the Rowan experience with actual persistence in the program, to see whether we can explain the relatively high retention of women in the program (shown below), especially compared to the traditional gap in retention found elsewhere. We therefore explore the relationship between retention and family and high school background characteristics, involvement in engineering activities at Rowan, grades, engineering self-confidence and the change in self-confidence over the academic year, and satisfaction with the Rowan program, for both male and female students.

RETENTION IN THE PROGRAM

In this section we present the retention statistics for the Engineering Program compiled by the Institutional Research division at Rowan, for students who began their first semester at Rowan in engineering. In addition to the information about their college major, we have the year the student started engineering and their gender.

Retention in engineering is measured in several different ways. First-year retention means that students who began in an engineering major return to engineering for the Fall of their sophomore year, rather than switching out of engineering or dropping out altogether. Second-year retention means that students return to engineering for the fall of their sophomore and the fall of their junior year. Third-year retention means in addition that they return for the fall of their senior year. Fourth-year retention means that they did not graduate in four years but still persisted in the engineering major. Graduation in the major indicates that they completed the undergraduate degree in engineering from this program. If they drop the engineering major, most students do so after the first year; a smaller proportion drop after the second year; and very few drop out of engineering as upper division students. Note that the tables presented here track all students who enrolled in engineering as first year students and do not take into account switching between engineering majors, nor do they account for the (relatively few) transfer students into the program.

Averaging the data from 1996-2001, we see that 19.7% of the students dropped out after the first year, giving a first-year retention rate of 80.3%. Another 9.7% dropped out after the second year, giving a second-year retention rate of 70.6%. Third-year retention is 66.8%, and fourth-year retention, 64.7%. Over 80% of the College's first engineering cohort (beginning in 1996) graduated in engineering. By 2001 51.9% of the 1997 cohort had graduated, but 7.8% were still enrolled in engineering. Of 1998 cohort, 57% were still enrolled or had completed the undergraduate degree by 2001.

TABLE IIF-1

RETENTION AND GRADUATION RATES FOR COHORTS 1996-2001: TOTAL

Cohort beginning year:	Total started	Total graduated in engineering (2002)	Total dropped engineering	Dropped after 1st year	Dropped after 2nd year	Dropped after 3rd year	Dropped after 4th year
1996	97	78 (80.4%)	18(18.6%)	12(12.4%)	7(7.2%)	0	1(1.0%)
1997	77	40 (51.9%)	31 (40.3%)	20 (26.0%)	6(7.8%)	5(5.2%)	0
1998	107	50(46.7%)	46 (43.0%)	21(19.6%)	14(13.1%)	6(5.6%)	5(4.7%)
1999	115		36(31.3%)	21(18.3%)	11 (9.6%)	4(2.6%)	
2000	117		37((31.6%)	25(21.4%)	12(10.2%)		
2001	120		26(21.6%)	26(21.6%)			
Total	633		194 (30.6%)	126 (19.7%)	50 (9.7%)*	15 (3.8%)**	6 (2.1%)***

* out of total 1996-2000 (n=513) ** out of total 1996-1999 (n=396) *** out of total 1996-1998 (n=281)

The graduation rate in engineering is considerably higher than that of Rowan as a whole (Table IIF-2, taken from Rowan Resource Book, 2002). For instance, 63.2% of all Rowan undergraduates who entered in 1996 graduated by 2002, compared to 80% of the engineering students in that cohort; 36.7% of the 1998 larger Rowan cohort had graduated by 2002, compared to 47% of the engineering cohort of that year. This is all the more noteworthy given that the rates of graduation in engineering do not take into account those students who changed major, while the total Rowan figures do. This is in stark contrast to the findings of the Astins (1993), who, based on their follow-up study of college students in the 1980's, found that engineering had one of the lowest graduation rates of all majors.

TABLE IIF-2

RETENTION RATES AT ROWAN (ALL MAJORS) FOR 1996-2001 COHORTS[A]

Cohort beginning year:	Total started	Total graduated by 2002	Enrolled after 1st year	Enrolled after 2nd year	Enrolled after 3rd year	Enrolled after 4th year
1996	1135	717 (63.2%)	953 (84.0%)	853(75.2%)	804(70.8%)	349 (30.7%)
1997	1039	554 (53.3%)	841 (80.9%)	740 (71.2%)	703(67.7%)	349 (33.6%)
1998	1114	409 (36.7%)	939 (84.3%)	836 (75.0%)	809 (72.6%)	389 (34.9%)
1999	1121		936 (83.5%)	845 (75.4%0	802 (71.5%)	
2000	1049		916 (87.3%)	836 (79.7%)		
2001	1277		1065 (83.4%)			
Total	6735		5640 (83.7%)	4110 (75.3%)*	3118 (70.7%)**	1087 (33.1%)***

[a] Source: Rowan Resource Book 2002.

*Out of total 1996-2000 (n=5458)

**out of total 1996-1999 (n=4409)

***out of total 1996-1998 (n=3288)

Retention rates are somewhat difficult to compare to other settings because in many colleges students do not declare major in first year. Retention estimates range from 44-64% depending on the measures and college used. The most definitive study is that of Adelman (1998), who uses High School and Beyond data to calculate "engineering paths" and reaches a figure of 57% completing B.A. in engineering of those who started out on an engineering path in 1982 (giving them more than 10 years to have completed the degree). Besterfield-Sacre et. al. (1997) report that nationwide, less than one half of freshmen who start in engineering graduate in engineering. Similarly, Astin & Astin (1993: 3-6) report that only 44% of the college students who started out in engineering in 1985 were majoring in engineering in 1989. Moller-Wong/Eide follow a cohort from 1990-95 and find a completion rate of 32%; the High School & Beyond sophomore cohort 1982-7 they follow had a completion rate of 39%. Rowan's graduation rate of 80% for the 1996 engineering cohort is therefore very high; 50.8% after 5 years for the1997 cohort and 46.7% after 4 years for the 1998 cohort are also high.

Looking at gender differences in retention, the average first-year retention rate for female students (85% for the past 5 years) is actually higher than that of male students (80%). In fact with few exceptions, especially for the last 3 cohorts, for every retention rate given (1st year, 2nd year, 3rd year, etc.) women's retention is the same or better than men's. The 6-year graduation rate for the 1996 cohort is the same for men and women, while the 5-year graduation rate for the 1997 cohort and the 4-year graduation rate for the 1998 cohort is higher for women than for men (Tables IIF 3 and 4).

TABLE IIF-3

RETENTION AND GRADUATION RATES FOR COHORTS 1996-2001: MALES

Cohort beginning year:	Total started	Total graduated in engineering	Total dropped engineering	Dropped after 1st year	Dropped after 2nd year	Dropped after 3rd year	Dropped after 4th year
1996	82	66 (80.4%)	16(19.5%)	9 (11.0%)	7(8.5%)	0	0
1997	61	31(50.8%)	28(45.9%)	17 (27.9%)	5(8.2%)	5(8.2%)	1(1.6%)
1998	90	41(45.6%)	39(43.3%)	17(18.9%)	11(12.2%)	7 (7.9%)	0
1999	96		30((31.3%)	19(19.8%)	9 (9.4%)	2(2.1%)	
2000	93		27(29.0%)	20(21.5%)	7(7.5%)		
2001	107		26(24.3%)	26(24.3%)			
Total	529		166 (31.4%)	108(20.4%)	39(9.2%)*	14 (4.3%)	1 (0.4)*

*out of total 1996-2000 (n=422)** out of total 1996-1999 (n=329) ***out of total 1996-1998 (n=233)

TABLE IIF-4

RETENTION AND GRADUATION RATES FOR COHORTS 1996-2001: FEMALES

Cohort beginning year:	Total started	Total graduated in engineering	Total dropped engineering	Dropped after 1st year	Dropped after 2nd year	Dropped after 3rd year	Dropped after 4th year
1996	15	12 (80.0%)	3 (20.1%)	3(20.1%)	0	0	0
1997	16	10 (62.5%)	6 (37.5%)	3(18.8%)	1 (6.3%)	1(6.3%)	1(6.3%)
1998	17	9 (52.9%)	7 (41.2%)	3(17.6%)	3(17.6%)	0	1(5.9%)
1999	19		4 (21.0%)	2(10.5%)	2(10.5%)	0	
2000	24		6 (25.0%)	5(20.8%)	1 (4.2%)		
2001	13		0	0			
Total	104 (16.4%)	31(64.5%)	26 (25.0%)	16 (15.4%)	7 (7.7%)	1(1.5%)	2 (4.2%)

* out of total 1996-2000 (n=91) ** out of total 1996-1999 (n=67) *** out of total 1996-1998 (n=48)

Completing Rowan's first year of engineering can be seen as comparable to Adelman's [1998:18] indicator of "crossing the threshold" of minimum math and introductory engineering courses which establish a student on the engineering "path". According to Adelman, 81.7% of male students who start out in engineering at 4-year institutions or universities, cross this "threshold", and 77.3% of female students do. Note that the Rowan's average first-year retention rate for males is comparable to the national average, while Rowan's female first-year retention rate is considerably higher than the national average.

Adelman (1998) finds a persistent 20% gap in completion rates for males and females: males 61.6%; females 41.9%. Astin & Astin (1993: 3-4) also show that the under-representation of women in engineering widens during the undergraduate years. That the Rowan data show no gender gap or females higher in graduation rates, and for every retention measure the same or better than males, is a very big achievement.

RETENTION AMONG STUDENTS WHO COMPLETED FALL SURVEY

In this section we look specifically at the students who took our survey, comparing those who stayed in the program to those who left, so that we can relate their retention to characteristics measured in our study. A student was considered to have dropped out of the program ("Leavers") if they formally had changed their major or graduated with a major other than engineering[38], if they were academically dismissed

[38] If a student had multiple majors, and at least one of them was engineering, they were not considered to have dropped out of the program.

from the university, or if they had not attended the university for 2 semesters or more. Students who were officially designated as "stop outs" on the university records were not considered to have dropped out of the program, as they had indicated an official intention to return to the program after a brief break in attendance. All other students, still in the engineering program in the spring of 2002 or who graduated earlier as an engineering major, were considered "stayers".

Of the 352 students who took the survey in the Fall of 2000 and/or the Spring of 2001, 33 could be classified as dropouts by 2002. Note that the percentage dropping out from our survey is smaller than the actual percentage dropping out of the program, as presented above. This is because a high proportion of students who dropped out were already on their way out when the survey was taken and did not complete the survey: they may not have been enrolled in required classes (where the survey was distributed), they may have had higher absenteeism, they may have been less cooperative with requests from the engineering faculty to participate.

The breakdown of the students who took our survey during the academic year 2000-1 and later dropped out of the engineering program is presented in Table IIF-5. The majority who dropped were first-year students at the time of the survey. About 25% who dropped out were sophomores when they took the survey; 12% juniors; and only 3% (1 student) seniors. Since most students switch out during the first two years, this distribution is to be expected. However, it does not mean that they necessarily dropped out as first-year students or sophomores; only that when they took our survey they were first-year students or sophomores. Because of the small numbers, we have not broken the "leavers" down by when they left the program.

The “leavers” were fairly evenly distributed between the majors. The slightly lower proportion of leavers who are chemical engineering majors results from there being fewer chemical engineering students who took the survey that year. The slightly lower proportion of students who dropped whose major was “general” is actually somewhat misleading, since this major was available primarily for first-year students and less than 10% of the entire population of engineering students had this major. Of all students in our survey who had a “general” engineering major, 20% of them later dropped out, as opposed to 8-11% of each of the other majors. This is one of the reasons that the “general” major was later eliminated from the program; it functioned as a “catch-all” category for students who were undecided about their specialization and made it more difficult for these students to form connections with other students and faculty in their first year or two.

Of the students who took our survey and later dropped, 27% were female. Given that women are 20% of the students in engineering at Rowan, this might be construed as meaning that more women drop out than men. However, this is not the case, as we presented above. The slightly higher percentage of women among those took our survey and later dropped out is because there is a slightly higher representation of the women in the program in our survey than from the male students.

TABLE IIF-5

ENGINEERING "STAYERS" AND "LEAVERS" WHO TOOK SURVEY, BY GENDER, YEAR IN SCHOOL AND MAJOR AT TIME OF SURVEY

	STAYERS	LEAVERS
Gender		
Males	80.6	72.7
Females	19.4	27.3
Year in School at Time of Survey		
First-year	27.0	60.6
Sophomore	30.4	24.2
Junior	24.8	12.1
Senior	17.9	3.0
Major at Time of Survey		
Chemical Engineering	17.6	15.2
Civil/Environmental Engineering	20.1	24.2
Electrical/Computing Engineering	28.8	21.2
Mechanical Engineering	27.3	24.2
General	6.3	15.2
Total %	100.0*	100.0*
(n)	(319)	(33)

*Percentages rounded off to 100.0.

In terms of background characteristics, stayers and leavers did not differ significantly in terms of parents' characteristics (Table IIF-6). Nor did they differ significantly in terms of having a sibling in the fields of science, engineering or math, nor in terms of the extent of support from significant others they perceived for their pursuit of engineering.

TABLE IIF-6

BACKGROUND CHARACTERISTICS OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

Background Characteristics	STAYERS	LEAVERS
Father's Education (% no college)	34.4	28.2
Mother's Education (% no college)	36.9	28.1
Prestige Score of Father's Occupation	53.5	50.2
Prestige Score of Mother's Occupation	53.1	50.8
% Have Sibling in Science, Engineering, Math	60.2	60.0
Support Index	6.6	6.4

In terms of pre-college background, stayers and leavers did not differ in terms of how many extra-curricular science/math activities they were involved in during high school, nor in terms of how many math and science AP courses they had, nor in terms of their math SAT score (Table IIF-7). Leavers did have slightly lower high school science and math grades, and significantly higher verbal SAT scores. The latter suggests that they may have strengths in other fields that pulled them away from engineering.

TABLE IIF-7

PRE-COLLEGE ACADEMIC CHARACTERISTICS OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

Pre-College Academic Background Indicator:	STAYERS	LEAVERS
Extra-Curricular Science/Math Activities (Mean #)	1.4	1.5
AP Scale	1.8	1.7
% High School Science Grades Mostly A's	46.8	34.4
% High School Math Grades Mostly A's	56.9	43.8
Verbal SAT Score*	582	616
Math SAT Score	649	643

*T-test between stayers and leavers significant at $p<.05$.

Leavers were less involved in engineering activities over the course of the academic year, as might be expected (Table IIF-8). They were less involved in academic activities and contact with faculty members (ACTACAD), they participated in fewer counseling or mentoring activities (ACTCOUNS), and they participated in fewer study activities (ACTSTUDY). They were less likely to participate in discipline-specific engineering organization activities, or to be members of any of these organizations. Having roommates in engineering, science or math, however, did not differentiate between stayers and leavers. Surprisingly, they were also less involved in non-engineering related activities, such as sports or other groups on campus (ACTNONENG). Since the leavers were more likely to be first- or second-year students, some of these differences may stem from the tendency for juniors and seniors to be more involved in these activities.

TABLE IIF-8

ACTIVITIES AT ROWAN OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

(Mean Factor Scores and Percentages)

Indicators of Activities at Rowan	STAYERS	LEAVERS
ACTACAD (Mean factor score)	.009	-.135
ACTCOUNS (Mean factor score)	.018	-.258
ACTSTUDY (Mean factor score)	.018	-.255
% member of discipline-specific engineering organization*	55.2	18.2
% participated in discipline-specific engineering organization*	67.1	30.3
% having roommates in engineering, science or math	36.0	40.0
ACTNONENG (Mean factor score)	.021	-.225

* T-test significant at $p<.05$.

