

**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<sup>14</sup>;
- 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;

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<sup>14</sup> 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.<sup>15</sup> 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

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<sup>15</sup> 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**

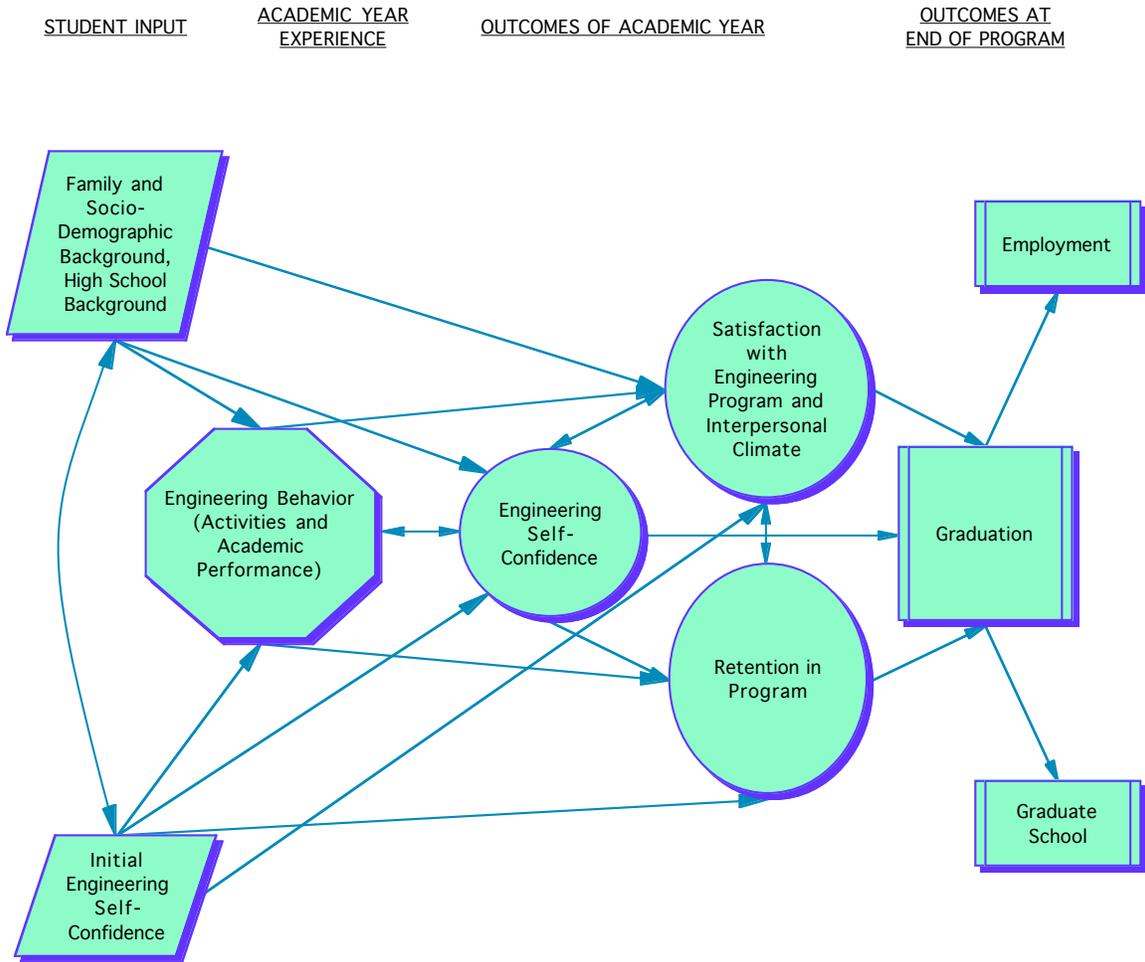
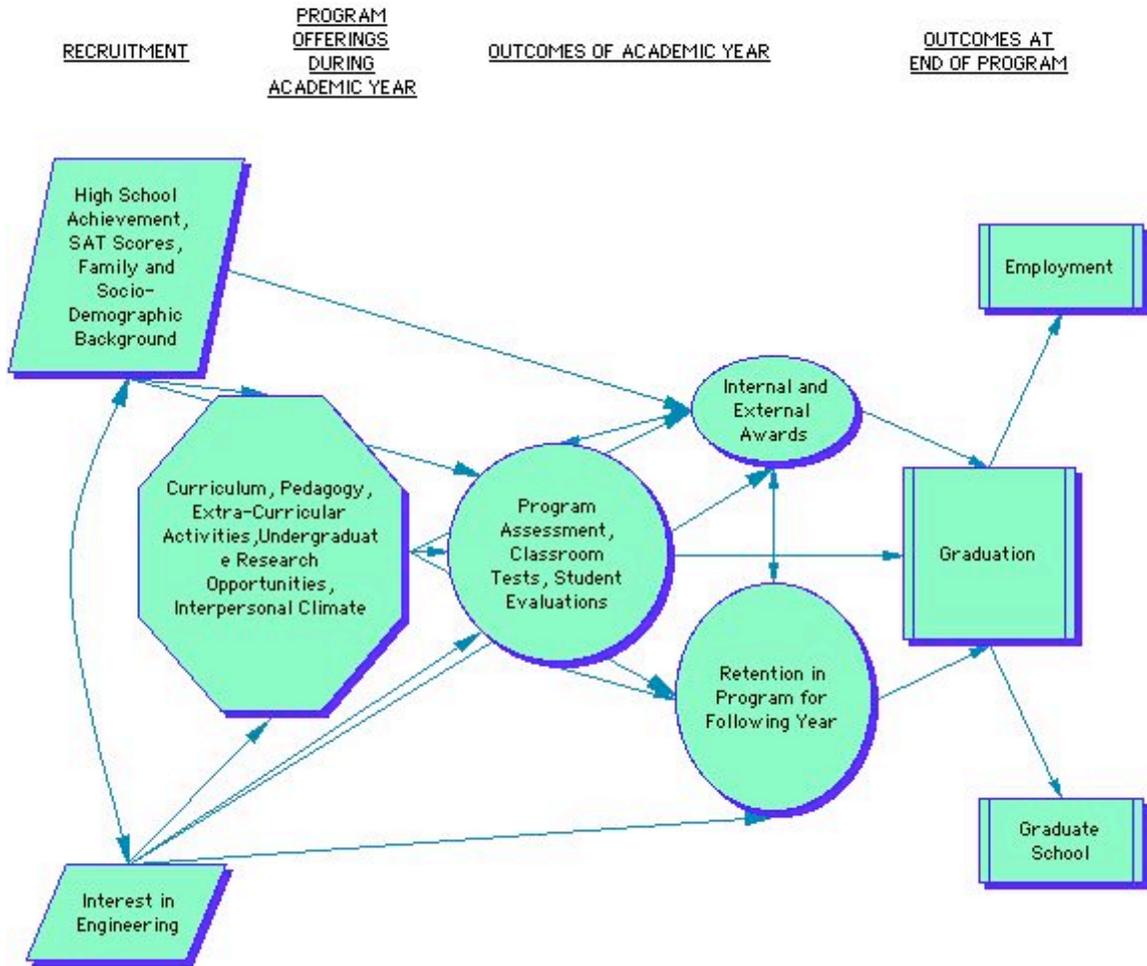


FIGURE IIA-2

**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.<sup>16</sup>

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

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<sup>16</sup> 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 ( $\lambda=20.1$ ).

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 ( $\lambda=18.1$ ).

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 ( $\lambda=15.5$ ).

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 ( $\lambda=14.0$ ).

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  $-0.356$  (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)**

<b>Self-Confidence Factor</b>	<b>First-Year Males</b>	<b>First-Year Females</b>	<b>Total First-Year Students</b>	<b>Students at All Levels</b>
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<sup>17</sup>, 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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<sup>17</sup> 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.<sup>18</sup>

### **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,

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<sup>18</sup> 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  $-\beta$ 's - in parentheses)*

<b>Independent Variable</b>	<b>Model 1</b>	<b>Model 2</b>
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 <sup>2</sup>	.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.<sup>19</sup>

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.

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<sup>19</sup> 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  $-\beta$ 's - in parentheses)*

<b>Year in Program Independent Variable</b>	<b>TOTAL</b>	<b>SOPHOMORES</b>	<b>JUNIORS</b>	<b>SENIORS</b>
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 <sup>2</sup>	.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  $-\beta$ 's - in parentheses)*

Independent Variable\Sex	Unstandardized Regression Coefficients (B's)		Standardized Regression Coefficients (B's )	
	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 <sup>2</sup>	.151	.271		

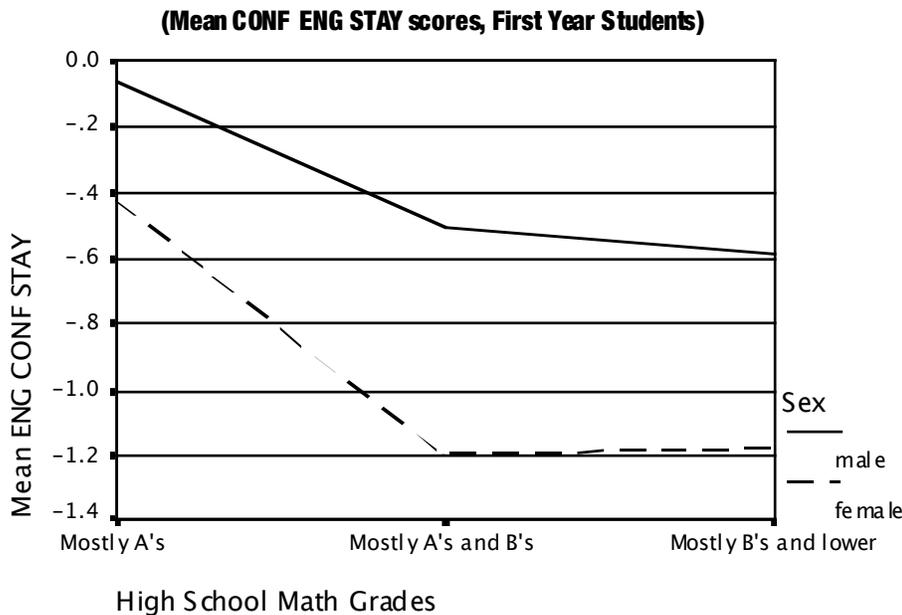
\*p<.05    \*\*p<.10

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**



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).<sup>20</sup> 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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<sup>20</sup> 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**

<b>Self-Confidence Indicator/Factor</b>	<b>MALES</b>	<b>FEMALES</b>
<b>CONF STAY ENG factor score (mean)***</b>	<b>.048</b>	<b>-.186</b>
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
<b>CONF ENG ABIL factor score (mean)****</b>	<b>.097</b>	<b>-.378</b>
Mechanically inclined (% strongly agreeing)**	36.3	16.7
Technically inclined (% strongly agreeing)**	34.5	20.0
<b>CONF ACAD ABIL factor score (mean)</b>	<b>-.029</b>	<b>.112</b>
Academic ability (% rating highest 10%)	25.2	25.0
Mathematical ability (% rating highest 10%)	34.5	27.9
<b>CONF COMM SKILL factor score (mean)</b>	<b>.046</b>	<b>-.144</b>
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)<sup>21</sup> and in their engineering grades specifically<sup>22</sup> (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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<sup>21</sup> Fall and Spring GPA's are taken from official transcripts of the students' grades.