Again as might be expected, leavers express less confidence that they will stay in engineering both in the fall survey and the spring survey (CONF STAY ENG) (Table IIF-9). Since many of the questions making up this factor relate to how well the student feels they fit in the major as opposed to other majors, this is not surprising. And the self-confidence of leavers that engineering is the right major for them decreased much more from fall to spring than did the stayers.

It is interesting, however, that leavers do not have less confidence in their engineering abilities and competencies than do stayers (CONF ENG ABIL). Nor do they have less self-confidence in their overall academic ability (CONF ACAD ABIL) nor in their communication skills (CONF COMM SKILL). Their lower self-confidence seems to be centered in their fit in the engineering niche rather than a more generalized lack of self-confidence.

TABLE IIF-9

ENGINEERING SELF-CONFIDENCE OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

(Mean Factor Scores and Percentages)

Engineering Self-Confidence Indicator:	STAYERS	LEAVERS
(Fall) CONF STAY ENG*	.056	-.564
CONF ENG ABIL	-.021	.202
CONF ACAD ABIL	-.025	.226
CONF COMM SKILL	.022	-.091
(Spring) CONF STAY ENG*	.075	-.930
CONF ENG ABIL	-.006	.058
CONF ACAD ABIL	.006	-.086
CONF COMM SKILL	-.000	-.107
Change in Engineering Self-Confidence from Fall to Spring % Lowered Confidence that Engineering is Right Major	19.9	27.8
% Lowered Confidence in Mechanical Ability	23.1	16.7

*T-test significant at p<.05.

Leavers are less satisfied with the programmatic elements of Rowan engineering – the opportunities the program offers and the choices within the program (SATCHOICE) (Table IIF-10). However, they do not show more dissatisfaction with the course workload (SATCLASS) than stayers. Further, leavers are not less satisfied with the clinic program in general (SATCLIN), with the emphasis on team or group work (SATTEAM) nor with the laboratory work (SATLAB). Leavers are just about as satisfied as stayers with the faculty-student relationships (SATFAC) and with peer relationships (SATPEERS). It should be noted that most of the differences in satisfaction are relatively small and are not statistically significant. This is especially important as an evaluation of the special emphases of the program: students apparently are not leaving because of the clinic program, the emphasis on team or group work, the extensive laboratory work integrated into every semester; nor are they dissatisfied with the student-faculty relationships, which Rowan faculty work so hard to achieve, and they are well integrated into the peer climate.

TABLE IIF-10

SATISFACTION WITH ROWAN ENGINEERING OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

(Mean Factor Scores)

Satisfaction Factor:	STAYERS	LEAVERS
Satisfaction with Programmatic Elements		
SATCHOICE	.014	-.224
SATCLASS	-.017	.265
Satisfaction with Applied Parts of Program		
SATLAB	-.005	.086
SATTEAM	-.013	.192
SATCLINIC	-.012	.107
Satisfaction with Interpersonal Climate		
SATFAC	.007	-.044
SATPEERS	-.010	.143

One way in which leavers significantly differ from stayers is in their GPA. Leavers have lower GPAs in both fall and spring, and report lower engineering grades as well (Table IIF-11). It is important to recognize that this finding is mainly true for the male students leaving the program; female students do not show the same degree of difference, as we shall show below.

TABLE IIF-11

ACADEMIC ACHIEVEMENT OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

(Means)

Academic Achievement at Rowan:	STAYERS	LEAVERS
Fall GPA*	3.17	2.20
Spring GPA*	3.18	2.43
Engineering GPA	3.43	3.26
(n)	(319)	(33)

GENDER DIFFERENCES IN LEAVERS' CHARACTERISTICS

There are some interesting gender differences in the comparison of stayers and leavers (Table IIF-12). Males who leave engineering had much lower math and science grades in high school than males who stay in engineering. They also had lower math SAT scores than males who stayed in engineering. Among females, there is hardly any difference between stayers and leavers in terms of their high school grades. And, in fact, females who leave engineering actually had a higher math SAT score than the females who stayed in engineering. This suggests that male students who leave engineering are less prepared for the kind of work they encounter; among females, however, the motivation for leaving may lie elsewhere. Among both males and females, leavers have higher verbal SAT scores than stayers, suggesting that their strengths may lie in other fields than engineering.

TABLE IIF-12

PRE-COLLEGE ACADEMIC CHARACTERISTICS OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN BY GENDER

Gender	**Males**		**Females**	
Pre-College Academic Background Indicator:	**STAYERS**	**LEAVERS**	**STAYERS**	**LEAVERS**
% High School Science Grades Mostly A's	45.2	29.2	53.4	50.0
% High School Math Grades Mostly A's	53.5	27.5	70.7	62.5
Verbal SAT Score	582	615	583	618
Math SAT Score	654	640	629	656

Both male and female leavers were less involved in engineering activities over the course of the academic year (Table IIF-13). They were less involved in academic activities and contact with faculty members (ACTACAD), and they participated in fewer counseling or mentoring activities (ACTCOUNS). Female leavers were particularly uninvolved in academic enrichment or counseling activities. Both male and female leavers were less likely to participate in or be members of discipline-specific engineering organizations; however, male leavers had particularly low participation and membership in these organizations, while a third of female leavers had been members of organizations and 44% had participated in them at least occasionally. Male leavers participated in fewer study activities (ACTSTUDY); female leavers, however, participated in more study-related activities than stayers. While male leavers were less active in non-engineering activities, female leavers were slightly more active in non-engineering activities than female stayers. Having roommates in science, engineering or math did not differentiate between stayers and leavers for either gender.

TABLE IIF-13

PARTICIPATION IN ENGINEERING-RELATED ACTIVITIES OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN BY GENDER

(Means)

Gender	**Males**		**Females**	
Participation in Engineering-Related Activities:	STAYERS	LEAVERS	STAYERS	LEAVERS
ACTACAD	-.078	-.107	.333	-.182
ACTCOUNS	.026	-.209	-.011	-.341
ACTSTUDY	-.010	-.550	.121	.252
% member of discipline-specific engineering organization	52.1	12.5	67.7	33.3
% participated in discipline-specific engineering organization	64.2	25.0	79.0	44.4
% having roommates in engineering, science or math	36.7	40.9	33.3	37.5
ACTNONENG	.075	-.305	-.170	-.088

The picture that emerges is that female leavers are more involved in some of the engineering-related activities and in non-engineering activities than are male leavers. As we shall see below, female leavers do not have the same low grades as male leavers, either, and they seem to have been well integrated into the engineering culture judging from their satisfaction with peer and faculty relationships. The female leavers may be responding more to an attraction from outside of engineering rather than a push out from engineering, in contrast to the male leavers.

For both males and females, engineering self-confidence is much lower among leavers than stayers in terms of staying in engineering, and the gender difference among leavers is much greater than among stayers (Table IIF-14). The women who leave engineering are quite sure they do not belong in engineering and that another major is better for them. This lack of engineering self-confidence is not reflected in less confidence in their engineering abilities and competencies; in fact among both males and females the leavers are more confident in their engineering abilities and in their academic abilities than are the stayers. Similar patterns are found for the fall and the spring, and for both males and females, leavers lower their confidence that engineering is the right major for them more than do stayers (as would be expected). About twice the proportion of male than female leavers lower their confidence that engineering is the right major for them from fall to spring, suggesting that a higher proportion of the male leavers started out with unrealistic expectations and change a lot during the year. However, their leaving is not reflected in changed confidence regarding their mechanical abilities.

TABLE IIF-14

ENGINEERING SELF-CONFIDENCE OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN

(Mean Factor Scores and Percentages)

Gender	**Males**		**Females**	
Engineering Self-Confidence Indicator:	**STAYERS**	**LEAVERS**	**STAYERS**	**LEAVERS**
Fall				
CONF STAY ENG*	.088	-.333	-.078	-1.256
CONF ENG ABIL	.081	.207	-.443	.187
CONF ACAD ABIL	-.049	.155	.074	.440
CONF COMM SKILL	.005	-.136	.089	.045
Spring				
CONF STAY ENG*	.062	-.969	.118	-.858
CONF ENG ABIL	.138	.108	-.473	-.032
CONF ACAD ABIL	-.025	-.331	.103	.363
CONF COMM SKILL	.031	.032	-.101	-.361
Change in Engineering Self-Confidence from Fall to Spring				
% Lowered Confidence that Engineering is Right Major	21.4	33.3	10.9	16.7
% Lowered Confidence in Mechanical Ability	25.5	16.7	14.5	16.7

As we saw above, students who leave engineering show less satisfaction with the programmatic elements of engineering at Rowan in terms of the opportunities offered; looking at males and females separately shows us that this dissatisfaction is coming from the female leavers; male leavers do not differ from the male stayers in this respect (Table IIF-15).

What is even more important to note, however, is the lack of differences in satisfaction that we had expected. Previous research has suggested that women in particular leave engineering because they find the coursework too demanding, the labwork daunting, the pedagogy unsuited to their preferences, the interpersonal climate "chilly" (Ginorio; Seymour & Hewitt, 1997; Adelman, 1998; Rosser, 1991). The women who left engineering at Rowan, however, were as satisfied or more with the workload in classes, the leavers expressed even more satisfaction with teamwork and clinic than the stayers; satisfaction with labwork was not significantly different between leavers and stayers. The female leavers are as satisfied or more with faculty and peer relationships than the women who stayed in the major. Among the males there was greater dissatisfaction among leavers with regard to student-faculty relationships, but not with regard to peer relationships.

TABLE IIF-15

SATISFACTION WITH ROWAN ENGINEERING OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN BY GENDER

(Mean Factor Scores)

	Males		**Females**	
Satisfaction Factor	**STAYERS**	**LEAVERS**	**STAYERS**	**LEAVERS**
Satisfaction with Programmatic Elements SATCHOICE	-.073	-.045	.342	-.507*
SATCLASS	-.066	.267	.172	.261
Satisfaction with Applied Parts of Program SATLAB	-.032	.128	.095	.018
SATTEAM	-.073	.048	.205	.440
SATCLINIC	-.057	.042	.175	.280
Satisfaction with Interpersonal Climate SATFAC	.023	-.159	-.069	.456
SATPEERS	-.081	-.076	.249	.520

* T-test between stayers and leavers significant at p<.05.

Males who leave engineering have a much lower GPA on average both in the fall and the spring, and for engineering classes in particular, than do female leavers (Table IIF-16). In fact, female leavers appear to have even higher grades in engineering courses than do female stayers. While some of this lack of variation among females is because of less variation in grades overall among female students more generally, it also reflects something that has been found in other studies: even highly qualified female engineering students, who are doing relatively well in classes, may leave engineering; while for male students, leaving is much more closely linked to grades.

TABLE IIF-16

ACADEMIC ACHIEVEMENT OF STAYERS vs. LEAVERS OF ENGINEERING AT ROWAN BY GENDER

(Means)

	Males		Females	
Academic Achievement at Rowan:	STAYERS	LEAVERS	STAYERS	LEAVERS
Fall GPA	3.14	1.90*	3.24	3.11
Spring GPA	3.13	2.25*	3.37	2.97
Engineering GPA	3.42	2.98*	3.47	3.74

*T-test between stayers and leavers significant at p<.05.

SUMMARY AND CONCLUSIONS

The results presented in this chapter are as significant for what is not found as for what is found. Our findings that there are few significant gender differences in academic achievement once year and major are controlled, reinforce similar findings by Felder et. al. (1993) and Seymour & Hewitt (1997). That grades play a stronger role in males' leaving engineering reinforces previous findings by Seymour & Hewitt (1997) that women leave engineering even when they might succeed in it.[39]

Because of the unusual nature of the Rowan program it was important to determine whether leavers were dissatisfied with the clinic set-up or the emphasis on teamwork throughout the curriculum. But we saw that this is not the case. Leavers (male or female) were even more satisfied with both the clinic and teamwork than stayers. This apparently was not a motivation for leaving the program among males or females.

[39] Goodman et al (2002:88) also show that 65% of the female students who left engineering received As and Bs in their engineering courses the year prior to their leaving, and 45% received As and Bs in their engineering courses the year they left engineering. However, Goodman et al also found that on the average females who left engineering had significantly lower grades than females who stayed in engineering.

Previous research has suggested that women in particular leave engineering because they find the coursework too demanding -- apparently not in the case of Rowan. Other research suggests that interpersonal climate as a factor in students' leaving engineering, especially women. Again, this is apparently not the case for Rowan. Both leavers and stayers are satisfied with faculty-student relationships and peer relationships.

So the main difference between stayers and leavers appears to be their grades (for males) and dissatisfaction with the opportunities offered in the program. That leavers have stronger verbal SAT scores than stayers suggests that they may have strengths rewarded better in other majors and careers.

A follow-up study will probe in greater depth where students who leave engineering are going and why. At this point it is important to recognize that the special "female-friendly" nature of the program does not push qualified men away nor does a chilly interpersonal climate characteristic of more traditional programs push females away.

CHAPTER II-G

PERCEPTION OF PROBLEMS FOR WOMEN IN ENGINEERING

While much research addresses the issues of why more women do not enter engineering or persist in their undergraduate engineering studies, students' perceptions of the problems women face in this field offer another angle on reasons women might be deterred from engineering. We were interested in discerning views on such questions as whether career and family issues were considered problematic, the lack of female role models in science, math and engineering, the need to be competitive (when women often are not), the lack of encouragement for pursuit of a nontraditional career, and discriminatory practices. Since more women have entered engineering-related fields if not engineering itself in the past few decades, problems that once deterred women from engineering may well be less salient to current students, particularly women. We were interested in determining which issues continue to be perceived as problematic for women, and how experience at Rowan might affect these perceptions. In particular, as students become more familiar with what engineering is and have real-world contacts with engineering (e.g., through the clinic projects, through internships, through job interviews), do they perceive more or fewer issues as problematic for women? Is this perception similar for males and females? Are any of the experiences during their undergraduate years related to the perception of such problems?

For women, we were interested in whether the perception of problems for women in engineering was related to women's self-confidence in the field and to their satisfaction with the Rowan program or with engineering as a career. In other words, we expected women's perception of problems for women in engineering to be related, ultimately, to their intentions to stay in the field and their ultimate retention in engineering. Identifying those issues the students themselves perceive as most problematic also offers a handle on what issues need to be worked on, either in terms of disseminating appropriate information, bolstering confidence, or addressing societal norms which might be impacting women's role in engineering.

For men, their perception of problems for women in engineering might well reflect their attitudes toward women in the field and/or influence those attitudes and ultimately their behavior toward women in the field. Perceiving women as "other", with a different set of problems than men might face, might be one of the obstacles for women's acceptance by male engineering students and engineers.

In studying these attitudes toward the problems women face in science, math and engineering, we expected to find:

(1) that women would be more attuned to the problems of women in science, engineering, and math (SEM) and therefore would be more likely than male students to perceive all of the issues as more problematic for women;

(2) that for males,

  (a) some background factors would make them more aware of problems for women in SEM , especially those indicating exposure to female role models in SEM, either by making students more aware of the problems for women in the field, or by making them less likely to perceive the issues as problematic because they were exposed to women who had “solved” the problems, i.e., were successfully employed in these fields.

(b) some Rowan experiences to influence their perception of problems for women in SEM, namely: (i) the higher the proportion of females in their major the greater the awareness of problems); (ii) the longer they had been in the engineering program, the more exposure to problems women might encounter; on the other hand, students are also exposed more to the solution of problems women might encounter, so the relationship may be inverse.

(3) for females,

(a) In terms of background variables, we expected women’s perception of problems for women to be related to achievement in science, engineering and math: female students with weaker backgrounds might perceive more problems for women in SEM.

(b) Similarly, women who have less support for their pursuit of engineering from significant others might be more likely to perceive problems for women in the fields of SEM.

(c) In terms of Rowan experiences, we expected that greater involvement in engineering -- as indicated by the extent of extra-curricular activities at Rowan, membership in SWE, and internships – the more the women would see that the barriers facing women in SEM can be overcome, and therefore would be less likely to see them as serious problems.

(4) We also expected the perception of problems to be related to engineering outcomes for women:

(a) The higher the self-confidence, the less likely the women would be to perceive problems for women in the field.

(b) Women would be more likely to expect more from a future in engineering when their perception of the problems for women in the field is lower.

(c) Women would be more satisfied with their choice of major and career when they did not perceive greater problems for women in the field.

To measure students' perception of problems for women in engineering and related math and science fields, students were asked whether they considered certain aspects of science, math and engineering to be serious, minor or no problem for women pursuing careers in these fields. [40] The eleven items were then factor analyzed, deriving three factors.[41]

We will first present the results from the individual items and then the factor analysis for males and females. Then the factors will be used to relate these items to background variables for males and females separately, and activity at Rowan, self-confidence in engineering, and satisfaction with the program, , for females.

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[40] The questions were adapted from a set of questions used at the University of Michigan.
[41] Student responses about perceived problems for women were factor analyzed for males and females, separately, and the same factors resulted. Therefore we were able to use the same factors for analyses of both male and female responses.

PERCEIVED PROBLEMS OF WOMEN IN ENGINEERING

First it is interesting to note that the majority of the students – both male and female -- did not perceive any of these issues as problems for women in science, math or engineering (Table IIG-1). Over three-quarters of the students rated discriminatory attitudes toward women at Rowan as no problem for women, and nearly as many did not see as problematic women's ability to be as competitive as was needed in classes. The long years of formal preparation, viewing women in these fields as unfeminine, lacking encouragement from teachers, counselors, friends or family, lacking information about scientific careers – were all seen as no problem for women by over half of the students.

On the other hand, only 23% of the students thought the possible conflict between career and family responsibilities was not a problem for women pursuing science, engineering or math careers. In fact, the students saw career-family conflict as the most likely issue to be a serious problem for women (23.3% rated this issue as a "serious problem").

That relatively few students perceived these issues as serious problems for women in SEM was echoed in the focus groups, where most of the female students did not feel that women had a more difficult time than men in engineering. On the contrary, there was an almost defiant ambience of equality between males and females, and even some advantages seen for women as opposed to men (e.g., that women might find it easier to get a job than men because it was politically and socially "correct" to be hiring women). As one student put it, " Some companies are hiring women to look good. "And another said, "Everyone has to hire a certain percentage of women due to regulations so I know

I'll get hired somewhere." While they were aware that some people might perceive gender differences, the women themselves did not accept those stereotypes. For instance, one female student said, "I think in general you're looked at as not as physically or mentally as strong as men for the job you're doing. I don't take that. I think men and women are completely equal."

At the same time there were some interesting gender differences in this perception. Female students were more likely than male students to perceive as problematic for women: discriminatory attitudes toward women on the part of teachers or others in scientific fields both generally and at Rowan (80.3% of the men thought such discriminatory attitudes were no problem for women at Rowan, compared to 64.1% of the women). This difference echoes recent research showing that gender issues, such as discrimination against women in the workplace, are more salient issues for women and that women are more likely to frame experiences as gender issues than men are (Rusch, 2002). Women were also more likely to see as problematic for women the lack of information about careers in scientific fields and the lack of female role models in scientific fields– presumably because they had experienced this themselves. Almost half of the men, on the other hand, saw a lack of encouragement by teachers, counselors, friends or family as problematic for women, but only a third of the women did – again, presumably because they themselves had strong support for their pursuit of engineering, as we saw above.

TABLE IIG-1
PERCEPTION OF PROBLEMS FOR WOMEN IN THE PURSUIT OF CAREERS IN SCIENCE, ENGINEERING OR MATH BY GENDER

% RATING AS NO PROBLEM FOR WOMEN

% Perceiving as No Problem for Women	**Male**	**Female**	**Total**
Discriminatory attitudes toward women on part of teachers or others in scientific fields at Rowan*	80.3	64.1	76.8
Women cannot be as competitive as science classes require	72.6	77.6	73.6
Long years of formal preparation needed*	62.6	69.7	64.0
View that women in science or technical fields are unfeminine**	58.0	56.7	57.8
Lack of encouragement from teachers or counselors	53.5	64.2	55.7
Lack of encouragement from family or friends	55.2	65.7	57.3
Lack of information about careers in scientific field	58.0	40.3	54.4
Women's lack of confidence that they can handle the work	50.2	49.3	50.0
Discriminatory attitudes toward women on part of teachers or others in scientific fields generally*	50.0	32.8	46.5
Lack of female role models in scientific field	43.5	31.3	41.0
Possible conflicts between career and family responsibilities	24.4	17.9	23.1
(n)	(262)	(67)	(329)

*Chi-square significant at $p<.05$.

To put this in some perspective, the responses can be compared to those of students in engineering and business at Texas A&M surveyed in 1995 (Rinehart and Watson, 1998:95). These students responded to the question "Which of the following do you perceive to be barriers to women pursuing a career in your major field?" Responses to categories comparable to those asked in our survey are reproduced in Table IIG-2.

Remember that Rowan students were asked specifically about women pursuing careers in science, engineering or math, while the Texas A&M students were asked about women pursuing a career in your major field (engineering or business, as two non-traditional fields for women).

TABLE IIG-2

STUDENTS' PERCEPTIONS OF PROBLEMS FOR WOMEN PURSUING CAREER AT TEXAS A&M AND ROWAN
(% perceiving as a problem)

<table>
<tr><th>PROBLEM
(Rowan's wording, when significantly different, in parenthesis)</th><th colspan="2">TEXAS A&M ENGINEERING AND BUSINESS (1995)</th><th colspan="2">ROWAN ENGINEERING (2000)</th></tr>
<tr><td></td><td>Males</td><td>Females</td><td>Males</td><td>Females</td></tr>
<tr><td>Discriminatory attitudes on the part of professors in the field (Discriminatory attitudes on the part of teachers or others in scientific fields generally)</td><td>29.4</td><td>47.5</td><td rowspan="2">56.5</td><td rowspan="2">67.2</td></tr>
<tr><td>Discriminatory attitudes on the part of professionals in the field</td><td>31.5</td><td>54.0</td></tr>
<tr><td>Demands of field that would pose conflict between career and family (Possible conflicts between career and family responsibilities)</td><td>29.8</td><td>48.2</td><td>75.6</td><td>82.1</td></tr>
<tr><td>View that women in the field are unfeminine</td><td>27.6</td><td>27.3</td><td>42.0</td><td>43.3</td></tr>
<tr><td>Lack of encouragement from friends or family</td><td>22.5</td><td>11.5</td><td>44.8</td><td>34.3</td></tr>
<tr><td>Lack of confidence about being able to complete the work</td><td>26.8</td><td>45.3</td><td>49.8</td><td>50.7</td></tr>
<tr><td>Lack of contact with women professors in the field (Lack of female role models)</td><td>29.4</td><td>47.5</td><td>56.5</td><td>68.7</td></tr>
<tr><td>Competitive atmosphere of field (Women cannot be as competitive as science classes require)</td><td>24.4</td><td>34.5</td><td>27.4</td><td>22.4</td></tr>
</table>

This comparison raises several interesting points. First, the men at Rowan seem to be much more aware of possible problems for women pursuing the careers of science, engineering and math than the male students in engineering and business at Texas A&M. As a result, the gender gap in perception of problems is smaller at Rowan.

Second, for all questions except the last, the Rowan perception of problems for women is higher than that of the students at Texas A&M. Whether this is because business students were included at Texas A&M or because of a heightened awareness of possible problems for women at Rowan, is something that merits further study.

Finally, like the Rowan students, at Texas A&M fewer women than men perceive problems of encouragement from friends or family to pursue non-traditional careers. Presumably these women receive support, and therefore are in the fields; men may be responding to the more stereotypical image of support for women in the non-traditional fields.

To understand better the underlying dimensions of these perceptions, the eleven items were factor analyzed (using a varimax rotation model). Three factors emerged, reflecting three different types of problems that women are perceived to encounter.

The first factor (SOCPROB) deals with society's attitudes to women in science, engineering and math: discriminatory attitudes toward women on the part of teachers or others in scientific fields generally and at Rowan in particular, lacking encouragement from teachers, counselors, family or friends (λ= .36).

The second factor (FEMPROB) dealt with the view that science, engineering or math require unfeminine characteristics: the view that women majoring in these fields are unfeminine, that women lack information about careers in the scientific field and lack female role models in scientific fields, the view that women cannot be as competitive as science classes require, and that women lack confidence that they can handle the work (λ=.13).

The final factor (FAMPROB) dealt with the conflict between career and family: the long years of formal preparation needed, and possible conflicts between career and family responsibilities (λ=-.11).

As standardized factor scores, the mean score was 0; the lower the score, the less problematic the issues were perceived to be. The scores ranged from approximately –2 to +3.

It should be noted that when the factor analysis was performed for male and female students separately, the same three factors emerged, showing that the structure of the perceived problems for women was similar for males and females. However, the importance of the factors differed. Males saw as more problematic society's attitudes toward women in these fields, while women saw as more important the conflict between science and feminine characteristics. For both, the conflict between career and family was less central to the perception of problems.

The results of the factor analysis show that overall the gender differences in perception of problems for women are not statistically significant (Table IIG-3). The gender differences in terms of how problematic are societal attitudes toward women in engineering – taking into account all of the individual items related to these attitudes -- or toward the conflict of feminine qualities and careers in science, engineering or math, are not statistically significant. Women are somewhat more likely to take seriously the conflict between career and family responsibilities as problematic for women (t-test significant at $p<.10$), a finding which echoes that found in a study of engineering students at Michigan State University in the late 1980's (Jackson, et. al., 1993).

TABLE IIG-3

PERCEPTION OF PROBLEMS FOR WOMEN IN THE PURSUIT OF CAREERS IN SCIENCE, ENGINEERING OR MATH: MEAN FACTOR SCORES BY GENDER

	Male	Female
SOCPROB	-.001	-.044
FEMPROB	-.009	-.029
FAMPROB*	-.214	.001
(n)	(231)	(61)

*T-test between the genders significant at p<.10.

MALE STUDENTS' PERCEPTION OF PROBLEMS FOR WOMEN IN SEM

In this section we focus on how males perceive the problems for women in science, engineering and math, and what factors affect their perception.

Males' Exposure to Females in the Labor Force and in SEM and their Perception of Problems for Women in SEM

We expected that more familiarity with female role models in science, engineering or math might be related to males' perception of problems for women in these fields. We did not have enough cases of mothers employed in these fields to analyze; however, we could analyze those who had mothers with a history of employment as opposed to students whose mothers were not working in the labor force.

We also could analyze the perception of problems for those who had sisters in the fields of science, engineering or math, as opposed to those who did not (Table IIG-4).[42]

Students were asked about the history of their mother's employment as the student was growing up (before they were born, when they were a preschooler, when they were in elementary school, when they were in high school). Students were divided into those whose mothers had never been employed or had worked in the labor force only before the student went to school (approximately 20% of the students) or had worked in the labor force while the student was in elementary and/or high school. The expectation was that if a mother was in the labor force while the student was old enough to understand it, the student would be more aware of problems women faced in careers. Indeed, as Table IIG-4 shows, male students whose mothers had a history of employment were more likely to perceive as problematic societal attitudes toward women in science, engineering or math and the conflict between feminine qualities and women in science, engineering or math. Perhaps they had been exposed to problems that their mothers had faced in the labor force.

TABLE IIG-4

PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING OR MATH (SEM) BY EXPOSURE TO MOTHER IN LABOR FORCE AND SISTER IN SEM
(Males, Mean Factor Scores)

		SOCPROB	FEMPROB	FAMPROB	(n)
Mother Employed While Student in School	**No**	-.212	-.219	-.162	(53)
	Yes	.061	.053	-.230	(178)
Sister in Science, Engineering or Math	**No**	-.009	-.028	-.236	(130)
	Yes	.142	.166	-.027	(26)

[42] We had also intended to analyze the difference between students who had had female instructors in high school math or science courses, but since only 11 males did not, there were not enough cases to analyze its influence.

Male students who had sisters in science, engineering or math were also more likely to perceive as problematic all three areas: societal attitudes toward women in science, engineering and math; the conflict between feminine qualities and science, engineering or math; and the conflict between family and career responsibilities (Table IIG-4).

Males' Experiences at Rowan and their Perception of Problems for Women in SEM

To explore whether exposure to female role models in engineering at Rowan are related to the perception of problems for women in SEM, we looked at the number of female instructors the student had over the course of the academic year. While this is a very rough approximation of exposure to female role models, since students may have had exposure to female instructors in previous semesters, we felt it would give a handle on how much students might be exposed to women's issues in SEM. We can see that the more female instructors a male student has, they are slightly more likely to perceive problems for women in terms of societal attitudes or feminine qualities conflicting with their career (Table IIG-5). However, they were less likely to see the conflict between family and career as a problem for women, presumably because they were exposed to women who were managing such conflicts acceptably.

TABLE IIG-5

PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING OR MATH (SEM) BY NUMBER OF FEMALE INSTRUCTORS AT ROWAN

(Males, Mean Factor Scores)

# Female Instructors at Rowan	SOCPROB	FEMPROB	FAMPROB	(n)
0	-.094	-.076	-.171	(47)
1	-.007	-.029	-.164	(109)
2+	-.003	-.004	-.361	(42)

Exposure to female fellow students is not related to the perception of problems for women in SEM. Since most students take classes with students in their cohort and major, each cohort and major was given a value for the proportion of females in that year's major. The resulting variable was correlated with each of the perception of problems factors; all correlations were under .1, and not statistically significant (for both males and females).

The perception of problems does vary by year in school (Table IIG-6). Males' perception of problems for women is particularly high in the junior year with regard to societal attitudes towards women in science, engineering and math and the conflict between feminine qualities and careers in these fields. The perception of problems for women concerning family-career conflicts is relatively low and varies little over the four years in the engineering program.

TABLE IIG-6

PERCEPTION OF PROBLEMS FOR WOMEN IN ENGINEERING BY YEAR IN SCHOOL

(Males, Mean Factor Scores)

Year in School	SOCPROB	FEMPROB	FAMPROB	(n)
First Year	-.043	-.041	-.132	(81)
Sophomore	-.178	-.087	-.203	(51)
Junior	.182	.135	-.317	(63)
Senior	.023	-.081	-.236	(36)

As we will show below, this pattern of the perception of problems for women varies differently for male and female students, resulting in a differential gender gap at various points in the program. Presumably this could result in some degree of tension between the genders about women's place in these professions, which might be worth exploring more in the future.

The question again arises whether the variation between the cohorts result from differences between the cohorts or changes over the course of the undergraduate career. As the questions about the perception of problems for women in SEM were repeated for the Fall and Spring surveys, change in response could be measured for the students who took both surveys. Between 30-60% of the students changed their responses to the questions from fall to spring (Table IIG-7). Of the students who changed their responses, more saw the issues as less problematic in the Spring than they did in the Fall, with few exceptions, i.e., a higher proportion decreased their perception of the problems than increased their perception of the problems from Fall to Spring. This suggests that as the male students become more familiar with the women in the program, they are less likely to perceive them as having problems unique to women, or are less likely to think of them as "other" than themselves, the male majority in the program. The main exception to this pattern is a larger proportion of male students who increased their perception of discriminatory attitudes toward women in scientific fields from Fall to Spring.