<sup>22</sup> 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)*

<b>Dependent Variable Independent Variable</b>	<b>Fall 2000 GPA</b>	<b>Engineering GPA</b>	<b>Spring 2001 GPA</b>
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 <sup>2</sup>	.280	.287	.124

\*p&lt;.05 \*\*p&lt;.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)*

<b>Independent Variable</b>	<b>Total</b>	<b>Males</b>	<b>Females</b>
Father's Education	-.001(-.004)	-.005 (-.024)	.051 (.184)
Mother's Education	-.002 (-.077)	-.002 (-.070)	-.006 (-.195)
Prestige of Father's Occupation	-.000(-.016)	.000 (.005)	-.003 (-.087)
Siblings College-Educated	.074 (.074)	.038 (.038)	.093 (.097)
Support Index	-.034 (-.120)	-.033 (-.115)	-.035 (-.131)
High School Science Grade	.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-Curricular 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 <sup>2</sup>	.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
<b>Mean GPA, Spring 2001 (overall)</b>					
<b>Males</b>	<b>3.06</b>	<b>3.11</b>	<b>3.14</b>	<b>3.14</b>	<b>3.27</b>
<b>Females</b>	<b>3.25</b>	<b>3.30</b>	<b>3.50*</b>	<b>3.15</b>	<b>3.57*</b>
<b>Mean GPA (Engineering)<sup>a</sup></b>					
<b>Males</b>	<b>3.41</b>	<b>3.59</b>	<b>3.24</b>	<b>3.31</b>	<b>3.44</b>
<b>Females</b>	<b>3.50</b>	<b>3.64</b>	<b>3.56*</b>	<b>3.13</b>	<b>3.57</b>
<b>% 4.0 GPA (Engineering)<sup>a</sup></b>					
<b>Males</b>	<b>16.7</b>	<b>49.1</b>	<b>2.0</b>	<b>2.0</b>	<b>5.0</b>
<b>Females</b>	<b>26.8*</b>	<b>50.0</b>	<b>11.8</b>	<b>18.2*</b>	<b>9.1</b>
<b>% Dean's List, Spring 2001</b>					
<b>Males</b>	<b>31.3</b>	<b>32.3</b>	<b>20.6</b>	<b>40.3</b>	<b>43.2</b>
<b>Females</b>	<b>42.9*</b>	<b>42.9</b>	<b>40.0**</b>	<b>46.2</b>	<b>38.5</b>

<sup>a</sup>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 <sup>a</sup>)

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

<sup>a</sup>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<sup>23</sup> 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

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<sup>23</sup> 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**

	<b>Enrichment Activity</b>	<b>Help Activity</b>
<b>With engineering community beyond Rowan</b>	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 <sup>1</sup> )
<b>With faculty or advisor at Rowan</b>	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
<b>With other students</b>	Residence with other science, engineering, math students	Participation in study group Peer mentoring Tutoring or being tutored <sup>1</sup>

<sup>1</sup>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<sup>24</sup> resulting in three factors of involvement:

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<sup>24</sup> 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)

	<b>ACTACAD</b>	<b>ACTCOUNS</b>	<b>ACTSTUDY</b>
<b>First-year</b>	-.448	-.423	-.004
<b>Sophomore</b>	-.099	-.143	.056
<b>Junior</b>	.324	.338	-.036
<b>Senior</b>	.470	.478	-.033
<b>Total</b>	.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)*

<b>Dependent Variable</b> <b>Independent Variable</b>	<b>ACTACAD</b>	<b>ACTCOUNS</b>	<b>ACTSTUDY</b>
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 <sup>2</sup>	.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)

Dependent Variable Independent Variable	Total			Males			Females		
	ACTACAD	ACTCOUNS	ACTSTUDY	ACTACAD	ACTCOUNS	ACTSTUDY	ACTACAD	ACTCOUNS	ACTSTUDY
<b>Father's Education</b>	.016 (.028)	-.049 (-.091)	.029 (.054)	-.009 (-.016)	-.046 (-.043)	.035 (.064)	.006 (.009)	<b>-.142(.359)**</b>	.131 (.291)
<b>Mother's Education</b>	.041 (.068)	-.010 (-.017)	.004 (.007)	.040 (.066)	-.011 (-.017)	.012 (.020)	-.011 (-.017)	.025 (.058)	-.051 (-.103)
<b>Prestige of Father's Occupation</b>	.007 (.094)	<b>.016 (.214)</b>	.005 (.061)	.008 (.108)	<b>.014 (.175)</b>	.005(.062)	.006 (.076)	<b>.029 (.520)</b>	-.003 (-.047)
<b>Siblings College-Educated</b>	<b>-.261 (-.124)**</b>	.172 (.086)	-.121 (-.061)	-.183 (-.089)	.055 (.026)	<b>-.297(.143)**</b>	<b>-.639(-.286)**</b>	<b>.494 (.339)*</b>	<b>.530 (.321)**</b>
<b>Support Index</b>	<b>-.079 (-.142)**</b>	.027 (.052)	<b>.145 (.276)*</b>	<b>-.097(-.180)*</b>	.042 (.075)	<b>.150 (.277)*</b>	-.029 (-.049)	-.023 (-.058)	<b>-.144(-.323)**</b>
<b>High School Science Grades</b>	.074 (.041)	-.059 (.035)	.148 (.087)	.087 (.051)	-.064 (-.036)	.101 (.058)	.468 (.228)	-.113 (-.084)	-.048 (-.032)
<b>High School Math Grades</b>	.018 (.011)	-.071 (-.045)	.032 (.020)	-.107 (-.173)	-.057 (-.036)	.191 (.012)	-.401 (-.180)	-.349 (-.240)	.502 (.369)
<b>Verbal SAT score</b>	.000 (.013)	-.000 (-.031)	.000 (.013)	.000 (.018)	-.001 (-.048)	.000 (.001)	-.003 (-.141)	.002(.145)	.004 (.272)
<b>Math SAT score</b>	-.002 (-.098)	.001 (.047)	-.001 (-.030)	-.001 (-.045)	.001 (.035)	-.001 (-.047)	-.003 (-.128)	.001 (.084)	-.003 (-.185)
<b>High School Extra-Curricular SEM Activities</b>	<b>.103 (.159)*</b>	<b>.080(.131)**</b>	<b>.123 (.203) *</b>	.054 (.089)	.054 (.085)	<b>.146 (.238)*</b>	<b>.264(.336)**</b>	<b>.359 (.700)*</b>	-.050 (-.086)
<b>CONF STAY ENG</b>	<b>.257 (.239)*</b>	.097 (.096)	-.075 (-.075)	<b>.297 (.263)*</b>	.169 (.145)	-.063 (-.056)	.189 (.195)	-.077 (-.122)	-.007 (-.010)
<b>CONF ENG ABIL</b>	.028 (.028)	-.057 (-.060)	<b>-.176 (-.187)*</b>	.065 (.066)	-.076 (-.074)	<b>-.153(-.154)**</b>	-.060 (-.056)	-.020 (-.029)	<b>-.221(.281)**</b>
<b>Multiple R</b>	.347	.275	.423	.338	.261	.411	.546	.762	.681
<b>R<sup>2</sup></b>	.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<sup>25</sup> 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).

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<sup>25</sup> 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)

<b>Gender</b>	<b>Male</b>	<b>Female</b>
<b>Enrichment activity</b>		
% read engineering listserv or newsletter	72.6	<b>81.2</b>
% heard engineering speaker outside of class	71.1	<b>87.2*</b>
% went on engineering field trip	49.8	<b>64.1</b>
% had engineering internship during summer and/or academic year	33.3	<b>37.5</b>
% participated in student chapter of professional organization <sup>a</sup>	60.9	74.6
% member of student chapter of professional organization <sup>a</sup>	48.8	63.4
% officer of student chapter of professional organization <sup>a</sup>	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  $p < .05$ .

<sup>a</sup> 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**

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

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

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

	<b>Males</b>	<b>Females</b>	<b>Total</b>
<b>Help Activity During Academic Year</b>			
% who visited faculty outside classroom	96.4	<b>97.7</b>	96.7
% who talked to faculty about coursework	96.4	<b>99.2</b>	97.0
% who talked to faculty about courses to take	77.4	<b>85.0</b>	78.9
% who talked to faculty about career	65.9	<b>67.2</b>	66.2
% who talked to faculty about personal concerns	45.7	<b>47.2</b>	46.0
% met academic advisor at least once a semester	76.3	<b>84.4*</b>	77.6
% received career counseling at least once a semester	<b>29.8</b>	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	Males	Females
<b>Help Activity with Other Students</b>		
% participated in study group once a week or more	57.7	<b>68.8</b>
% tutored another student at least once a semester	28.9	<b>43.7*</b>
% received tutoring at least once a semester	26.3	<b>40.6*</b>
% received peer mentoring at least once a semester	<b>22.8</b>	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.