TABLE IIG-7

CHANGE IN PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING AND MATH FROM FALL TO SPRING
(Males)

Issue:	% Decreased Perception of Problems	% Increased Perception of Problems
Discriminatory attitudes toward women on part of teachers or others in scientific fields generally*	27.4	33.5
Discriminatory attitudes toward women on part of teachers or others in scientific fields at Rowan	14.6	13.5
Women cannot be as competitive as science classes require	18.0	16.6
Long years of formal preparation needed*	24.5	12.5
View that women in science or technical fields are unfeminine*	21.1	23.4
Lack of encouragement from teachers or counselors[a]	32.4	8.7
Lack of encouragement from family or friends[a]	29.0	11.6
Lack of information about careers in scientific field	28.8	12.5
Women's lack of confidence that they can handle the work	30.4	14.0
Lack of female role models in scientific field	36.7	16.9
Possible conflicts between career and family responsibilities	33.2	15.4
(n)		

[a]The wording of these questions was changed slightly from Fall to Spring, which may account for some of the difference in response.

In summary, exposure to women in the field and to the Rowan program seems to sensitize the male students to some of the problems women face in science, engineering or math, such as discrimination; however, it also seems to decrease their perception of the women as different from themselves, hence they are less likely to perceive the women as facing stereotypical kinds of problems when they have more exposure to women in the field and in the Rowan program itself.

FEMALE STUDENTS' PERCEPTIONS OF PROBLEMS FOR WOMEN IN SEM

Next we turn to female students' perceptions of problems for women in science, engineering and math, and the factors influencing their perceptions.

Background Factors and Female Perceptions of Problems for Women in SEM

Exposure to Female Role Models

First it should be noted that very few (only 5) of the female students had mothers who had not been employed while they were in elementary or high school. This is itself is an interesting finding, as nearly a third of the male students had mothers who were not employed while they were in school. However, with so few whose mothers had not been employed, it is difficult to reach any conclusions about the differences between them and students whose mothers were employed.

Of the female students who had sisters, about a fourth of them were in the fields of science, engineering or math. Here there were very clear differences between those with sisters in SEM and those who did not have sisters in SEM: those with sisters in SEM were much more likely to perceive as problematic all three areas: societal attitudes toward women in science, engineering or math; the conflict between feminine qualities and SEM; and the conflict between family and career responsibilities (Table IIG-8). The sister's role model apparently sensitized the female students to possible problems for women in these fields. Nevertheless, these students had chosen to major in engineering, presumably with an understanding that they may encounter some problems in the field because of their gender.

TABLE IIG-8

PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING OR MATH (SEM) BY HAVING SISTER IN SEM
(Females, Mean Factor Scores)

Sister in SEM	SOCPROB	FEMPROB	FAMPROB	(n)
No	-.132	-.088	-.118	(29)
Yes	.582	.585	.777	(9)

High School Background in Science and Math

We expected that women with stronger backgrounds in science and math at the high school level would perceive fewer problems for women in these fields. Our findings lent mild support to this hypothesis. Females who received higher grades in high school math and science are somewhat less likely to perceive as problematic any of the issues about women in science, engineering or math, especially societal attitudes and the conflict with femininity (Table IIG-9). This suggests that female students who had stronger math and science backgrounds in high school are more confident that the problems women may face in science, engineering and math are not too much of a barrier to following these careers. On the other hand, the perceived conflict between family and career does not seem to be related to high school achievement.

TABLE IIG-9

PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING AND MATH BY HIGH SCHOOL MATH AND SCIENCE GRADES
(Females)

(Mean Factor Scores)

High School Math and Science Grades	SOCPROB	FEMPROB	FAMPROB	(n)
Mostly A's	-.159	-.136	-.063	(33)
Mostly A's and B's	.137	.114	.165	(13)
Mostly B's or lower	.051	.083	-.000	(15)

Experiences at Rowan and the Perception of Problems for Women in SEM

Female Role Models at Rowan

Female students with greater exposure to the female faculty at Rowan seem to be more sensitized to the problems women may face in the fields of science, math and engineering (Table IIG-10). The more female instructors a female student had, the more likely she was to perceive as problematic each of the issues – societal attitudes, the conflict between femininity and SEM, as well as the conflict between career and family.

TABLE IIG-10

PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING AND MATH BY NUMBER OF FEMALE INSTRUCTORS AND GENDER
(Mean Factor Scores)

Number of Female Instructors	SOCPROB	FEMPROB	FAMPROB	(n)
0	-.384	-.248	-.276	(12)
1	-.071	-.056	.002	(25)
2+	.222	.158	.099	(20)

As with males, having more women in their major did not change the female students' perceptions of problems for women in SEM (not negatively or favorably); the correlations of each of the factors with proportion of women in the students' cohort and major were all under .1 and not statistically significant.

Membership in Student Chapters of Professional Organizations

One of our interests was how discipline-specific organizational membership and SWE membership were related to the perception of problems for women. The most striking finding was that those female students who chose to be members of discipline-specific organizations but not SWE, were much less likely to perceive as problematic societal attitudes toward women in SEM or a conflict between femininity and careers in SEM (Table IIG-11). On the other hand, they were more likely to perceive as problematic the conflict between career and family than were the other female students. While members of SWE acknowledged some problems related to societal attitudes toward women in SEM or the conflict between femininity and SEM, they were less likely to see as problematic the role conflict between family and career.

These differences may reflect the type of women who are attracted to belong to these different types of organizations: the women choosing not to affiliate with SWE do not want to acknowledge specifically feminine barriers to participation in SEM. However, they are also less privy to encountering the types of solutions about family-career conflict that might be geared specifically to a female audience.

TABLE IIG-11

PARTICIPATION IN ENGINEERING-RELATED ORGANIZATIONS AND PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING AND MATH
(Mean Factor Scores)

Organizational Membership	SOCPROB	FEMPROB	FAMPROB	(n)
None	.167	.153	-.049	(22)
Discipline-specific organization only	-.342	-.357	.191	(20)
Discipline-specific organization and SWE	.068	.150	-.039	(17)

Year in School

The perception of problems for women in science, engineering and math does vary by year in school, and the patterns differ for males and females. The female students enter as first-year students with a perception that all of the issues are somewhat problematic for women. However, after the first and second years at Rowan, the perception of problems for women is much lower. The senior women again perceive all of the issues as problematic, most especially the conflict between family and career (Table IIG-12).

TABLE IIG-12

PERCEPTION OF PROBLEMS FOR WOMEN IN ENGINEERING BY YEAR IN SCHOOL
(Females, Mean Factor Scores)

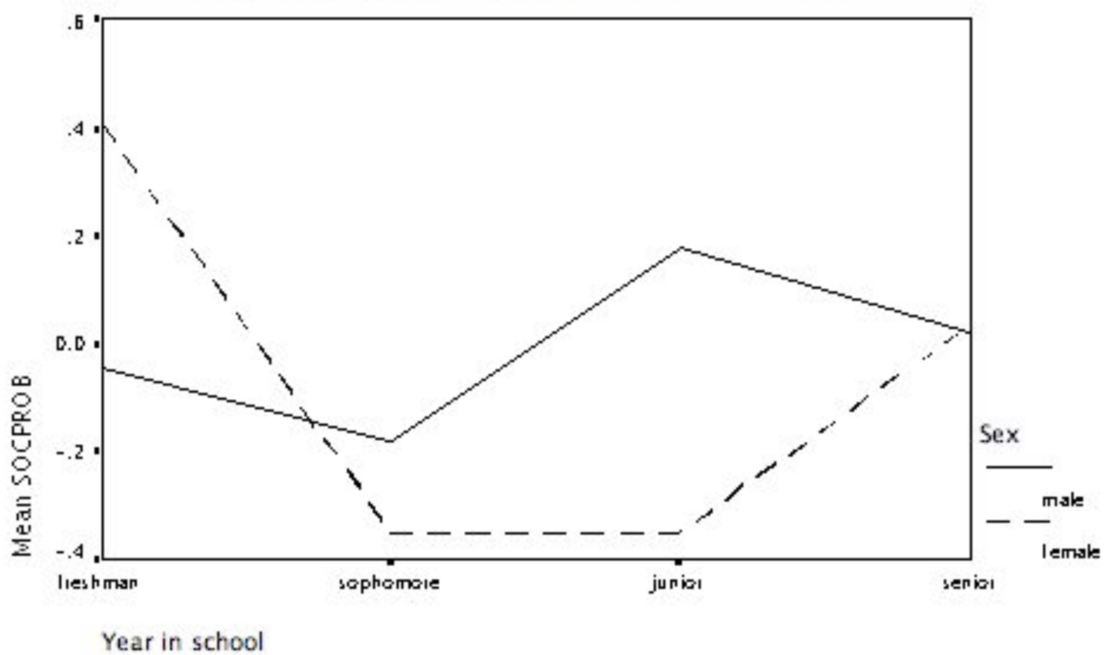
Year in School	SOCPROB	FEMPROB	FAMPROB	(n)
First Year	.410	.384	.251	(20)
Sophomore	-.351	-.291	-.386	(18)
Junior	-.349	-.354	-.111	(14)
Senior	.037	.084	.392	(9)

The female patterns of perceiving problems for women in SEM are different from the male patterns by year in school. As a result of these different patterns for the genders, the gap between male and female students in their perception of problems for women in engineering is different for each of the years (Figures IIG-1, IIG-2, and IIG-3). The difference between male and female perceptions is greatest for first-year students: females are much more likely to perceive each of these areas as problematic for women in SEM. In the sophomore year, the perception of problems is quite similar for the genders, as female students are much less likely to consider the issues seriously problematic than the first-year female students, and males' perception is not very different from the first-year male students. The junior male students are more likely than the junior female students to perceive societal attitudes and femininity as problematic for women in SEM. In the senior year, the gender gap has closed with regard to the perception of problems for women stemming from societal attitudes and the conflict between femininity and careers in SEM. However, female seniors are much more likely than male seniors to perceive as problematic the conflict between family and career responsibilities.

FIGURE IIG-1

PERCEPTION OF PROBLEMS FOR WOMEN IN SEM

BY GENDER AND YEAR IN SCHOOL (Mean SOCPROB)

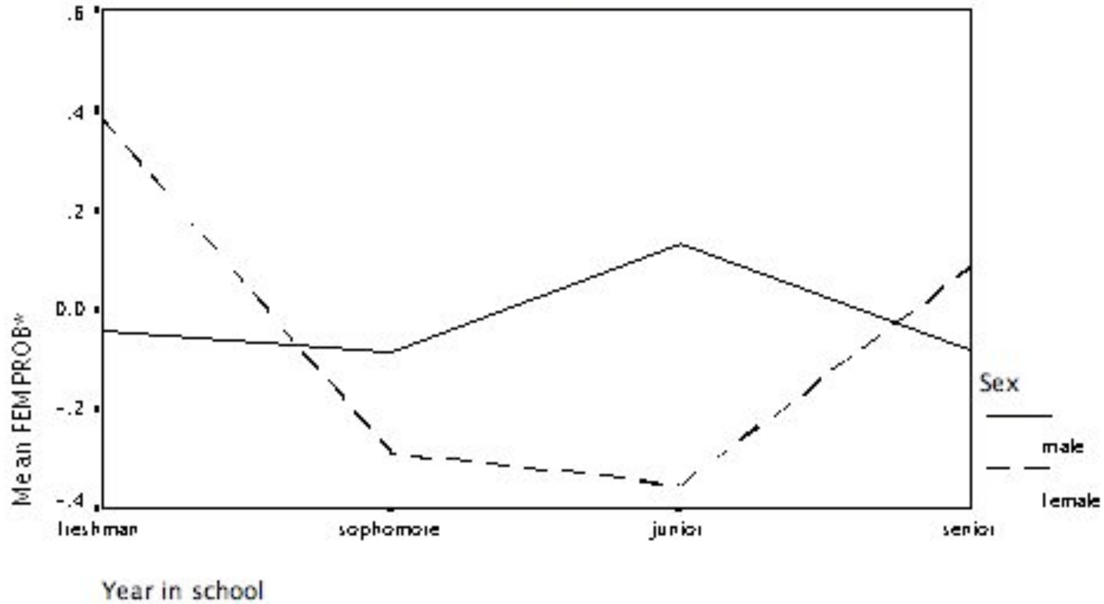


SOCPROB defined in text (perception of problems from societal attitudes)

FIGURE IIG-2

PERCEPTION OF PROBLEMS FOR WOMEN IN SEM

BY GENDER AND YEAR IN SCHOOL (Mean FEMPROB)

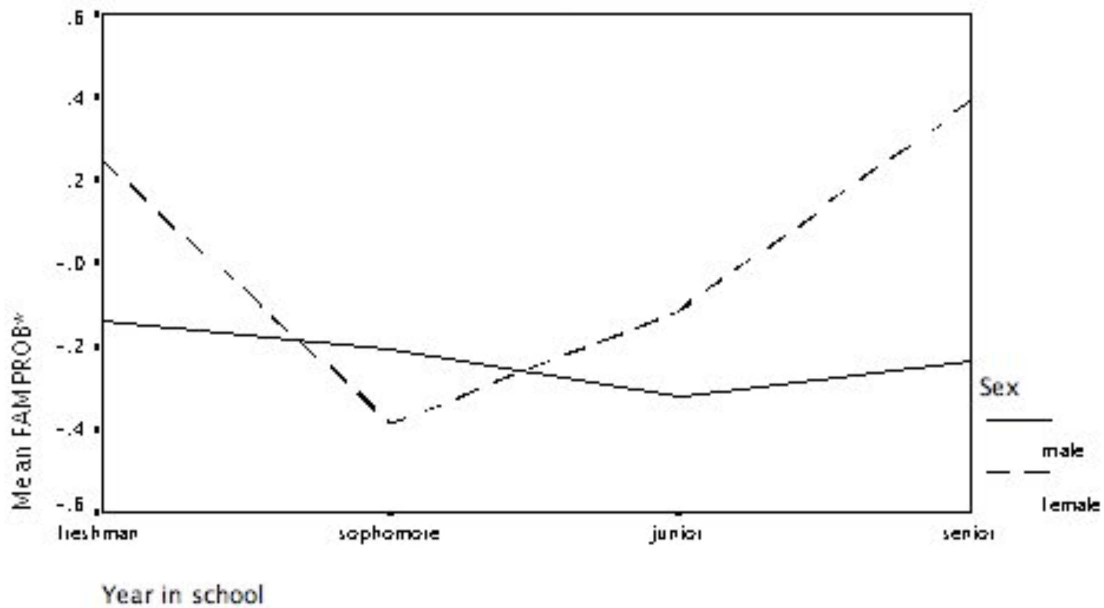


*FEMPROB defined in text (perception of problems from conflict between feminine qualities and SEM)

FIGURE IIG-3

PERCEPTION OF PROBLEMS FOR WOMEN IN SEM

BY GENDER AND YEAR IN SCHOOL (Mean FAMPROB)



*FAMPROB defined in text (perceptions of problems for women in SEM from conflict between family and career

CHANGE IN PERCEPTION OF PROBLEMS OVER THE COURSE OF THE ACADEMIC YEAR

To study more closely how Rowan experiences affected the perception of problems in SEM for women, we looked at the changes in females' perception of the problems from the Fall to the Spring semester. As we found for the males, there was quite a bit of change in perception of the problems from the Fall to the Spring, with from 25-55% of the female students changing their responses to the questions (Table IIG-13). On almost every question, a higher proportion weakened their perception of the issue as problematic in the Spring (on the only question in which as high a proportion increased their perception of the issue as problematic, the wording was slightly changed from Fall to

Spring, which might account for the difference). Particularly high proportions of female students seemed to relax about lacking information about careers in scientific fields and not having enough female role models in the fields of SEM. The Rowan experience seems to directly contribute to this decrease in perception of the problems, by the female role models it provides in faculty and by disseminating information about engineering.