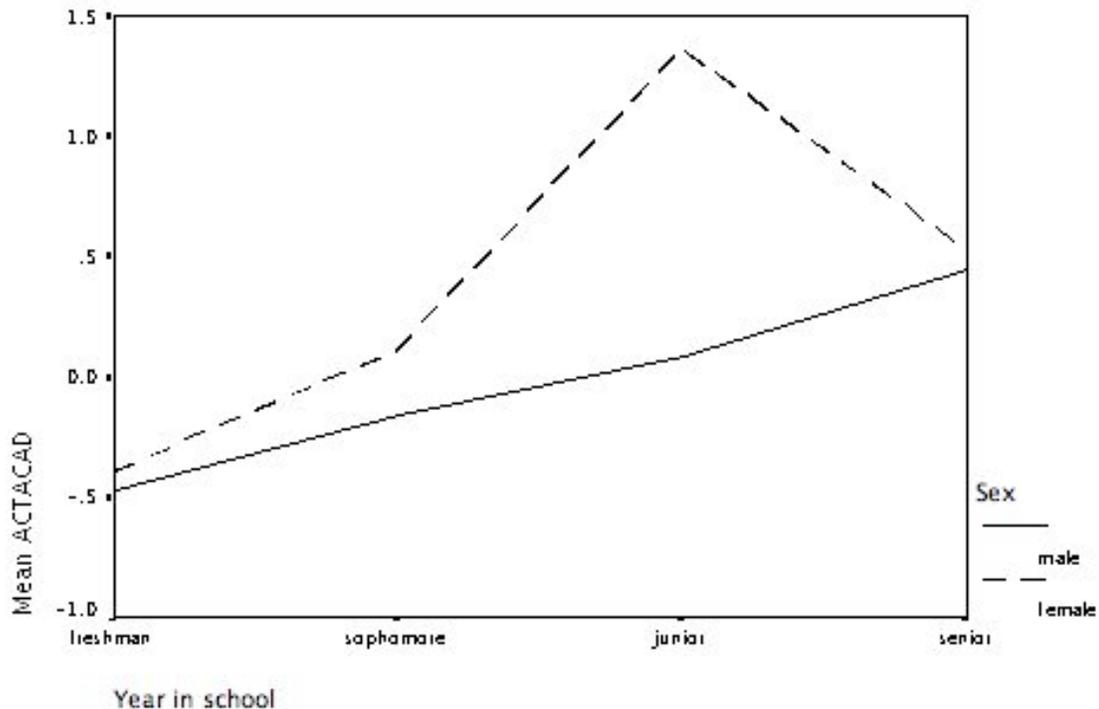
#### **VARIATION IN LEVEL OF ACTIVITY BY YEAR IN PROGRAM**

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.

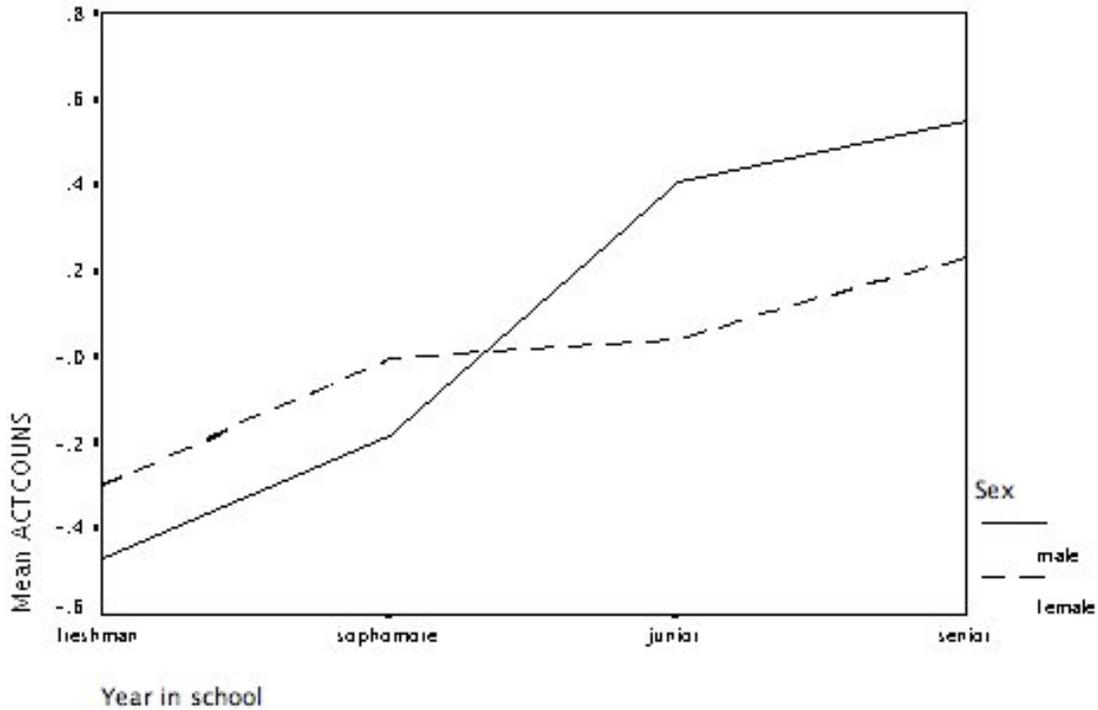
FIGURE IIC-1  
ACADEMIC ACTIVITIES BY GENDER AND YEAR IN SCHOOL  
(Mean ACTACAD)



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

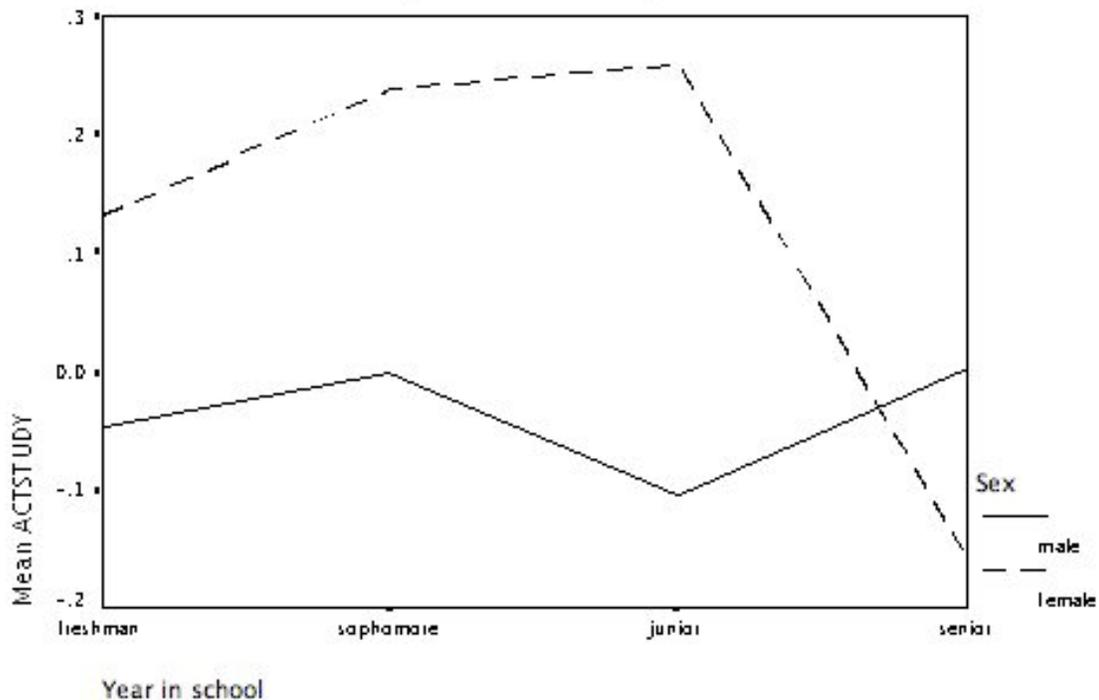
primarily the male's career counseling and peer mentoring which is greater than the females at the junior and senior levels.

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).

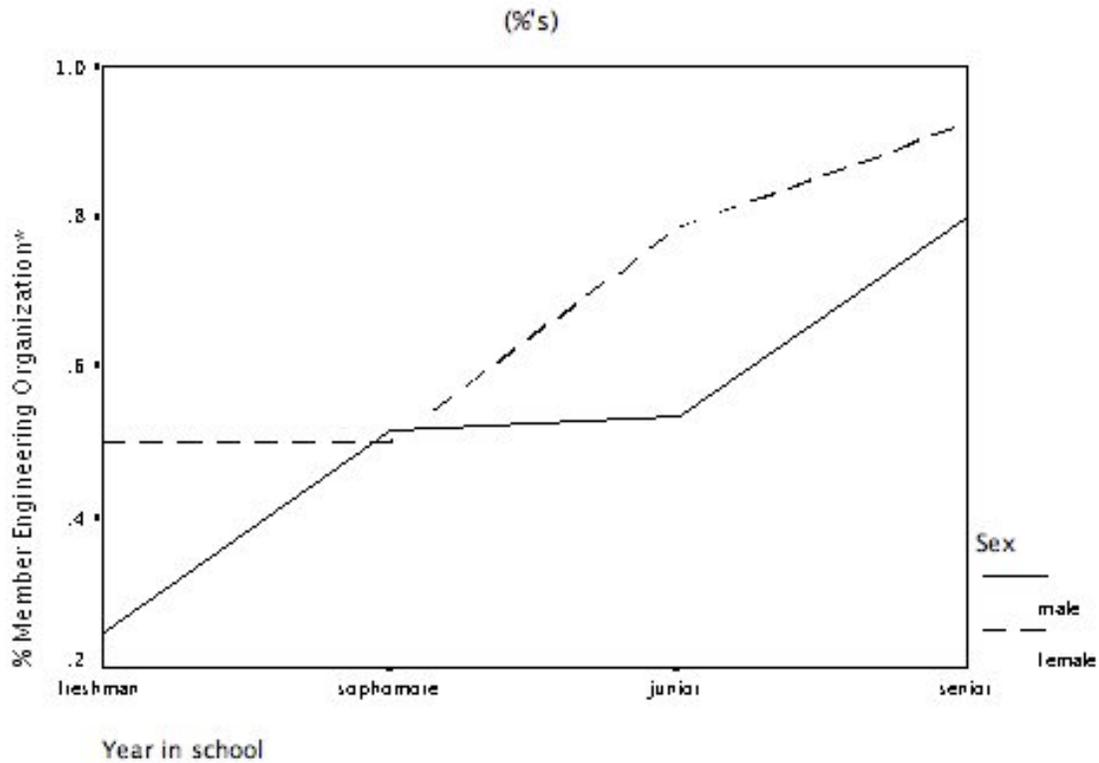
FIGURE IIC-3  
 STUDY ACTIVITIES BY GENDER AND YEAR IN SCHOOL  
 (Mean ACTSTUDY)



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.

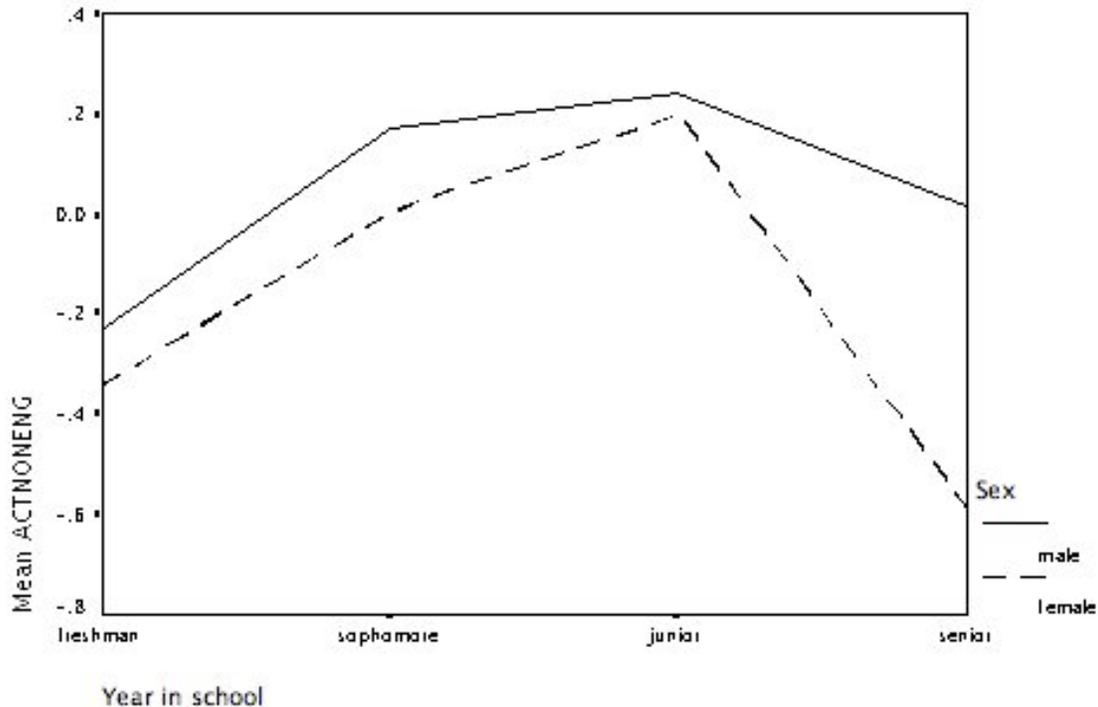
Looking at organizational membership (Figure IIC-4), we see that the level of membership is higher for upper division than lower division students, and highest for senior students. Females are more involved in the professional organizations in every year except sophomore. As for the other enrichment 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



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 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)

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

<b>Organizational Membership</b>	<b>Mean GPA Fall 00</b>	<b>Mean GPA Spring 01</b>
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.<sup>26</sup>

### **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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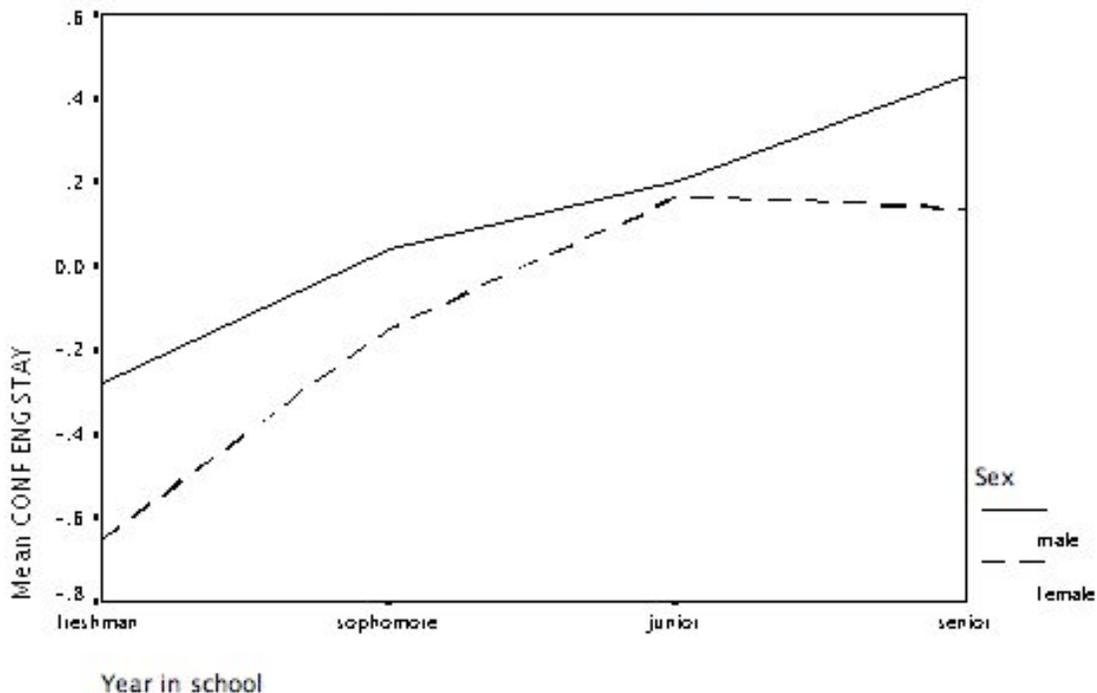
<sup>26</sup> In this report we present only within-year changes. The change will be followed year to year with a longitudinal study, currently in progress.

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

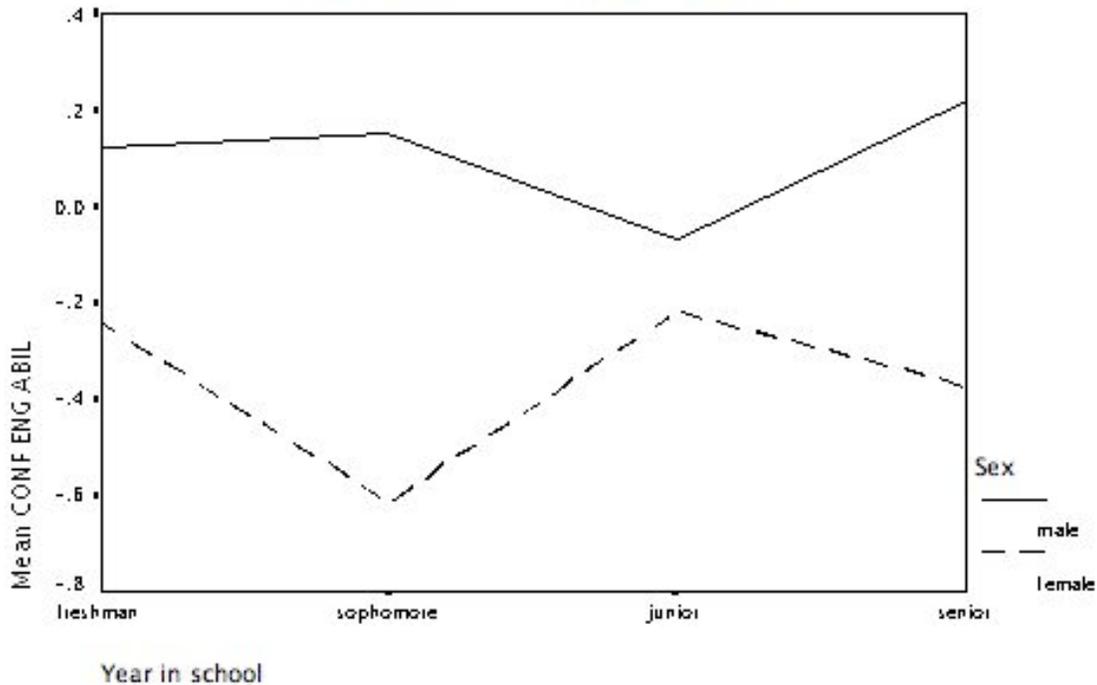
will stay in engineering is narrower for sophomores than for first-year students, and practically non-existent for juniors. That females start out with less self-confidence than males is similar to findings in previous studies (Dresselhaus, 1985; McIlwee and Robinson, 1992); what is notable is the narrowing 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.<sup>27</sup>



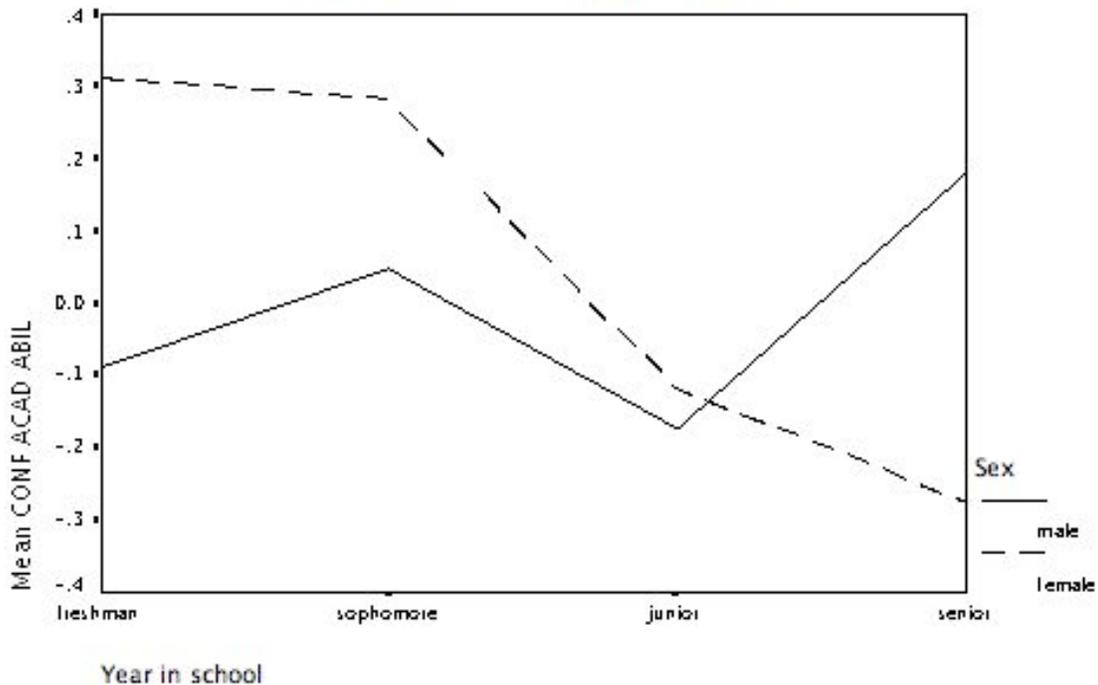
**Confidence in Academic Ability**

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

<sup>27</sup> 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.