TABLE IIG-13

CHANGE IN PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, ENGINEERING AND MATH FROM FALL TO SPRING BY GENDER

(Females, Mean Factor Scores)

Issue:	% Decreased Perception of Problems	% Increased Perception of Problems
Discriminatory attitudes toward women on part of teachers or others in scientific fields generally	33.8	22.5
Discriminatory attitudes toward women on part of teachers or others in scientific fields at Rowan	25.9	8.6
Women cannot be as competitive as science classes require	14.8	9.8
Long years of formal preparation needed	23.3	15.0
View that women in science or technical fields are unfeminine	19.7	11.5
Lack of encouragement from teachers or counselors[a]	23.0	24.7
Lack of encouragement from family or friends[a]	21.3	13.1
Lack of information about careers in scientific field	42.6	16.4
Women's lack of confidence that they can handle the work	23.0	19.7
Lack of female role models in scientific field	44.3	16.4
Possible conflicts between career and family responsibilities	31.1	14.8
(n)		

[a]The wording of these questions was changed slightly from Fall to Spring, which may account for some of the difference in response.

We wanted to know whether the female students became more attuned to problems of women in the field because of their experiences in internships or in jobs in the field of engineering (that is, their contact with the world of engineering outside of Rowan). The results suggest the contrary (Table IIG-14): students who did not have jobs in engineering were likely to perceive more problems for women in SEM than the students who did have jobs in engineering over the course of the academic year. Female students who had internships were more likely to decrease their perception of how problematic discrimination is than students who did not have internships. That is, students with more contact with the outside world of engineering were less likely to perceive discrimination than the students who had no contact with the outside world of engineering; perhaps, in fact, this perception may have been a deterrent to students seeking jobs or internships in the field. Similarly, students who did have internships or jobs in engineering were less likely to change their perception of conflicts between family and career to more problematic in the spring than in the fall, and were more likely to change their perception to less problematic in the spring, suggesting that their real world experience may have made them more aware of how family-career conflict may be resolved. These results reinforce how important it is for female students to have "real-world" experiences in engineering during their undergraduate engineering education.

TABLE IIG-14

CHANGE IN PERCEPTION OF PROBLEMS FOR WOMEN IN SCIENCE, MATH, OR ENGINEERING FROM FALL TO SPRING BY INTERNSHIP AND JOB EXPERIENCE
(Selected Problems, Females Only)

	% Decreased Perception of Problems		% Increased Perception of Problems	
Issue	Had Internship	Did not have internship	Had Internship	Did not have internship
Discriminatory attitudes toward women on part of teachers or others in scientific fields generally	45.0	22.2	17.5	18.5
Lack of female role models in scientific field	43.2	45.8	16.2	16.7
Possible conflicts between career and family responsibilities	37.5	27.0	12.5	16.2
(n)	(40)	(27)	(40)	(27)
	Had job in engineering	Had job, not in engineering	Had job in engineering	Had job, not in engineering
Discriminatory attitudes toward women on part of teachers or others in scientific fields generally	44.4	21.7	5.6	26.1
Lack of female role models in scientific field	41.2	45.0	17.6	10.0
Possible conflicts between career and family responsibilities	35.3	25.0	5.9	20.0
(n)	(18)	(23)	(18)	(23)

PERCEPTION OF PROBLEMS FOR WOMEN IN ENGINEERING, ENGINEERING SELF-CONFIDENCE AND SATISFACTION WITH ENGINEERING

In this final section of the chapter, we look at whether the perception of problems in engineering is related to the engineering self-confidence of the female students and their satisfaction with the engineering program. First we look at the relationship between the perception of the problems in the Spring and these variables.

Female students who perceive the issues as problematic tend to have lower engineering self-confidence and to be less satisfied with the various aspects of the engineering program, (Table IIG-17). (Mean factor scores that are bolded in the table indicate that the higher score supports these conclusions.) Using the first two factors of engineering self-confidence described above, we can see that the female students who perceived any of these issues as problematic, had lower confidence that they would stay in engineering, and lower confidence in their engineering abilities than female students who did not perceive these issues as problematic for women.

The female students who perceived that discrimination against women in scientific fields was a serious or minor problem, were less satisfied with the coursework load, the lab work, the teamwork, the student-faculty relationships and the peer relationships than the students who did not perceive this issue as a problem. Similarly, those students who perceived the lack of female role models as a problem for women were less satisfied with almost all of the aspects of the Rowan program. This relationship was found for the perception of family-career conflict as a problem only regarding satisfaction with the programmatic aspects of the engineering program and satisfaction with peer relationships.

TABLE IIG-17

PERCEPTIONS OF PROBLEMS FOR WOMEN IN ENGINEERING (SELECTED ASPECTS) BY ENGINEERING SELF-CONFIDENCE AND SATISFACTION WITH ENGINEERING PROGRAM
(Mean Factor Scores, Female Students only)

Issue	Discrimination		Female role models		Family-career conflict	
Problem for women? / Engineering Outcome	No	Yes	No	Yes	No	Yes
Engineering Self-Confidence						
CONF STAY ENGIN	**-.334**	-.616	**-.408**	-.443	-.537	-.394
CONF ENGIN ABIL	**.152**	-.252	**.133**	-.114	**.163**	-.030
Satisfaction with Engineering Program (Mean factor scores)						
SATCHOIC	.222	.285	**.417**	.057	**.466**	.177
SATCLASS	**.278**	.032	**.253**	.138	**.105**	.225
SATCLIN	.136	.263	**.209**	.152	.103	.205
SATLAB	**.148**	-.146	**.181**	-.027	.073	.082
SATTEAM	**.246**	.151	.048	.374	.029	.258
SATFAC	**.147**	-.342	**.061**	-.070	-.528	.166
SATPEERS	**.501**	-.198	**.307**	.223	**.592**	.170
(n)	(43)	(22)	(34)	(32)	(15)	(51)

Apparently the perception of problems for women in engineering by women in engineering, is indicative of how positively the women feel about their place in engineering at present and in the future.

CONCLUSIONS

Students' perceptions of problems for women in engineering reveal many interesting results. First, the majority of students do not perceive special problems for women pursuing careers in science, engineering or mathematics, particularly with regard to the length of preparation required, how feminine women in these fields are considered to be, or social encouragement to pursue these fields. On the other hand, they do perceive as problematic possible conflicts between career and family responsibilities, the lack of female role models in these fields, and discriminatory attitudes toward women by people in scientific fields. Women were especially concerned about discriminatory attitudes, and a lack of information about scientific careers (in focus groups, many of the female students mentioned that they had no idea what an engineer did until they were in the program several months, and they saw this as a deterrent for more women pursuing this career).

Exposure to female role models in science, engineering or math sensitized both male and female students to possible problems women encounter in those fields. Women were especially more aware of potential problems when they had sisters in science, engineering or math, or had more female instructors for their engineering courses. Members of SWE were also more sensitized to the potentially negative societal stereotypes about women in SEM and conflicts between these fields and femininity; however, they were less likely to perceive conflicts between career and family as problematic, presumably because they were exposed to ways of resolving these conflicts.

Having job or internship experience in engineering reduced the perception of problematic issues for women in science, engineering or math, reinforcing the importance of exposing female students in these fields to positive real-world experiences in these fields, so that their fears may be alleviated.

The perception of problems for women in SEM was related to women's engineering self-confidence and their satisfaction with the engineering program. Addressing the issues women find problematic, and showing how problems can be resolved, would appear to have a major impact on how comfortable women feel in engineering and whether they intend to stay in the field.

CHAPTER II-H

COMPARISONS TO OTHER STUDIES

Rowan is a relatively new and small school. It is possible to understand the patterns of variation among the students at Rowan by internal comparisons, as we have done. However, the findings gain significance when they are put in the context of findings among other engineering students. This chapter compares results from the current study with comparable questions included in the national WEPAN Pilot Climate Survey, which surveyed more than 8000 male and female undergraduate engineering students from 29 institutions in (reported in Brainard, et. al., 1998), the repetition of this survey at the University of Washington, 2002[43], and the recent WECE (Women in College Engineering) study (reported in Goodman, et. al., 2002). We begin by comparing our questions on engineering self-confidence, continue to questions of involvement in engineering activities, and conclude with comparisons of satisfaction with various aspects of the respective engineering programs.

COMPARISONS OF ENGINEERING SELF-CONFIDENCE

Comparing the self-confidence of women at Rowan to women in other engineering programs shows that women at Rowan have relatively higher engineering self-confidence.

The following comparison is taken from the WEPAN Student Experience Survey administered at the University of Washington in Spring, 2002 and is compared to responses from Rowan received in Fall and Spring of 2000-1. Both surveys used a 5-

[43] Data from University of Washington were provided courtesy of Suzanne Brainard and Penelope Huang. See also Brainard and Huang (2002).

point scale in which the responses indicating greater self-confidence were higher and the responses indicating lower self-confidence were lower.

Rowan students – both males and females – are more confident that engineering is the right major for them than are University of Washington students (Table IIH-1). They also express more confidence in their abilities in their engineering, physics and chemistry abilities. Their confidence in their mathematical abilities is similar, and they are about as likely to be overwhelmed by the fast pace and heavy workload of their classes (note that on this last question, lower scores, indicating that they disagreed, expressed greater self-confidence). While their confidence in their overall academic ability seems to be a little lower, it should be noted that Rowan students are asked to rate themselves to the average engineering student in their class, while University of Washington students were simply asked how confident they were in their academic ability.

It should also be noted that there tends to be a bigger difference between the University of Washington male and female students in their self-confidence, with the males having higher self-confidence than the females. The gender differences among the Rowan students are smaller.

These comparisons suggest that female engineering students at Rowan are expressing higher engineering self-confidence than female engineering students at the University of Washington, and that the traditional gender gap in self-confidence is somewhat narrowed at Rowan.

TABLE IIH-1

ENGINEERING SELF-CONFIDENCE FOR ROWAN AND UNIVERSITY OF WASHINGTON ("UWA") STUDENTS BY GENDER

(Means)

University	**University of Washington**			**Rowan University**		
Gender Item	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Confident that engineering is right major for you	3.27	3.52	3.02	4.09	4.11	4.02
Confident in abilities in college engineering courses	3.61	3.81	3.44	4.18	4.22	3.99
Confident in abilities in physics	3.18	3.55	2.84	4.06	4.10	3.91
Confident in abilities in chemistry	2.96	2.84	3.09	3.25	3.28	3.16
Confident in mathematical abilities	3.73	3.82	3.63	3.73	3.75	3.67
Confident in overall academic ability	4.01	4.10	3.93	3.81	3.82	3.80
Overwhelmed by fast pace/heavy workload	3.29	3.03	3.53	3.32	3.19	3.32
(n)	(132)	(62)	(68)	(331)	(263)	(68)

This perception is also reinforced by comparison with the national sample of women who were surveyed for the WECE (Women in College Engineering) survey, among whom 1/3 of all sophomore and more advanced WECE respondents reported that they seriously considered leaving engineering during sophomore year (Goodman, et. al., 2002). In contrast, only 10% of the Rowan female sophomores indicated that they were considering changing majors before they graduated (answering "not sure," "possible" or "very likely"), and only 5% said that they were considering dropping out of the engineering program before earning a degree[44].

COMPARISONS OF ENGINEERING ACTIVITIES

The involvement of Rowan's female engineering students in engineering activities is quite high compared to other female student populations in engineering. Compared to results from the national WECE sample of engineering women, Rowan's women are more highly engaged in enrichment activities: much higher proportions of Rowan women read engineering newsletters or listservs, heard engineering speakers, and went on field trips to industry (Table IIH-2). Higher proportions of Rowan sophomores and seniors had internship experiences, although slightly lower proportions of the junior women did.

Rowans engineering students in general, and especially females, are also more involved in enrichment activities than University of Washington ("UW") engineering students45. About 17% of University of Washington students are active in student professional societies and engineering related activities-- similar percentages of males and females (16.6% of the males answered 4 or 5 on a scale of 1 "not at all" to 5 "very much", compared to 17.7% of the females). As we have seen, at Rowan, a much higher proportion of females than males were involved in the professional societies and also other enrichment activities (see Table IIH-2).

[44] The discrepancy may be that 5% were considering changing majors within engineering.
[45] Based on unpublished data provided by Suzanne Brainard and Penelope Huang of University of Washington. See also Brainard and Huang (2002).

Rowan females are also more involved in many of the help activities than are students in the WECE sample or the University of Washington female students. Rowan's women were more active in study groups and were more likely to be tutors themselves. In terms of other help activities, similar proportions of Rowan women and women in the WECE sample received tutoring. The comparison of peer mentoring fluctuated by year, perhaps reflecting the uneven establishment of the program at Rowan: sophomores and seniors received peer mentoring similar to the national sample, but first-year and junior students engaged in it less. Lower proportions of Rowan women received career counseling. Study groups are utilized by all Rowan engineering students more than by University of Washington engineering students, and are utilized more by females than males in both settings (Table IIH-2).

The Rowan population is also more likely to have contact with a mentoring faculty member than at University of Washington, and this is true for males and females alike (Table IIH-3). In comparison to the national sample of women in engineering surveyed in the WECE project (Goodman, et. al., 2002), Rowan's female students are more likely to have a supportive faculty member. Goodman et. al. report that 30-40% of the female students in each undergraduate year said they did not have a "mentor"46, as compared with the 18% of Rowan females who did not have a faculty member particularly supportive of them.

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[46] A "mentor" was defined as "someone with more experience in engineering, to whom the student turns for advice or support about educational or professional decisions" (Goodman, et. al., 2002:47).

TABLE IIH-2
% ENGAGING IN ENRICHMENT AND HELP ACTIVITIES BY YEAR IN SCHOOL
(Rowan Female Engineering Students and National WECE Sample of Female Engineering Students)[a]

Activity	Rowan Females	WECE
Read engineering newsletter or listserv		
First year	61.4	53.6
Sophomore	70	61.6
Junior	100	71.5
Senior	100	78.9
Heard engineering speaker		
First year	81	33.2
Sophomore	84.2	38.5
Junior	92.3	48.6
Senior	92.3	58.0
Went on field trip to industry		
First year	46.5	18.7
Sophomore	60	27.5
Junior	84.6	42.2
Senior	69.2	55.7
Internship		
Sophomore	50.0	37.6
Junior	46.2	57.8
Senior	84.6	70.3
Participated in Study group		
First year	85.7	71.9
Sophomore	100	75.5
Junior	100	78.9
Senior	84.6	83.9
Was tutor		
First year	42.9	18.0
Sophomore	40.0	25.1
Junior	53.8	29.4
Senior	46.2	34.8
Received tutoring		
First year	42.9	47.2
Sophomore	45.0	43.3
Junior	38.5	34.5
Senior	38.5	33.1
Received peer mentoring		
First year	14.3	31.7
Sophomore	25	24.9
Junior	16.7	23.9
Senior	23.1	26.6
Received career counseling		
First year	9.5	18
Sophomore	25	32.8
Junior	23.1	40.4
Senior	38.5	46.9

[a]As reported in Goodman, et. al., 2002.