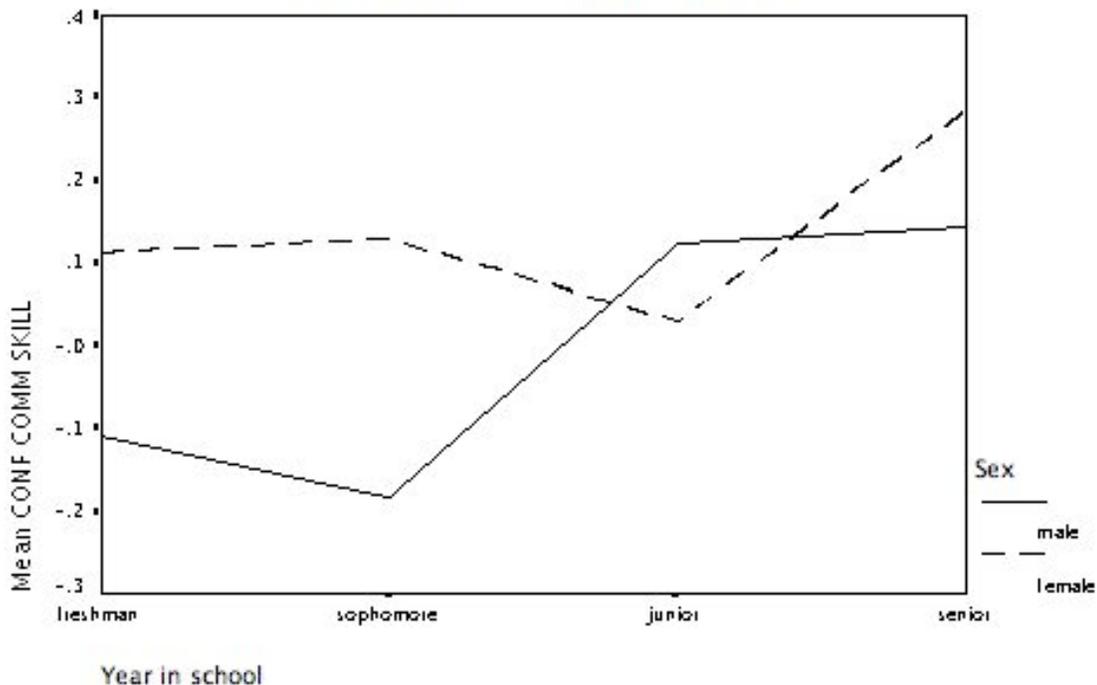
**FIGURE IID-4**  
**CONFIDENCE IN ACADEMIC ABILITY**  
**BY GENDER AND YEAR IN SCHOOL**



### **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)

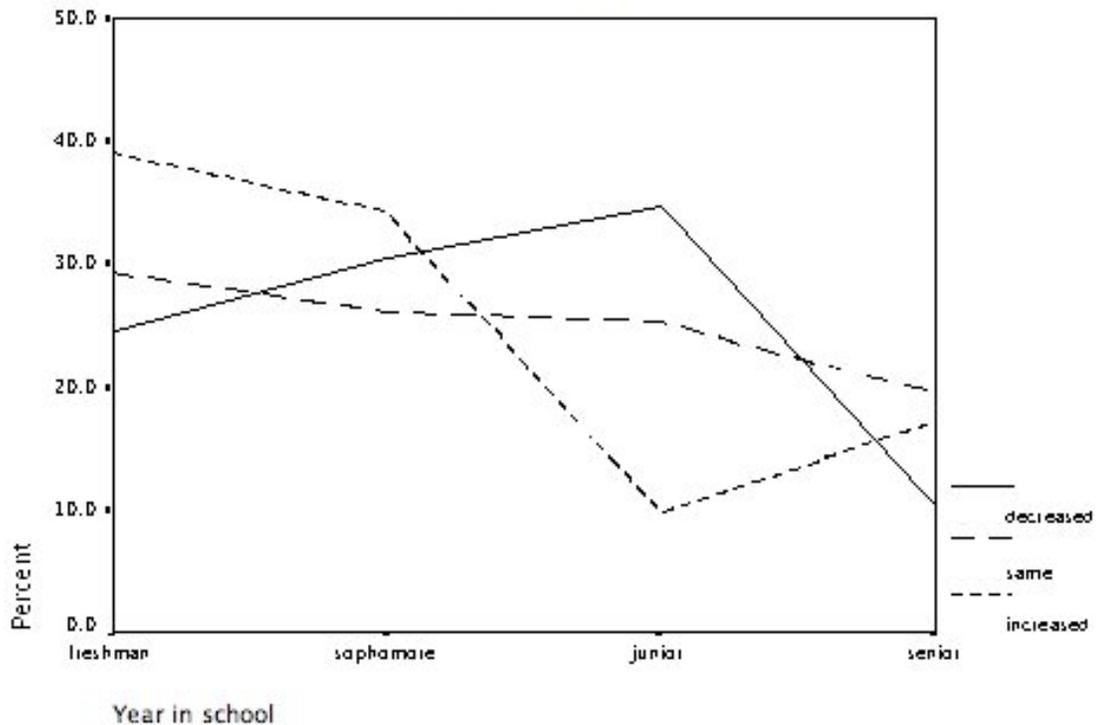
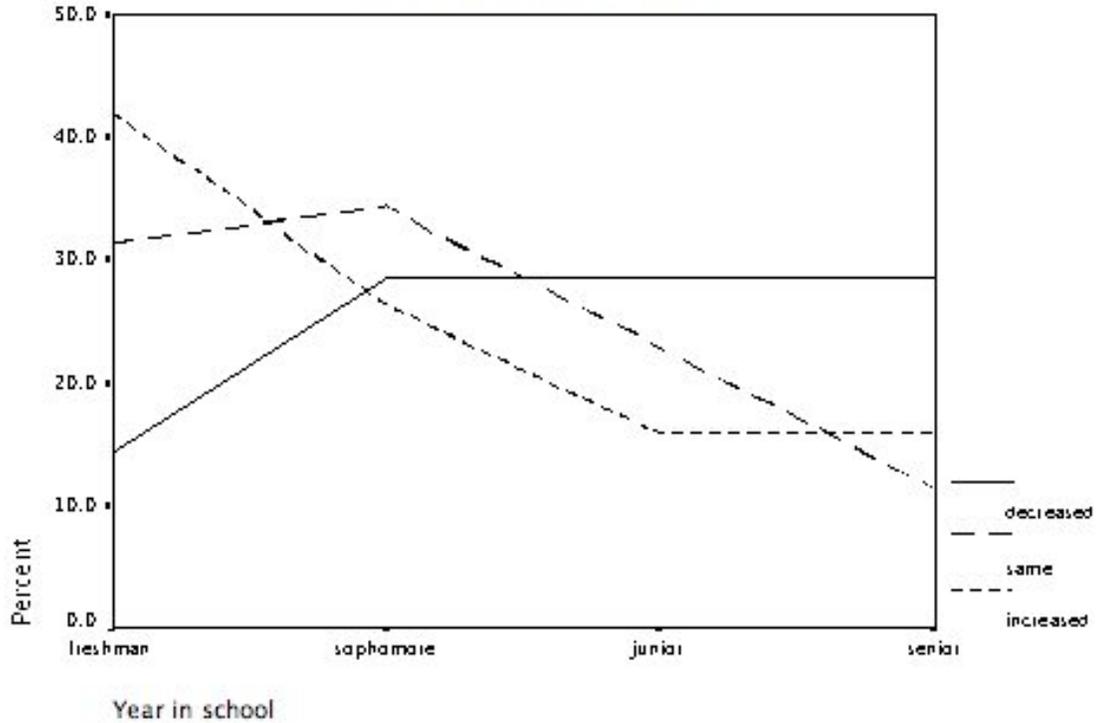


FIGURE IID-7  
 CHANGE IN CONFIDENCE ABOUT MAJOR FROM FALL TO SPRING  
 BY YEAR IN SCHOOL (Females)



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.

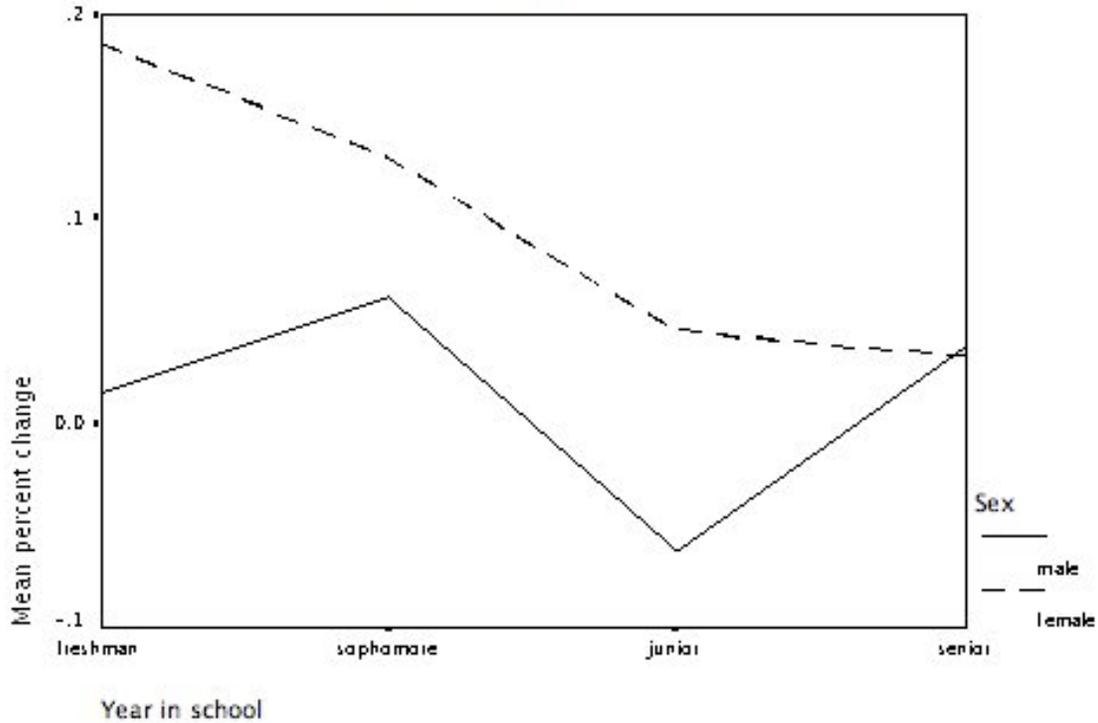
Similarly, for junior females, a higher proportion lose confidence during the course of the year than increase self-confidence.

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.

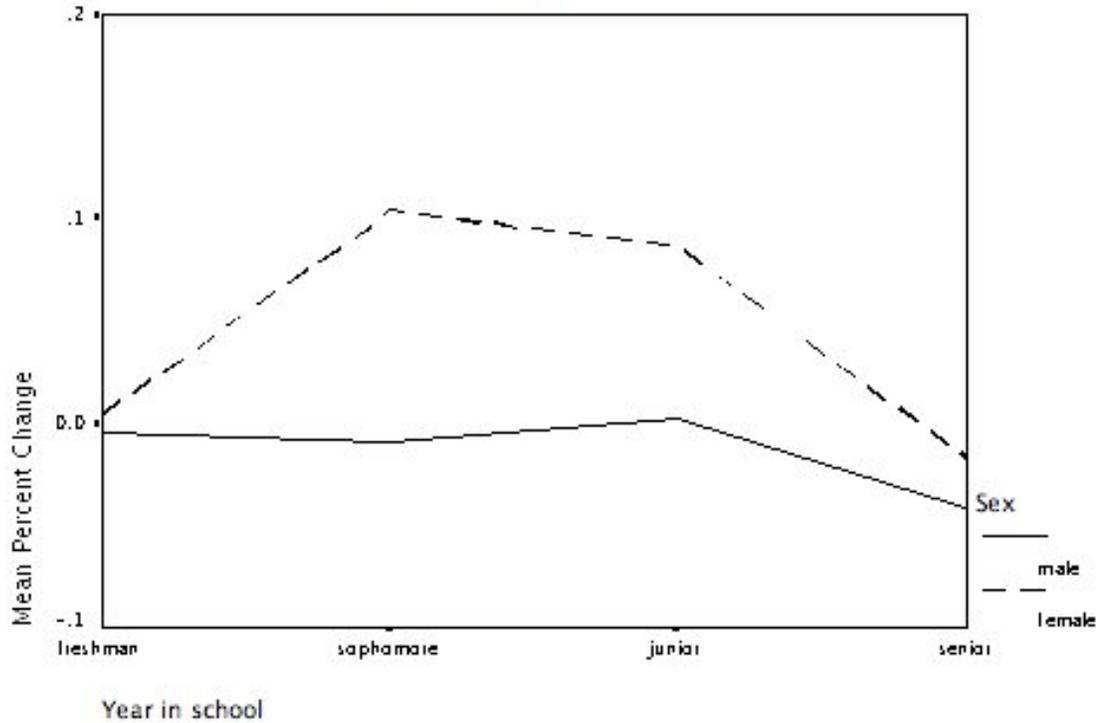
FIGURE IID-8  
 PERCENT CHANGE IN ENGINEERING SELF-CONFIDENCE ABOUT MAJOR  
 BY GENDER AND YEAR IN SCHOOL



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
<i>% Increased Self-Confidence</i>		
Total	21.9	19.4
Male	19.2	18.4
Female	31.1	23.0
<i>% Self-Confidence Stayed Same</i>		
Total	57.7	57.9
Male	57.7	56.6
Female	57.4	62.3
<i>% Decreased Self-Confidence</i>		
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 III-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 <sup>a</sup>
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

<sup>a</sup>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<sup>a</sup>**

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	<b>.008</b>	<b>61.0</b>	Na
Females	Decreased	.404	-.491	-.179	.049	85.7	29.6
	Same	.120	<b>.090</b>	.135	-.207	60.0	36.4
	Increased	<b>.471</b>	<b>-.076</b>	<b>.172</b>	-.152	68.4	<b>44.5</b>

<sup>a</sup>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<sup>a</sup>**

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	<b>.036</b>	<b>.232</b>	<b>-.117</b>	58.5	na
Females	Decreased	.056	.031	-.014	-.155	64.3	64.3
	Same	<b>.349</b>	-.146	.076	-.092	66.7	29.1
	Increased	<b>.264</b>	<b>.192</b>	<b>.321</b>	<b>-.342</b>	64.3	30.8

<sup>a</sup>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**

<b>Change from Fall to Spring in Self-Confidence “Engineering is right major for me.”</b>	<b>Males</b>	<b>Females</b>
<b>Decreased</b>	3.21	3.51
<b>Same</b>	3.43	3.50
<b>Increased</b>	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**

<b>Change from Fall to Spring in Self-Confidence that “I am mechanically inclined.”</b>	<b>Males</b>	<b>Females</b>
<b>Decreased</b>	3.23.	3.43
<b>Same</b>	3.47	3.47
<b>Increased</b>	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.<sup>28</sup> 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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<sup>28</sup> 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 IIIH). 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.<sup>29</sup> 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.

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<sup>29</sup> 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<sup>30</sup>. 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)***

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<sup>30</sup> 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.”

### ***III.E. 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:**

#### ***III.A. 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.”

#### ***III.B. 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 IIIH, 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<sup>31</sup>, 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.

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<sup>31</sup> 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
<b>I can...get classes I need in semester I need them</b>	78.3	86.5	86.3	100.0	87.0
<b>Advisors do a good job</b>	79.5	70.5	78.9	75.4	76.0
<b>There are ample opportunities for students to do independent research at Rowan</b>	30.1	41.0	46.3	64.9	43.8
<b>SATCHOIC (mean score)</b>	-.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<sup>32</sup>; 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).

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<sup>32</sup> 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”)*

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

Family characteristic	Year in School:	First Year		Students of All Levels	
	Satisfaction Factor:	SATCHOIC	SATCLASS	SATCHOIC	SATCLASS
<b>Father's Ed</b>	College ed	-.29	.50*	-.04	.12
	Less than college	-.39	.20	.04	-.02
<b>Mother's Education</b>	College ed	-.33	.38	.00	.10
	Less than college	-.36	.33	-.02	.02
<b>Sibling's Education</b>	College ed	-.40	.20	.04	.00
	Not college ed	-.33	.44	-.07	.13
<b>Father's occupation</b>	Sciences/engineering	-.81*	.45	-.04	.25**
	Other	-.25	.34	-.01	.00
<b>Support for Engineering Pursuit</b>	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.<sup>33</sup>: 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	
		SATCHOIC	SATCLASS	SATCHOIC	SATCLASS
<b>High School Background</b>	<b>Satisfaction Factor:</b>				
<b>High school math and science grades</b>	Mostly A's and B's	-.277	.588*	.076	.132
	Mostly B's or lower	-.387	-.198	-.059	-.004
<b>Extra-Curricular math and Science Activities</b>	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

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<sup>33</sup> 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<sup>2</sup> 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.<sup>34</sup>

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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<sup>34</sup> 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,  $\beta$ 's, in parentheses)*

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

Year in School Satisfaction Item	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).<sup>35</sup>

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<sup>35</sup> 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)*

Satisfaction Factor		SATLAB	SATTEAM	SATCLINIC
<b>Father's Education</b>	College ed	-.079	-.020	-.083
	Less than college	-.000	.008	.049
<b>Mother's Education</b>	College ed	-.096	-.061	-.096
	Less than college	.031	-.068	.031
<b>Sibling's Education</b>	College ed	-.062	.012	-.083
	Not college ed	.024	-.030	.053
<b>Father's occupation</b>	Sciences/ engineering	.020	.043	-.150
	Other	-.045	-.019	.013
<b>Support for Engineering Pursuit</b>	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)*

	<b>Year in School:</b>	<b>First Year</b>			<b>Students of all Levels</b>		
<b>High School Background</b>	<b>Satisfaction Factor:</b>	SATLAB	SATTEAM	SATCLINIC	SATLAB	SATTEAM	SATCLINIC
<b>High school math and science grades</b>	Mostly A's and B's	.189	.052	-.317	-.069	.001	.004
	Mostly B's or lower	.142	-.073	-.105	-.004	-.011	-.035
<b>Extra-Curricular math and Science Activities</b>	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**

<b>Dependent Variable</b>	<b>Multiple R</b>	<b>R<sup>2</sup></b>
<b>SATLAB</b>	.308	.095
<b>SATTEAM</b>	.225	.051
<b>SATCLINIC</b>	.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,  $\beta$ 's, in parentheses)*

Dependent Variable Independent Variable	SATTEAM	SATCLIN	SATLAB
ACTACAD	<b>.129</b> (.069)**	.040 (.039)	-.022 (-.023)
ACTCOUNS	<b>.204</b> (.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 <sup>2</sup>	.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”)

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

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

	<b>Year in School:</b>	<b>First Year</b>		<b>Students of all Levels</b>	
<b>High School Background</b>	<b>Satisfaction Factor:</b>	<b>SATFAC</b>	<b>SATPEERS</b>	<b>SATFAC</b>	<b>SATPEERS</b>
<b>High school math and science grades</b>	Mostly A's and B's	.373	.044	.031	.056
	Mostly B's or lower	.180	-.217	-.034	-.019
<b>Extra-Curricular Math and Science Activities</b>	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<sup>2</sup> 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,  $\beta$ 's, in parentheses)*

Dependent Variable: Independent Variable:	First Year Students		Students at All Levels	
	SATFAC	SATPEERS	SATFAC	SATPEERS
ACTACAD	-.122 (-.085)	<b>.323</b> <b>(.256)*</b>	-.046 (-.046)	.203 (.215)
ACTCOUNS	.253 (.141)	<b>.482</b> <b>(.311)*</b>	<b>-.129</b> <b>(-.126)**</b>	.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 <sup>2</sup>	.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
<i>SATISFACTION FACTOR:</i>		
<b>SATCHOIC</b>	<b>.210**</b>	.046
<b>SATCLASS</b>	<b>.182**</b>	-.041
<b>SATLAB</b>	<b>.112**</b>	.070
<b>SATTEAM</b>	<b>.122*</b>	.000
<b>SATCLIN</b>	.017	.056
<b>SATFAC</b>	-.018	-.022
<b>SATPEERS</b>	<b>.319*</b>	.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)*

Satisfaction Factor:	Change in Self-Confidence that “Engineering Right Major for Me”			Change in Self-Confidence in Mechanical Abilities		
	Decreased	Same	Increased	Decreased	Same	Increased
<b>SATCHOIC</b>	<b>-.244</b>	-.018	.204	<b>-.143</b>	.028	.041
<b>SATCLASS</b>	<b>-.115</b>	.161	.080	.118	.071	.113
<b>SATTEAM</b>	<b>-.151</b>	.029	-.034	<b>-.084</b>	-.027	.055
<b>SATCLINIC</b>	.102	-.090	.038	<b>-.203</b>	.031	-.009
<b>SATLAB</b>	<b>-.367</b>	.048	.010	<b>-.292</b>	.035	.012
<b>SATFAC</b>	-.039	-.032	-.037	.082	-.010	-.280
<b>SATPEERS</b>	<b>-.216</b>	.025	.145	<b>-.119</b>	-.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
<b>Programmatic Issues:</b> SATCLASS**	-.051	.181
SATCHOICE*	.071	.253
<b>Program Applications:</b> SATLAB	.021	.086
SATTEAM*	-.066	.230
SATCLINIC**	.018	.188
<b>Interpersonal Climate:</b> 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.<sup>36</sup>

**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.

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<sup>36</sup> 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”)*

	<b>Total</b>	<b>Male</b>	<b>Female</b>
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”)*

	<b>Total</b>	<b>Male</b>	<b>Female</b>
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”)*

	<b>Total</b>	<b>Males</b>	<b>Females</b>
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”)*