TABLE IIH-3

PARTICIPATION IN SELECTED ENGINEERING-RELATED ACTIVITIES BY GENDER AND UNIVERSITY
(University of Washington, Rowan)
(%'s)

University	University of Washington			Rowan University		
Gender / Activity	Total	Male	Female	Total	Male	Female
% Having any contact with a mentor [a]	62.0	60.0	64.2	80.5	80.1	82.1
% Having any involvement with study groups	75.8	72.8	77.9	89.3	88.3	92.5
% Having any involvement in professional societies or engineering-related activities [b]	62.5	62.9	62.7	63.6	60.9	74.6
(n)	(132)	(62)	(68)	(331)	(263)	(68)

[a] At Rowan, the question read: "During this academic year, have there been any particular faculty who encouraged you or were personally supportive of you?"
[b] At Rowan, the question was about participation in professional society only (as other engineering-related activities were covered in many separate questions).

These comparisons show that compared to women in other engineering programs, Rowan women in engineering are well integrated into both enrichment and help activities, and that their involvement often exceeds that of the male students at Rowan, a pattern unlike that found at the University of Washington.

COMPARISONS OF SATISFACTION

Comparing the satisfaction of Rowan engineering students to that of students elsewhere gives us a perspective on general satisfaction with the Rowan program as well as the relative satisfaction of the female students in it. Some of the questions used in the Rowan survey, are the same as questions that appeared and have been reported for the national WEPAN study of 29 institutions, with over 8000 students. On these questions the most striking difference is that nationally women are less satisfied than men; at

Rowan there is either no significant gender difference in satisfaction or the women are more satisfied than the men.

More detailed data was made available from the University of Washington self-study made in 2002. On satisfaction questions asked both of University of Washington and Rowan engineering students, Rowan engineering students, and particularly female students, are comparatively highly satisfied with their engineering program. As in the national sample, at the University of Washington, males on many of the variables are more satisfied than females; at Rowan, as we have seen above, it is more common to find Rowan males more critical than the female students.

Satisfaction with Programmatic Elements

Rowan students are less likely than University of Washington engineering students to agree that they are overwhelmed by the coursework. Considering the workload in engineering courses, 20.6% of the UW females said they felt "very much" overwhelmed by the fast pace and heavy workload, compared to less than 10% of the UW males. On a scale of 1-5 (1="not at all"; 5= "very much"), more than half of the females answered 4 or 5 ("very much") compared to 25.8% of the UW males. On the same question, WEPAN's Pilot Climate Survey found that women were significantly more likely to be overwhelmed by the fast pace and heavy workload of engineering than were male students (Brainard, et. al., 1998).

On similar questions, the gender gap among Rowan students was reversed and much smaller: 42.9% of the males and 37.1% of the females agreed or strongly agreed that the workload for engineering is too heavy and difficult; 36.6% of the males and 32.4% of the females agreed or strongly agreed that “the pace of learning in many of the required courses is too fast.”

On the scale of 1-5 (1=”not at all”; 5= “very much”) only a third (34.9%) of the UW engineering students felt that their grades reflected their knowledge of course material at a level of 4 or 5. In contrast, 2/3 of the Rowan engineering students agreed or strongly agreed that the grading system reflected students’ knowledge and competency in the subject matter. Again, comparing UW males to females, males were more positive in their assessment of the fairness of grades (45.2% of the males answered 4 or 5, nearly double the 26.5% of the females). In contrast, 72.5% of the Rowan females agreed or strongly agreed with the fairness of the grading system, compared to 63.6% of the Rowan males. These differences are reflected in the higher mean scores reported for Rowan males and females compared to University of Washington students (Table IIH-4).

Satisfaction with Labwork

Asked how much lab work adds to their understanding of course material, less than half of the UW students answered 4 or 5 on a scale of 1 (not at all) to 5 (very much) – 44.2% of the males and 45.3% of the females. In contrast, more than 3/4 of the Rowan students agreed or strongly agreed that lab work adds a lot to their understanding of course material – 79% of the males, and 72.5% of the females. The mean scores of Rowan females reflect greater satisfaction with this aspect of laboratory work than University of Washington females.

About a quarter of the UW students thought lab experiments were explained well prior to labs – similar percentages of males (23%) and females (23.5%) answered 4 or 5 on a scale of 1”not at all” to 5 “very much”. In contrast, more than 2/3 of the Rowan students agreed or strongly agreed that expectations for lab work are explained well – 68.9% of the males and 72.6% of the females. The mean scores for this question are much higher for Rowan students than for University of Washington students, and the Rowan females show more satisfaction in this respect than the Rowan males, in contrast to the University of Washington females who are more critical than the University of Washington males.

The overall lack of gender difference which we found on the factor indicating satisfaction with lab work, and the greater satisfaction of females on some of these individual items contributing to the factor, thus gains importance when compared to the University of Washington and the national WEPAN study, which showed female students significantly less comfortable in the lab than male students (Brainard et. al., 1998). A lack of gender difference, or greater satisfaction of females, therefore indicates a better engineering environment for women in this respect, in comparison to the more traditional programs.

Satisfaction with Faculty-Student Relations

Engineering students at Rowan are more likely than University of Washington engineering students to feel that their professors care whether they learn the course material. 52.2% of the University of Washington engineering students answered 4-5 on a scale from 1"not at all" to 5 "very much", compared to 82.5% of the Rowan students. The male engineering students at University of Washington were slightly more likely to feel that their professors cared about their learning the course material (57.4% of the males vs. 50.0% females); at Rowan, female students were more likely to agree that their professors cared than were the males (80.3% males vs. 91.9% females).

Asked whether professors treated them with respect, about a quarter of the UW students answered "very much" – similar percentages of males and females. In contrast, nearly half of the Rowan students said that it was "very true" that engineering faculty at Rowan show that they respect students, slightly more females (50%) than males (44.5%) expressing this opinion.

TABLE IIH-4

INDICATORS OF SATISFACTION WITH ELEMENTS OF THE UNDERGRADUATE ENGINEERING PROGRAM OR CLIMATE BY GENDER AND UNIVERSITY (University of Washington, Rowan)

(Means)

University	**University of Washington**			**Rowan University**		
Gender **Satisfaction item:**	**Total**	**Male**	**Female**	**Total**	**Male**	**Female**
Grades reflect knowledge of course material	3.03	3.23	2.88	3.47	3.46	3.51
Lab adds to understanding of course material	3.19	3.34	3.07	3.33	3.32	3.34
Lab experiments are explained prior to lab	2.61	2.69	2.56	3.66	3.59	3.79
Professors care whether I learn	3.46	3.50	3.46	4.42	4.38	4.57
Professors treat me with respect	3.83	3.87	3.78	4.30	4.37	4.40
(n)	(132)	(62)	(68)	(331)	(263)	(68)

In sum, comparing selected satisfaction measures asked of Rowan engineering students to those of University of Washington shows that overall Rowan students seem to be more satisfied with various aspects of their engineering program and climate, and that where there are gender differences, females tend to be more satisfied than males; in contrast, at University of Washington, it is the males who are more likely to express satisfaction with the engineering elements than are females. Rowan seems to have broken the traditional gender gap in satisfaction with the undergraduate engineering program.

SUMMARY AND CONCLUSIONS

In summary, comparisons to other engineering students shows that Rowan women are more self-confident in their place in engineering, that they are highly involved in the engineering enrichment and help activities, and that they are more satisfied with their engineering program and its interpersonal climate. The gender gap at Rowan in terms of these aspects is relatively smaller than in other student populations. It is not surprising, therefore, that the retention of females, without these familiar sources of gender bias, compares so favorably to that of males in this setting.

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 <u>every</u> semester in engineering clinic
- Nurturing approach rather than weed-out
- Hands-on laboratory experience <u>every</u> 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*.

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APPENDIX A

INSTRUMENTS USED IN THE STUDY

A-1 Fall Questionnaire

A-2 Student Consent Form

A-3 Spring Questionnaire

A-4 Focus Group Interview Schedule

A-5 Faculty Interview Schedule

ENGINEERING STUDENT SURVEY I

Dear Student,

This information is being collected as part of a study of engineering education conducted under the auspices of the Department of Sociology and the National Science Foundation. Your participation in this research will help us to achieve a better understanding of how students are affected by their college engineering education experiences. Detailed information on this research program is available from the principal investigator. Your responses are held in the strictest professional confidence, and your privacy will be maintained in all published and written data resulting from the study. Identifying information has been requested only in order to make subsequent follow-up study possible and will be available only to the principal investigator.

Sincerely,

Harriet Hartman, Principal Investigator
Department of Sociology
Campus extension 3787; hartman@rowan.edu

☐☐☐
(10-11-12)

ENGINEERING STUDENT SURVEY I

Please mark all answers clearly with an X. If you need to change an answer, please erase completely.

1. Year in School: (13)
① Freshman ② Sophomore ③ Junior ④ Senior

2. Your major: (14)
① Chemical engineering
② Civil engineering
③ Electrical engineering
④ Mechanical engineering
⑤ General Engineering
⑥ Other ___________________________

3. Year of Birth: 19____________________ (15-16)

4. Sex:
① Male ② Female (17)

5. Marital Status: (18)
① Single
② Married
③ Divorced
④ Other____________________________

6a. Do you have any children? (19)
① Yes ② No

6b. If yes, number of children who are currently living with you:

.__________________ (20)

7. Please answer the following questions about your living arrangements for this academic year:

7a. Are you living: (21)

① In your parents' or other relatives home
② Other private home, apartment, or room off-campus.
③ On campus housing
④ Other______________________________

7b. Which best describes your roommates? (22)
① Other students majoring in science, mathematics or engineering
② Other students not majoring in science, mathematics or engineering.
③ Not students

8a. How close is Rowan to your permanent home? (23)

① 5 miles or less
② 6-10 miles
③ 11-50 miles
④ 51-100 miles
⑤ 101-500 miles
⑥ Over 500 miles

8b. Is your permanent home (24)

① Urban or Suburban
② Rural

9. Your race/ethnicity: (25)

① African American/Black
② Asian American/Asian
③ Caucasian/ White
④ Mexican American/Chicano/Hispanic
⑤ Native American/American Indian
⑥ Other, specify:___________________

10. Is your native language English? (26)

① Yes
② No

Family Background

11. What was the highest level of formal education obtained by your parents? *Mark one in each column.*

	11a. **Father**	11b. **Mother**
Elementary school or less	①	①
Some high school	②	②
High school graduate	③	③
Post-secondary school other than college	④	④
Some college	⑤	⑤
College degree	⑥	⑥
Some graduate school	⑦	⑦
Master's degree	⑧	⑧
Ph.D./Doctorate	⑨	⑨
Other graduate or professional degree (indicate which)	⑩________	⑩__________
	(27)	(28)

12. What is your father's occupation? *Please describe in detail*

-
____

____________________________________ ☐☐ (29-30)

13. What is your mother's occupation? *Please describe in detail.*

-
____

____________________________________ ☐☐ (31-32)

14. Please describe the history of your mother's employment status during the following times. *For each period in question, mark the answer that was true for most of the time in question.*

	Employed full-time	Employed part-time	Not employed	
14a. **Before you were born**	①	②	③	(33)
14b. **When you were a preschooler**	①	②	③	(34)
14c. **When you were in elementary school**	①	②	③	(35)
14d. **When you were in high school**	①	②	③	(36)

15. What are your parents' ages?
If one or both of your parents is no longer living or you don't know details about them, please write N/A.

15a. Mother _____ (37)

15b. Father ______ (38)

16a. When you were in elementary school or younger, did you live most of the time: (39)

① With both parents
② With your mother
③ With your father
④ Other__________________

16b. When you were in middle or junior high or older, did you live most of the time: (40)

① With both parents
② With your mother
③ With your father
④ Other__________________

17a. How many younger brothers do you have?________ (41)

17b. How many younger sisters do you have?_________ (42)

17c. How many older brothers do you have?__________ (43)

17d. How many older sisters do you have?___________ (44)

	Yes	No	
18a. Have any of your siblings gone to college? *(If no, go to #19)*	①	②	(45)
18b. If yes, do you have a brother who studied or studies Engineering?	①	②	(46)
18c. Do you have a brother who studied or studies another science or math field?	①	②	(47)
18d. Do you have a sister who studied or studies Engineering?	①	②	(48)
18e. Do you have a sister who studied or studies another science or math field?	①	②	(49)

19. For each of the following people, what was their opinion about your pursuit of an engineering major or career?
Mark whether their opinion was positive, negative, or neutral.

	Positive	Neutral	Negative	
19a. **Mother**	①	②	③	(50)
19b. **Father**	①	②	③	(51)
19c. **Other relative**	①	②	③	(52)
19d. **Best friend(s)**	①	②	③	(53)
19e. **Boyfriend/girlfriend**	①	②	③	(54)
19f. **Most influential teacher**	①	②	③	(55)
19g. **High school guidance counselor**	①	②	③	(56)
19h. **Someone else you knew who works in a science/math/ engineering field**	①	②	②	(57)

20. To what extent do your parents support your being in engineering? *Mark one answer in each column.*

	20a. **Mother**	20b. **Father**
Strongly supportive	①	①
Moderately supportive	②	②
Neutral	③	③
Moderately oppose	④	④
Strongly oppose	⑤	⑤
	(58)	(59)

High School Background

21. In what year did you graduate from high school? (60-61)

____

22. Approximately how many students were in your high school senior class?_______________ (62-63-64)

23. Which of the following describes your high school?
Mark one answer for each question.

23a. My high school was: (65)

① Public
② Parochial/religious
③ Other private
④ I was home schooled

23b. My high school was: (66)

① Co-ed
② Single-sex

23c. My high school was located in (67)

① an urban area
② a suburban area
③ a rural area.

24a. What was your overall GPA in high school?

______________________________ (68)

24b. In your high school science courses, did you receive (69)

① Mostly A's
② Mostly A's and B's
③ Mostly B's and C's
④ Mostly C's or lower

24c. In your high school mathematics courses, did you receive: (70)

① Mostly A's
② Mostly A's and B's
③ Mostly B's and C's
④ Mostly C's or lower

25a. What was your verbal SAT score?

______________________ (71-72-73)

25b. What was your math SAT score?

______________________ (74-75-76)

26. How many semesters of each of the following subjects did you study during grades 9 to 12 (including summers)?
Count a yearlong course as two semesters and a summer course as one. Include AP courses and courses taken at a local college.

	Number of Semesters	
26a. **Biology**	________	(77)
26b. **Chemistry**	________	(78)
26c. **Earth science/Geology/ Anthropology**	________	(79)
26d. **Physics**	________	(80)
26e. **Environmental science**	________	(81)
26f. **Engineering**	________	(82)
26g. **Computer science**	________	(83)
26h. **Other science (Specify:___________)**	________	(84)
26i. **Calculus**	________	(85)
26j. **Math/Statistics other than calculus**	________	(86)

27. Did any of your high school science courses have a lab component?

① Yes ② No (87)

28. Prior to entering college did you take any of the following advanced placement courses?

	Yes	No	
28a. **AP Calculus AB**	①	②	(88)
28b. **AP Chemistry**	①	②	(89)
28c. **AP Calculus BC**	①	②	(90)
28d. **AP Biology**	①	②	(91)
28e. **AP Physics**	①	②	(92)
28f. **AP Environmental science**	①	②	(93)
28g. **Other honors or advanced science or math course (Specify:_____________)**	①	②	(94)

29a. Did you ever have a female teacher for math or science in high school?

① Yes ② No (95)

29b. If yes, how many? (96)

① 1-2
② 3-4
③ 5 or more

30. Did you participate in any of the following science, math or engineering activities during grades 9 to 12?

	Yes	No	
30a. **Summer science, math or engineering programs**	①	②	(97)
30b. **Science or math competitions or contests**	①	②	(98)
30c. **After-school clubs**	①	②	(99)
30d. **Special programs or workshops (on weekends, after-school)**	①	②	(100)
30e. **Independent science research course**	①	②	(101)
30f. **A science or math course at a local college**	①	②	(102)
30g. **Teaching science, math, or engineering**	①	②	(103)
30h**. Research experience**	①	②	(104)
30i. **Paid work experience in science, math or engineering**	①	②	(105)
30j. **Volunteer work experience or internship**	①	②	(106)

You As A Student

31. How would you rate yourself on each of the following traits as compared with the average student your age?
Mark one answer for each trait.

	Lowest 10%	Below average	Average	Above average	Highest 10%	
31a. **academic ability**	①	②	③	④	⑤	(107)
31b. **drive to achieve**	①	②	③	④	⑤	(108)
31c. **mathematical ability**	①	②	③	④	⑤	(109)
31d. **popularity with the opposite sex**	①	②	③	④	⑤	(110)
31e. **self-confidence**	①	②	③	④	⑤	(111)
31f. **interest in science**	①	②	③	④	⑤	(112)
31g. **communication skills**	①	②	③	④	⑤	(113)

32. A number of different factors influence grades. When you consider your grades in science and mathematics in the previous year, how much of your grades were due to each of the factors listed below?
Please rank from 1-5, 1 being the least important, 5 being the most important.

32a. **My ability**	①	②	③	④	⑤	(114)
32b. **How much effort I put in**	①	②	③	④	⑤	(115)
32c. **Luck**	①	②	③	④	⑤	(116)
32d. **Ease/difficulty of material**	①	②	③	④	⑤	(117)
32e. **Quality of teaching**	①	②	③	④	⑤	(118)

33. Please indicate the extent to which you agree or disagree with the following statement:

Getting help for my academic work would be an admission of my own lack of ability or ignorance. (119)

① Strongly disagree
② Disagree
③ Unsure
④ Agree
⑤ Strongly agree

34. The following items relate to different study habits. Please indicate how strongly you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree	
34a. **Studying in a group is better than studying by myself**	①	②	③	④	⑤	(120)
34b. **Creative thinking is one of my strengths**	①	②	③	④	⑤	(121)
34c. **I need to spend more time studying than I currently do**	①	②	③	④	⑤	(122)
34d. **I have strong problem solving skills**	①	②	③	④	⑤	(123)
34e. **I prefer studying alone**	①	②	③	④	⑤	(124)
34f. **I enjoy group assignments or projects in class**	①	②	③	④	⑤	(125)

You and Engineering

35. Was your current major your first choice? (126)

① Yes ② No

36. How satisfied are you with your major in engineering?
Please indicate the extent to which you agree with the following statements.

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree	
36a. **I am personally satisfied with my choice of a college major**	①	②	③	④	⑤	(127)
36b. **I have no desire to change to another major (biology, English, chemistry, art, history, etc.**	①	②	③	④	⑤	(128)
36c. **I can think of several other majors that would be more rewarding than engineering**	①	②	③	④	⑤	(129)
36d. **I am confident that engineering is the right major for me**	①	②	③	④	⑤	(130)
36e. **The advantages of studying engineering outweigh the disadvantages**	①	②	③	④	⑤	(131)
36f. **The future benefits of studying engineering are worth the effort**	①	②	③	④	⑤	(132)
36g. **The rewards of getting an engineering degree are not worth the effort**	①	②	③	④	⑤	(133)

37. Below are some of the subjects and skills needed in engineering. Please indicate how confident you are of your abilities in the subject or skill.

	Not strongly confident	Not confident	Neutral	Confident	Strongly confident	
37a. **Chemistry**	①	②	③	④	⑤	(134)
37b. **Physics**	①	②	③	④	⑤	(135)
37c. **Calculus**	①	②	③	④	⑤	(136)
37d. **Engineering**	①	②	③	④	⑤	(137)
37e. **Writing**	①	②	③	④	⑤	(138)
37f. **Speaking**	①	②	③	④	⑤	(139)
37g. **Computer skills**	①	②	③	④	⑤	(140)

38. Students have different assessments of their own engineering strengths To what extent do you agree with the following statements about yourself?

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree	
38a. **I am well-suited for my choice of college major**	①	②	③	④	⑤	(141)
38b. **I consider myself mechanically inclined**	①	②	③	④	⑤	(142)
38c. **I am confident that I will do well in the math, science, and engineering courses I have this year.**	①	②	③	④	⑤	(143)
38d. **I am competent in skills required for my major**	①	②	③	④	⑤	(144)
38e. **I am good at designing things**	①	②	③	④	⑤	(145)
38f. **I consider myself technically inclined.**	①	②	③	④	⑤	(146)
38g. **I am well-suited for my chosen career**	①	②	③	④	⑤	(147)
38h. **I am confident that I will be able to handle my course work this year**	①	②	③	④	⑤	(148)

39. People enjoy different things about engineering. To what extent do you agree with the following statements about your self?

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree	
39a. **I enjoy solving open-ended problems**	①	②	③	④	⑤	(149)
39b. **I enjoy problems that can be solved in different ways.**	①	②	③	④	⑤	(150)
39c. **I have a high level of interest in engineering.**	①	②	③	④	⑤	(151)
39d. **I enjoy the subjects of science and mathematics the most.**	①	②	③	④	⑤	(152)
39e. **I enjoy taking liberal arts courses more than math and science courses.**	①	②	③	④	⑤	(153)
39f. **I am overwhelmed by the workload in my engineering courses.**	①	②	③	④	⑤	(154)

40. The statements listed below have been suggested as difficulties that especially women face in the pursuit of careers in science, mathematics, or engineering. Based on your observations and experiences, please indicate your opinions about these claims. Do you think these constitute no problem, minor problems, or serious problems for women?

	No problem	Minor problem	Serious problem	
40a. **Long years of formal preparation needed**	①	②	③	(155)
40b. **Possible conflicts between career and family responsibilities**	①	②	③	(156)
40c. **View that women majoring in science or technical fields are unfeminine**	①	②	③	(157)
40d. **Lack of encouragement from teachers or counselors**	①	②	③	(158)
40e. **Lack of encouragement from family or friends**	①	②	③	(159)
40f. **Women's lack of confidence that they can handle the work**	①	②	③	(160)
40g. **Lack of information about careers in scientific field**	①	②	③	(161)
40h. **Lack of female role models in scientific fields**	①	②	③	(162)
40i. **Women cannot be as competitive as science classes require**	①	②	③	(163)
40j. **Discriminatory attitudes toward women on part of teachers or others in scientific fields generally**	①	②	③	(164)
40k. **Discriminatory attitudes toward women on part of teachers or others in scientific fields at Rowan**	①	②	③	(165)

Future Expectations

41. What is the highest degree you expect to complete? (166)

① B.A./B.S
② M.A./M.S.
③ Ph.D.
④ Other (please specify)___________

42. How likely is it that you would consider dropping out of the engineering program before earning a degree? (167)

① Very unlikely
② Not likely
③ Not sure
④ Possible
⑤ Very likely

43. Do you have any concern about your ability to finance your college education? (168)

① I am confident that I will have sufficient funds
② I will probably have enough funds
③ I am not sure I will have enough funds to complete college
④ I am seriously concerned about having enough funds to complete college

44. People have different expectations of what a degree in Engineering will lead to. Please indicate the degree to which you agree or disagree with each of the following statements.

A degree in Science/Mathematics/Engineering will allow me to:

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree	
44a. **get a well-paying job**	①	②	③	④	⑤	(169)
44b. **choose to live in any geographic location I want**	①	②	③	④	⑤	(170)
44c. **get a job I like doing**	①	②	③	④	⑤	(171)
44d. **be respected by others**	①	②	③	④	⑤	(172)
44e. **get a job where I can use my talents**	①	②	③	④	⑤	(173)
44f. **get a secure job throughout my adult life**	①	②	③	④	⑤	(174)
44g. **get a challenging job**	①	②	③	④	⑤	(175)
44h. **have time to devote to interests outside my job**	①	②	③	④	⑤	(176)
44i. **get a job where I will associate with interesting people**	①	②	③	④	⑤	(177)
44j. **be an important contributor to society**	①	②	③	④	⑤	(178)

ENGINEERING STUDENT SURVEY II

Dear Student,

This questionnaire is designed to understand more about your experiences this year in the engineering program at Rowan and how you see yourself and your future in engineering at this point in time. This information is being collected as part of a study of engineering education sponsored by the National Science Foundation, in cooperation with the Department of Sociology and the Center for Student Life and Development at Rowan. Your participation in this research is voluntary, and your cooperation is greatly appreciated. Your responses are held in the strictest professional confidence, and your privacy will be maintained in all published and written data resulting from the study. Identifying information, which will be available only to the principal investigator, has been requested only in order to link up to your answers on the first questionnaire earlier this year and to make subsequent follow-up study possible. Additional information on this research project is available from the principal investigator.

Sincerely,

Harriet Hartman, Principal Investigator
Department of Sociology
Campus extension 3787; hartman@rowan.edu

Name________________

Social Security # ___ __ ____

ENGINEERING STUDENT SURVEY II

Please mark all answers clearly with an X. If you need to change an answer, please erase completely.

Academic Activities

1. Year in School:
① Freshman ② Sophomore ③ Junior ④ Senior

2. Your current major:
- ① Chemical engineering
- ② Civil engineering
- ③ Electrical engineering
- ④ Mechanical engineering
- ⑤ General engineering
- ⑥ Other ___________________________

3. Have you changed your major during the past year?
- ① No, I didn't change my major.
- Yes, I switched major:
- ② From chemical engineering
- ③ From civil engineering
- ④ From electrical engineering
- ⑤ From mechanical engineering
- ⑥ From general engineering
- ⑦ From another field. Which? _______

4a. The total number of engineering credits you have completed in engineering (including this semester):

____

b. The total number of general education credits you have completed (including this semester):

____

5.Do you think your high school education prepared you adequately for your experience in engineering?

(Please indicate how strongly you agree or disagree with the following statements.)

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a. Overall, the education I received in high school prepared me well for my academic course work here	①	②	③	④	⑤
b. My high school chemistry prepared me well for chemistry course work here	①	②	③	④	⑤
c. My high school mathematics prepared me well for mathematics course work here	①	②	③	④	⑤
d. My high school physics prepared me well for physics course work here	①	②	③	④	⑤
e. My high school prepared me well for computer science here	①	②	③	④	⑤
f. My high school prepared me well for the writing that is required here	①	②	③	④	⑤

6. Did you ever attend another college before coming to Rowan?
- ① Yes, a two-year college.
- ② Yes, a four-year college or university.
- ③ No, Rowan is the first college or university I've attended.

7. During this academic year, how frequently have you participated in any of the following activities?

	Once a week or more	1-3 times a month	1-3 times a semester or less	Never
a. Participated in a study group	①	②	③	④
b. Received tutoring	①	②	③	④
c. Been a tutor	①	②	③	④
d. Met with an academic advisor	①	②	③	④
e. Received career counseling	①	②	③	④
f. Received peer mentoring	①	②	③	④
g. Read an engineering newsletter or listserv	①	②	③	④
h. Heard an engineering speaker (outside of class)	①	②	③	④
i. Went on a field trip to industry site	①	②	③	④

8. How active are you in the following student professional societies*?

	AIChE	ASCE	IEEE	ASME	SWE
a. Participation					
1. Go to most meetings	①	①	①	①	①
2. Go occasionally	②	②	②	②	②
3. Rarely go	③	③	③	③	③
4. Never go	④	④	④	④	④
b. Membership					
1.Yes	①	①	①	①	①
2. No	②	②	②	②	②
c. Officer					
1.Yes	①	①	①	①	①
2. No	②	②	②	②	②

*AIChE=American Institute of Chemical Engineers
ASCE=American Society of Civil Engineers
IEEE=Institute of Electrical & Electronic Engineers
ASME=American Society of Mechanical Engineers
SWE=Society of Women Engineers

9. Have you had an engineering internship in the past year?

① No
② Yes, in the summer only
③ Yes, during the academic year only
④ Yes, both in the summer and during the academic year

10. During this academic year, have you:

	Yes	No
a. worked, for pay, for a faculty member	①	②
b. conducted research with a faculty member	①	②
c. had a faculty member give you a job reference or help you find a job	①	②

11. During this academic year, how many women engineering faculty have been the primary instructors of the courses you have taken?

0 ① ② ③+

12. **The following items relate to different study habits**. (*Please indicate how strongly you agree or disagree with the following statements.)*

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a. Studying in a group is better than studying by myself	①	□	③	④	⑤
b. I need to spend more time studying than I currently do	①	□	③	④	⑤
c. I have strong problem solving skills	①	□	③	④	⑤
d. Creative thinking is one of my strengths	①	□	③	④	⑤
e. I prefer studying alone	①	□	③	④	⑤
f. I do not enjoy working in assigned groups in class	①	□	③	④	⑤
g.Working in assigned teams with classmates helps me understand material presented in class	①	□	③	④	⑤
h. The clinic experience of working with students in other majors gives good teamwork experience	①	□	③	④	⑤
i. Teamwork slows down the learning process in the clinic setting	①	□	③	④	⑤
j. I don't like group work because usually not everyone does their fair share	①	□	③	④	⑤

13. Has your experience in the engineering clinics made you more or less positive about working in groups/teams?
① More positive
② Hasn't changed my opinion about groups/teams
③ More negative

14. As of last semester,
a. what is your overall GPA? ____________

b. what is your average GPA in your engineering courses? _______________

Non-Academic Activities

15. During this academic year, how frequently have you participated in any of the following activities?

	Once a week or more	1-3 times a month	1-3 times a semester or less	Never
a. Participated in one or more (non-engineering specific) student organizations	①	②	③	④
b. Participated in an intramural or varsity sport	①	②	③	④
c. Socialized with non-engineering students	①	②	③	④

16. Are you a member of a fraternity or a sorority?
①Yes ②No

17. During this academic year, have you held any paid job?
① No (skip to question 22)
② Yes, one job
③ Yes, more than one job

18. How many weeks during the academic year (excluding the summer) did you work in a paid job?

----

19. During those weeks that you worked (excluding the summer), what was the average number of hours per week you worked?

----

20. Where was your primary place of employment?
① On-campus
② Off-campus

21. Were any of your jobs related to your academic or career interest?
① Yes, in engineering
② Yes, but not in engineering
③ No

Interpersonal Interaction

22. During this academic year, how often have you talked with faculty about:

	Once a week or more	1-3 times a month	1-3 times a semester or less	Never
a. course material, assignments, tests, etc.	①	②	③	④
b. your career	①	②	③	④
c. what courses to take	①	②	③	④
d. other personal concerns	①	②	③	④

23. During this academic year, how often have you visited faculty in their offices or outside the classroom (e.g., during office hours or by appointment)?

① Never
② Once or twice
③ Occasionally
④ Often

24. During this academic year, have there been any particular faculty who encouraged you or were personally supportive of you?