	<b>Total</b>	<b>Males</b>	<b>Females</b>
% “agree” and “strongly agree” that peers usually:			
Are approachable	32.6	29.6	<b>43.3</b>
Support and encourage each other	28.9	27.4	<b>34.3</b>
Are friendly	32.5	29.9	<b>41.8</b>
Listen to me when I am troubled	16.7	16.0	<b>19.4</b>
Help each other on coursework projects, ideas	45.0	40.0	<b>62.7</b>
Respect me*	23.4	21.2	<b>31.3</b>
Care about me as individual	21.1	20.3	<b>23.9</b>
Feel sense of community in Engineering College*	54.8	50.0	<b>71.6</b>
Are proud to be engineering students	57.7	53.3	<b>73.1</b>
	(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.<sup>37</sup>

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<sup>37</sup> 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 of SATCLASS Factor)

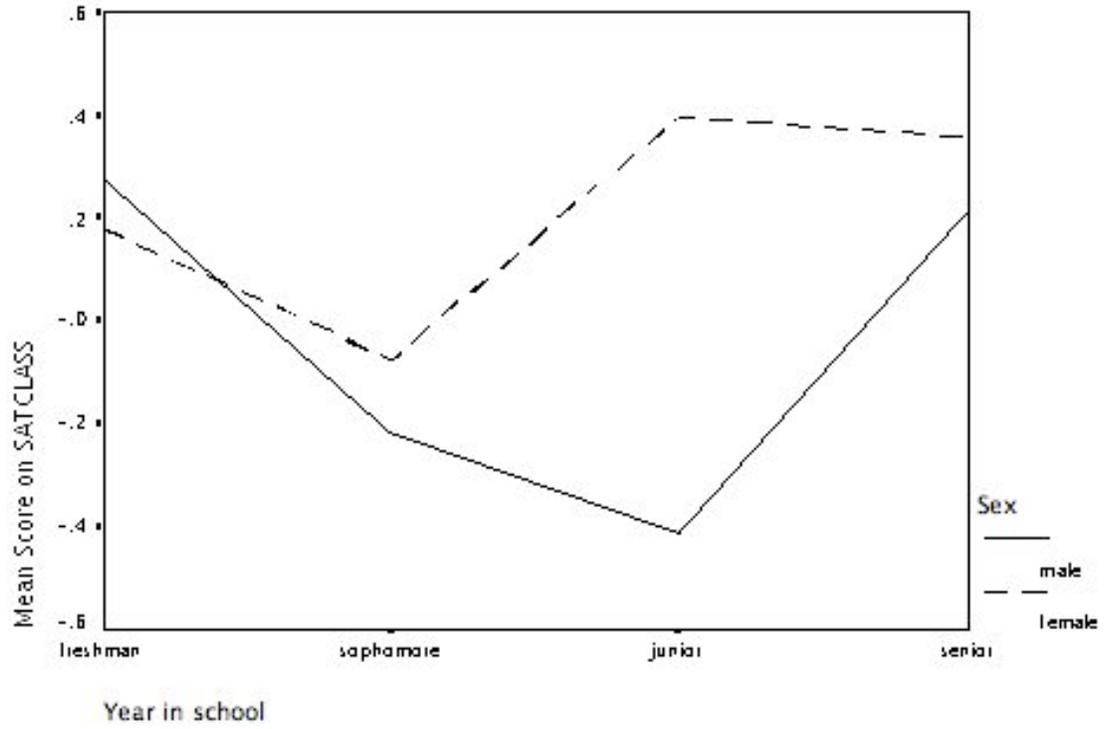
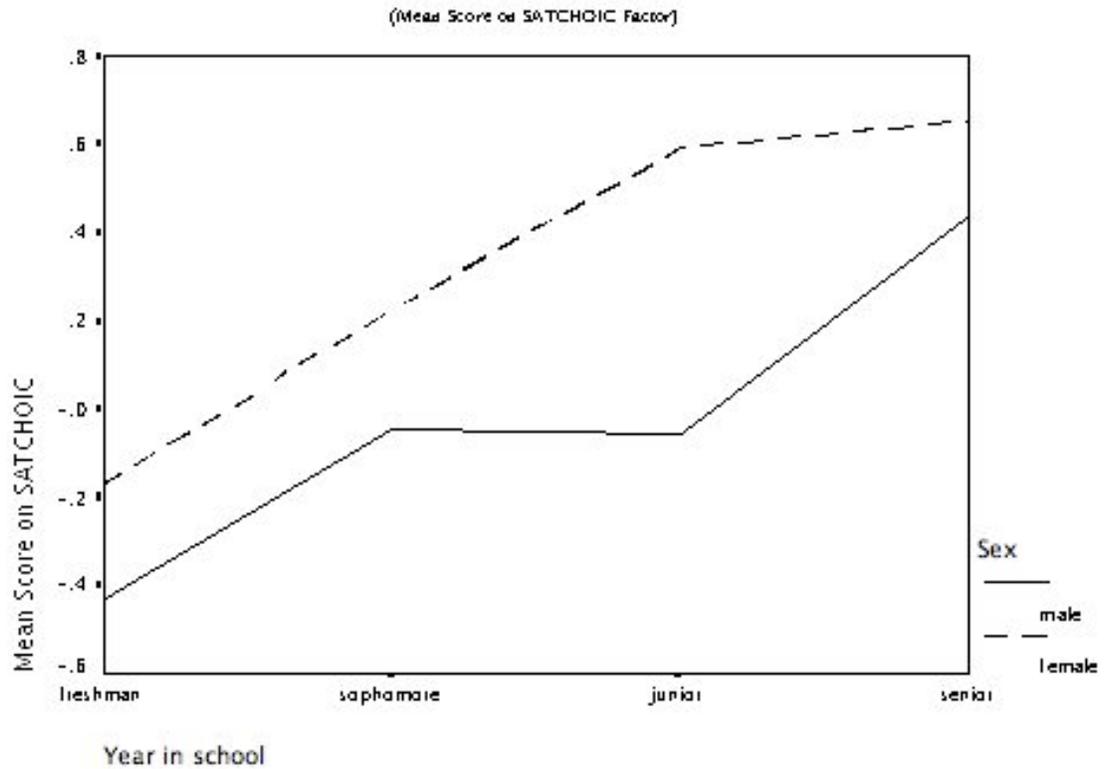


FIGURE IIE-2

SATISFACTION WITH OPPORTUNITIES BY GENDER AND YEAR IN SCHOOL



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

**a. SATLAB**

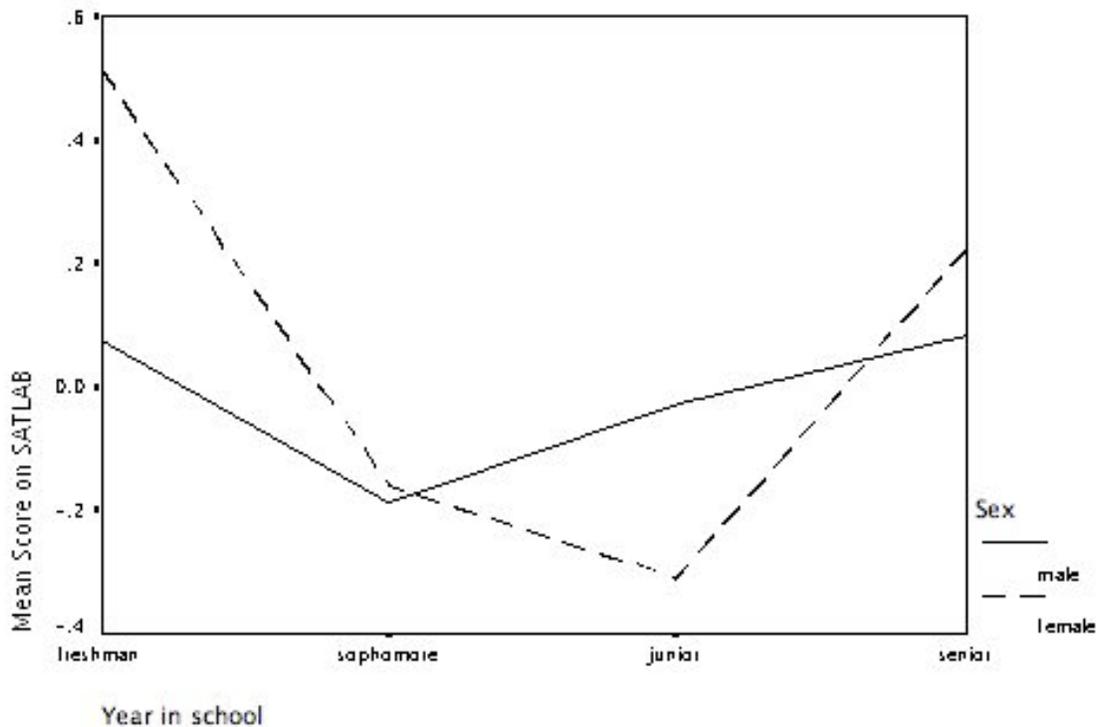
While overall there is no gender gap in satisfaction with lab work, we can see that the overall mean camouflages considerable differences among the students (Figure IIE-3). Female variation in level of satisfaction with lab work is much greater than among male students: there is a curvilinear relationship 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.