① No
② Yes, female faculty
③ Yes, male faculty
④ Yes, both female and male faculty

25. From your experience, engineering faculty at Rowan usually: *(Please indicate how true the following are for your experience. 1= not at all true, 2=somewhat untrue, 3=sometimes true and sometimes untrue, 4=somewhat true, 5=very true)*

a.	are approachable	① ② ③ ④ ⑤
b.	expect too much of students	① ② ③ ④ ⑤
c.	are available to students outside of classroom hours	① ② ③ ④ ⑤
d.	are friendly	① ② ③ ④ ⑤
e.	expect everyone to act the same	① ② ③ ④ ⑤
f.	listen to me when I am troubled about something	① ② ③ ④ ⑤
g.	give me helpful feedback on papers, projects, and ideas	① ② ③ ④ ⑤
h.	support and encourage me	① ② ③ ④ ⑤
i.	show that they respect me	① ② ③ ④ ⑤
j.	show they care about me as an individual	① ② ③ ④ ⑤
k.	care whether I learn the course material	① ② ③ ④ ⑤

26. From your experience, engineering students at Rowan usually: *(Please indicate how true the following are for your experience. 1= not at all true, 2=somewhat untrue, 3=sometimes true and sometimes untrue, 4=somewhat true, 5=very true)*

a.	**are approachable**	① ② ③ ④ ⑤
b.	**are very competitive**	① ② ③ ④ ⑤
c.	**support and encourage each other**	① ② ③ ④ ⑤
d.	**are friendly**	① ② ③ ④ ⑤
e.	**help each other out on coursework, projects and ideas**	① ② ③ ④ ⑤
f.	**work harder than non-engineering students at Rowan**	① ② ③ ④ ⑤
g.	**are proud to be engineering students**	① ② ③ ④ ⑤
h.	**feel a sense of community in the Engineering College**	① ② ③ ④ ⑤
i.	**are highly regarded by non-engineers at Rowan**	① ② ③ ④ ⑤
j.	**mix in well with non-engineering students at Rowan**	① ② ③ ④ ⑤
k.	**listen to me when I am troubled about something**	① ② ③ ④ ⑤
l.	**show that they respect me**	① ② ③ ④ ⑤
m.	**show they care about me as an individual**	① ② ③ ④ ⑤

Satisfaction with Engineering

27. How satisfied are you with your major in engineering? *(Please indicate the extent to which you agree with the following statements.)*

		Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a.	**I am personally satisfied with my choice of a college major**	①	□	③	④	⑤
b.	**I have no desire to change to another major (biology, English, chemistry, art, history, etc.**	①	□	③	④	⑤
c.	**I can think of several other majors that would be more rewarding than engineering**	①	□	③	④	⑤
d.	**I am confident that engineering is the right major for me**	①	□	③	④	⑤
e.	**The advantages of studying engineering outweigh the disadvantages**	①	□	③	④	⑤
f.	**The future benefits of studying engineering are worth the effort**	①	□	③	④	⑤
g.	**If I could start over, I would again choose to go to Rowan for my engineering degree**	①	□	③	④	⑤

28. People enjoy or dislike different things about engineering. *(Please indicate the extent to which you agree with the following statements.)*

		Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a.	**I enjoy solving open-ended problems**	①	□	③	④	⑤
b.	**I enjoy problems that can be solved in different ways.**	①	□	③	④	⑤
c.	**I enjoy the subjects of science and mathematics the most.**	①	□	③	④	⑤
d.	**I enjoy laboratory work**	①	□	③	④	⑤
e.	**I enjoy working with computers.**	①	□	③	④	⑤
f.	**I like to reason mathematically.**	①	□	③	④	⑤
g.	**I like to trouble-shoot problems.**	①	□	③	④	⑤
h.	**I have a lot in common with other students in my department.**	①	□	③	④	⑤
i.	**I enjoy making presentations about my work.**	①	□	③	④	⑤

29. How satisfied are you with the following aspects of the Rowan engineering program? *(Please indicate the extent to which you agree or disagree with the following statements)*

		Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a.	Departmental advisors do a good job	①	□	③	④	⑤
b.	I can usually get the classes I need in the semester that I need them	①	□	③	④	⑤
c.	More lab experience would be worthwhile	①	□	③	④	⑤
d.	Expectations for lab work are explained well	①	□	③	④	⑤
e.	Lab work adds a lot to my understanding of course material	①	□	③	④	⑤
f.	Many of my classes are too large	①	□	③	④	⑤
g.	There are ample opportunities for students to do independent research at Rowan	①	□	③	④	⑤
h.	The grading system reflects students' knowledge and competency in the subject matter	①	□	③	④	⑤
i.	There are ample opportunities offered for student internships in engineering	①	□	③	④	⑤
j.	Engineering courses are intellectually challenging	①	□	③	④	⑤
k.	The workload for engineering students is too heavy and difficult	①	□	③	④	⑤
l.	The pace of learning in many of the required courses is too fast	①	□	③	④	⑤
m.	Too much group work is required in the engineering classes	①	□	③	④	⑤
n.	Not enough attention is given to different styles of learning in engineering classes	①	□	③	④	⑤
o.	Engineering professors expect students to have better developed computer skills than they actually have	①	□	③	④	⑤

30. Many things are said about the engineering clinics.
(Please indicate the extent to which you agree or disagree with the following statements about the clinic program.)

		Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a.	The clinic system provides realistic experiences like in the work world	①	□	③	④	⑤
b.	The clinic projects provide useful hands-on experience in engineering	①	□	③	④	⑤
c.	The interdisciplinary nature of the clinic system enables me to connect things from different discipline which I wouldn't have done without it	①	□	③	④	⑤
d.	Too much work is expected in the clinic courses for the amount of credit that is given	①	□	③	④	⑤
e.	The clinic setting serves to unify engineering students in the same class but from different majors	①	□	③	④	⑤
f.	The interdisciplinary nature of the engineering clinics means that a lot of time is spent learning material or approaches irrelevant to my major	①	□	③	④	⑤

31. What was your best course this year?

____

32. Which course did you least like this year?

____

Engineering Strengths

33. Students differ in terms of how well-suited they think they are to be an engineer. To what extent do you agree with the following statements about yourself?

		Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a.	I am well-suited for my choice of college major	①	□	③	④	⑤
b.	I consider myself mechanically inclined	①	□	③	④	⑤
c.	I am good at designing things	①	□	③	④	⑤
d.	I consider myself technically inclined.	①	□	③	④	⑤
e.	I am am well-suited for my chosen career	①	□	③	④	⑤

34. How would you rate yourself on each of the following traits as compared with the average engineering student in your class?

		Lowest 10%	Below average	Average	Above average	Highest 10%
a.	drive to achieve	①	□	③	④	⑤
b.	mathematical ability	①	□	③	④	⑤
c.	interest in science	①	□	③	④	⑤
d.	speaking skills	①	□	③	④	⑤
e.	writing skills	①	□	③	④	⑤
f.	test-taking	①	□	③	④	⑤
g.	problem-solving skills	①	□	③	④	⑤
h.	computer skills	①	□	③	④	⑤
i.	library skills	①	□	③	④	⑤
j.	study skills	①	□	③	④	⑤
k.	critical thinking	①	□	③	④	⑤
l.	overall academic ability	①	□	③	④	⑤

35. Have your abilities in any of the following increased or decreased during this academic year?

		Increased	Stayed the same	Decreased
a.	Mathematical ability	①	□	③
b.	Interest in science	①	□	③
c.	Speaking	①	□	③
d.	Writing	①	□	③
e.	Speaking	①	□	③
f.	Test taking	①	□	③
g.	Problem-solving skills	①	□	③
h.	Computer skills	①	□	③
i.	Library skills	①	□	③
j.	Study skills	①	□	③
k.	Critical thinking	①	□	③
l.	Overall academic ability	①	□	③

36. A number of different factors influence grades. When you consider your grades in engineering this academic year, how important were each of the factors listed below as contributions to your grades?

	Least important	Not so important	In the middle	Somewhat Important	Most important
a. My ability	①	□	③	④	⑤
b. How much effort I put in	①	□	③	④	⑤
c. Luck	①	□	③	④	⑤
d. Ease/difficulty of material	①	□	③	④	⑤
e. Quality of teaching	①	□	③	④	⑤
f. Amount of preparation	①	□	③	④	⑤

37. The statements listed below have been suggested as difficulties that especially women face in the pursuit of careers in science, mathematics, or engineering. Based on your observations and experiences, please indicate your opinions about these claims. Do you think these constitute no problem, minor problems, or serious problems for women?

	No problem	Minor problem	Serious problem
a. **Long years of formal preparation needed**	①	②	③
b. **Possible conflicts between career and family responsibilities**	①	②	③
c. **View that women majoring in science or technical fields are unfeminine**	①	②	③
d. **Less encouragement from teachers or counselors than male engineering students get**	①	②	③
e. **Less encouragement from family or friends than male engineering students get**	①	②	③
f. **Women's lack of confidence that they can handle the work**	①	②	③
g. **Lack of information about careers in scientific field**	①	②	③
h. **Lack of female role models in scientific fields**	①	②	③
i. **Women are not as competitive as science classes require**	①	②	③
j. **Discriminatory attitudes toward women on part of teachers or others in scientific fields generally**	①	②	③
k. **Discriminatory attitudes toward women on part of teachers or others in scientific fields at Rowan**	①	②	③

Future Expectations

38. How likely do you think you are to change majors before you graduate?

① Very unlikely
□ Not likely
③ Not sure
④ Possible
⑤ Very likely

39. What is the highest degree you expect to complete?

① B.A./B.S
□ M.A./M.S.
③ Ph.D.
④ Other (please specify)___________

40. How likely is it that you might transfer to an engineering program in another institution before completing your degree?

① Very unlikely
□ Not likely
③ Not sure
④ Possible
⑤ Very likely

41. How likely is it that you might drop out of the engineering program before earning a degree?

① Very unlikely
□ Not likely
③ Not sure
④ Possible
⑤ Very likely

42. Do you have any concern about your ability to finance your college education?

① I am confident that I will have sufficient funds
□ I will probably have enough funds
③ I am not sure I will have enough funds to complete college
④ I am seriously concerned about having enough funds to complete college

43. How likely is it that you will be working in an engineering-related field 10 years from now?

① Very unlikely
□ Not likely
③ Not sure
④ Possible
⑤ Very likely

44. People have different expectations of what a degree in Engineering will lead to. *(Please indicate the degree to which you agree or disagree with each of the following statements.)*

A degree in Science/Mathematics/Engineering will allow me to:

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
a. get a well-paying job	①	□	③	④	⑤
b. choose to live in any geographic location I want	①	□	③	④	⑤
c. get a job I like doing	①	□	③	④	⑤
d. be respected by others	①	□	③	④	⑤
e. get a job where I can use my talents	①	□	③	④	⑤
f. get a secure job throughout my adult life	①	□	③	④	⑤
g. get a challenging job	①	□	③	④	⑤
h. have time to devote to interests outside my job	①	□	③	④	⑤
i. get a job where I will associate with interesting people	①	□	③	④	⑤
j. be an important contributor to society	①	□	③	④	⑤

FOCUS GROUP INTERVIEW QUESTIONS

I. Opening questions

Tell [us] your name and how long you have been at Rowan.
When did you first become interested in engineering?
When did you decide to become an engineering major?
How did you learn of Rowan's engineering program?

II. Transition Questions

What made you decide to go into engineering? (or into your [specific major]?
Do you think girls decide to go into engineering for the same reason that boys do?

III. Key Questions (2-5)

How do you think being female has affected your experience as an engineering student?[List 3 ways you think your experience as an engineering student has been affected by being female.]

Reflecting on your experiences during the past academic year, to what extent were you at an advantage or disadvantage compared to male students in engineering?(especially with respect to: interacting with faculty, receiving attention of the type you wanted, relating to advisor, getting good grades, getting support from engineering faculty, classes, campus, dorms)

In the survey you filled out earlier in the year, more females than males indicated that gender discrimination was a problem for women at Rowan. What types of gender discrimination have you encountered or observed?[Have you heard any stories about ways in which men and women are treated differently at Rowan? Elsewhere?]

How do you think your career as an engineer will be affected by your gender?(Do you think it is easier for women to go into some fields of engineering than other fields? Do you think being a women improves or hinders your prospects of finding a job in engineering? A high paying job?)

IV. Ending questions

All things considered,
Would you encourage other women to major in engineering?

Suppose you could make one recommendation to the faculty and staff in the Engineering College, to improve the experience of female engineering students at Rowan. What would be your recommendation?
[Magic wand to make dream come true. Pass around. What would dream be?]

Of all the issues we have discussed today, which one stands out as most [important, difficult] for women in engineering at Rowan? in engineering in general?

[Summarize] *Have we missed anything? Is there anything that we should have talked about; but didn't*

Would you like to have another meeting like this [next semester] [before the end of the semester]?

FACULTY INTERVIEW QUESTIONS

1. Your background, how long at Rowan
2. What do you see as the major strengths, unique features of the program
3. Changes in the program over time (as key to cohort differences)
4. [Key courses to look at grades in]
5. Any sense of gender differences
    a. In qualifications
    b. In performance
    c. Any particularly good female students? Dropouts?
    d. In self-confidence, self-image
    e. In ambition, commitment
    f. In interaction
        i. In class
        ii. With faculty
        iii. With peers
    g. In attitudes toward, respect of
    h. Activities outside of class
        i. In engineering (e.g., professional societies)
        ii. Outside of engineering
    i. Any events in last few years indicative of gender discrimination?
    j. Do they come to you as female faculty for advice?
    k. Any special problems that female students face?
        i. Competitiveness?
        ii. Viewed as unfeminine?
        iii. Lack of support?

iv. Lack of role models? (as teachers, in industry)

v. Lack of appropriate career info?

vi. Combining family & career

vii. "Locker room" talk

viii. Discrimination in workplace, at Rowan

ix. "Old boy (white male) network"

6. Is Rowan doing all it should for female students?

   a. Is SWE a good thing?

   b. What about the special machining class that Eric Constans ran last year?

   c. Will female graduates be equipped to deal with "old boy (white male) network" in employment or other graduate programs?

7. Any gender issues among the faculty, do female faculty band together in any way?

8. Where do you see the program going in the future?

APPENDIX B

ENGINEERING SELF-CONFIDENCE FACTORS

The indices of engineering self-confidence were derived from a factor analysis of about 20 survey items related to self-confidence that the students were asked in the Fall survey. Items with low commonality were excluded. The remaining items and their loading on the four resulting factors are presented in Table Appendix B-1.

TABLE APPENDIX B-1
LOADINGS OF SURVEY ITEMS ON SELF-CONFIDENCE FACTORS AND % VARIANCE EXPLAINED BY EACH FACTOR

	SELF-CONFIDENCE FACTOR			
Survey Item	**CONF STAY ENG**	**CONF ENG ABIL**	**CONF COMM SKILL**	**CONF ACAD ABIL**
Engin right major for me	.839	.188		
Consider dropping out	.813			
Well suited for college major	.763	.271		.238
Well-suited for chosen career	.694	.452	.102	.143
Mechanically inclined		.836		
Technically inclined	.233	.827	.128	
Good at designing	.208	.786	.197	
Confidence in speaking skills			.869	
Highest 10% in communication skills			.787	.150
Confidence in writing skills		.116	.718	
Highest 10% in academic ability			.124	.865
Highest 10% in mathematical ability	.106		-.123	.848
Highest 10% in science interest	.263	.106	.164	.471
% variance explained	20.1	18.1	15.5	14.0

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

Statistical analysis showed that the factor structure of females and males is similar enough to compare scores of the different genders.