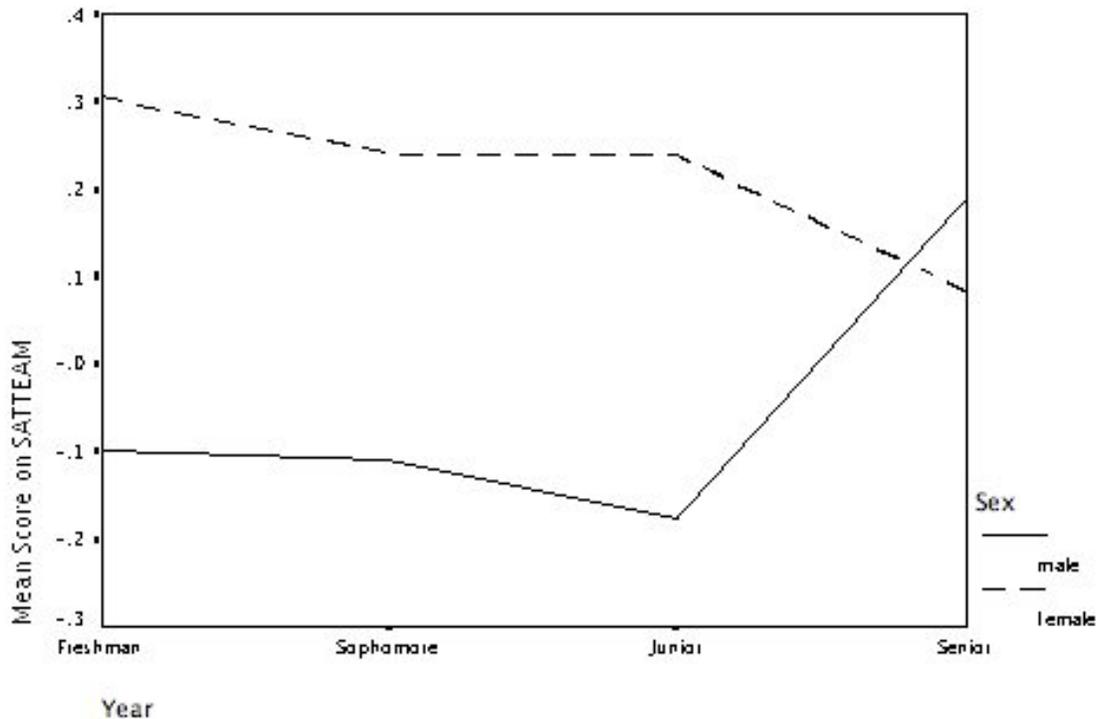
**b. SATTEAM**

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)

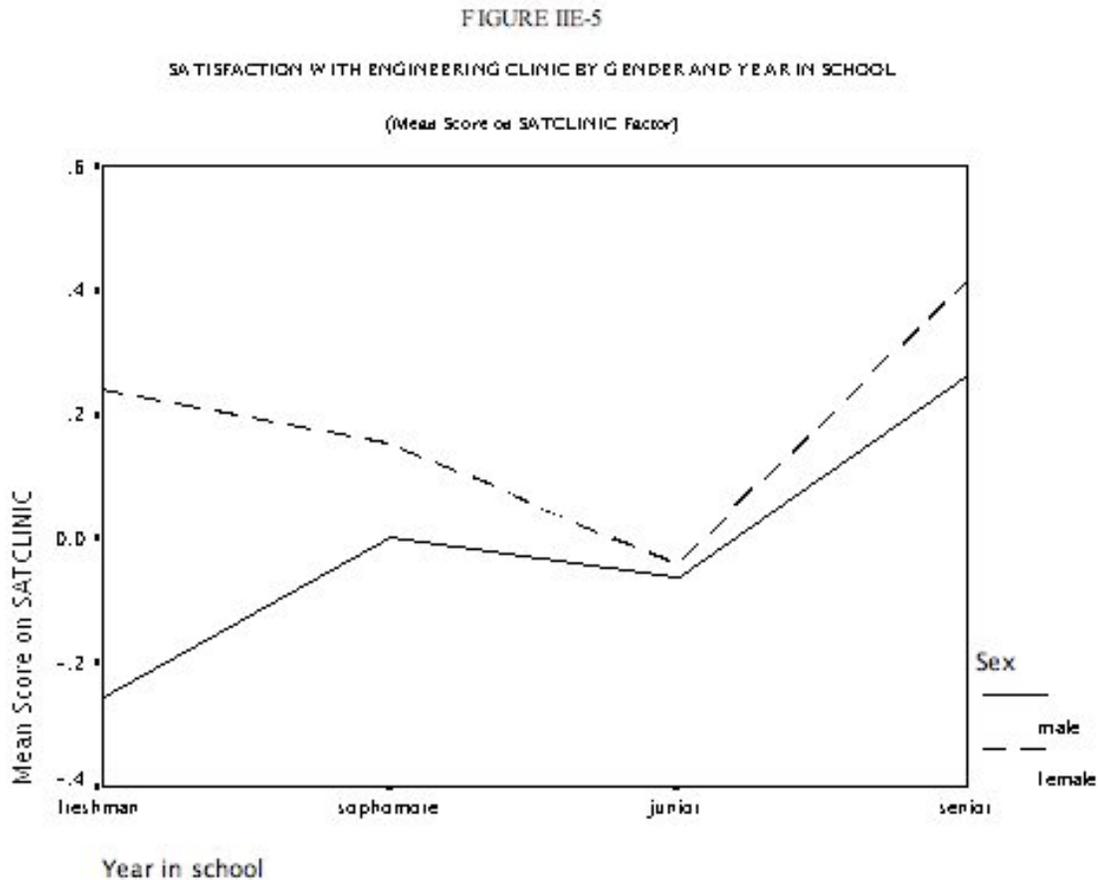


It should be noted that these findings lend mild support to those of Felder et. al. (1995), who, in their longitudinal study of cooperative learning among engineering students, found that females became less enamored with group work as time went on. In our sample, the level of satisfaction with teamwork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



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**

<b>GENDER</b>	<b>MALE</b>	<b>FEMALE</b>
<b>YEAR IN SCHOOL</b>		
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<sup>2</sup> 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,  $\beta$ 's, in parentheses)*

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

<sup>b</sup>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*

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

\*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**

<b>Satisfaction Factor</b>	<b>Males</b>	<b>Females</b>
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<sup>a</sup> AND GENDER**

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

<sup>a</sup>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)*

<b>Organizational Membership</b>	<b>NEITHER</b>	<b>ORG NOT SWE</b>	<b>ORG AND SWE</b>	<b>TOTAL</b>
<b>Satisfaction Factor</b>				
SATCHOICE*	-.20	<b>.49</b>	<b>.32</b>	.25
SATCLASS*	-.16	<b>.07</b>	<b>.72</b>	.23
SATFAC	-.47	<b>.22</b>	<b>-.09</b>	-.06
SATPEERS	.12	<b>.43</b>	<b>.46</b>	.36
SATTEAM	.07	<b>.30</b>	<b>.23</b>	.22
SATCLINIC	.14	.16	.15	.15
SATLAB	<b>.37</b>	-.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 1 <sup>st</sup> year	Dropped after 2 <sup>nd</sup> year	Dropped after 3 <sup>rd</sup> year	Dropped after 4 <sup>th</sup> 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<sup>A</sup>**

Cohort beginning year:	Total started	Total graduated by 2002	Enrolled after 1 <sup>st</sup> year	Enrolled after 2 <sup>nd</sup> year	Enrolled after 3 <sup>rd</sup> year	Enrolled after 4 <sup>th</sup> 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%)	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%)***

<sup>a</sup> 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 the 1997 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<sup>38</sup>, if they were academically dismissed

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<sup>38</sup> 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
<b>Gender</b>		
Males	80.6	72.7
Females	19.4	27.3
<b>Year in School at Time of Survey</b>		
First-year	27.0	60.6
Sophomore	30.4	24.2
Junior	24.8	12.1
Senior	17.9	3.0
<b>Major at Time of Survey</b>		
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
<i>(Fall)</i>		
CONF STAY ENG*	.056	-.564
CONF ENG ABIL	-.021	.202
CONF ACAD ABIL	-.025	.226
CONF COMM SKILL	.022	-.091
<i>(Spring)</i>		
CONF STAY ENG*	.075	-.930
CONF ENG ABIL	-.006	.058
CONF ACAD ABIL	.006	-.086
CONF COMM SKILL	-.000	-.107
<i>Change in Engineering Self-Confidence from Fall to Spring</i>		
% 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
<i>Satisfaction with Programmatic Elements</i>		
SATCHOICE	.014	-.224
SATCLASS	-.017	.265
<i>Satisfaction with Applied Parts of Program</i>		
SATLAB	-.005	.086
SATTEAM	-.013	.192
SATCLINIC	-.012	.107
<i>Satisfaction with Interpersonal Climate</i>		
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**

<b>Gender</b>	<b>Males</b>		<b>Females</b>	
<b>Pre-College Academic Background Indicator:</b>	<b>STAYERS</b>	<b>LEAVERS</b>	<b>STAYERS</b>	<b>LEAVERS</b>
% 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)

<b>Gender</b>	<b>Males</b>		<b>Females</b>	
	<b>STAYERS</b>	<b>LEAVERS</b>	<b>STAYERS</b>	<b>LEAVERS</b>
Participation in Engineering-Related Activities:				
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)

<b>Engineering Self-Confidence Indicator:</b>	<b>Males</b>		<b>Females</b>	
	<b>STAYERS</b>	<b>LEAVERS</b>	<b>STAYERS</b>	<b>LEAVERS</b>
<i>Fall</i>				
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
<i>Spring</i>				
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
<i>Change in Engineering Self-Confidence from Fall to Spring</i>				
% 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)

<b>Satisfaction Factor</b>	<b>Males</b>		<b>Females</b>	
	<b>STAYERS</b>	<b>LEAVERS</b>	<b>STAYERS</b>	<b>LEAVERS</b>
<i>Satisfaction with Programmatic Elements</i>				
SATCHOICE	-.073	-.045	.342	-.507*
SATCLASS	-.066	.267	.172	.261
<i>Satisfaction with Applied Parts of Program</i>				
SATLAB	-.032	.128	.095	.018
SATTEAM	-.073	.048	.205	.440
SATCLINIC	-.057	.042	.175	.280
<i>Satisfaction with Interpersonal Climate</i>				
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)

Academic Achievement at Rowan:	Males		Females	
	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.<sup>39</sup>

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.

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<sup>39</sup> 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.<sup>40</sup> The eleven items were then factor analyzed, deriving three factors.<sup>41</sup>

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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<sup>40</sup> The questions were adapted from a set of questions used at the University of Michigan.

<sup>41</sup> 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

<b>% Perceiving as No Problem for Women</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
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)

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

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 ( $\lambda = .36$ ).

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 ( $\lambda = .13$ ).

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 ( $\lambda = -.11$ ).

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).<sup>42</sup>

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)**

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

<sup>42</sup> 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 <sup>a</sup>	32.4	8.7
Lack of encouragement from family or friends <sup>a</sup>	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)		

<sup>a</sup>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)**

<b>Sister in SEM</b>	<b>SOCPROB</b>	<b>FEMPROB</b>	<b>FAMPROB</b>	<b>(n)</b>
<b>No</b>	<b>-.132</b>	<b>-.088</b>	<b>-.118</b>	<b>(29)</b>
<b>Yes</b>	<b>.582</b>	<b>.585</b>	<b>.777</b>	<b>(9)</b>

*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)

<b>High School Math and Science Grades</b>	<b>SOCPROB</b>	<b>FEMPROB</b>	<b>FAMPROB</b>	<b>(n)</b>
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)**

<b>Number of Female Instructors</b>	<b>SOCPROB</b>	<b>FEMPROB</b>	<b>FAMPROB</b>	<b>(n)</b>
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)

<b>Organizational Membership</b>	<b>SOCPROB</b>	<b>FEMPROB</b>	<b>FAMPROB</b>	<b>(n)</b>
<b>None</b>	.167	.153	-.049	(22)
<b>Discipline-specific organization only</b>	-.342	-.357	.191	(20)
<b>Discipline-specific organization and SWE</b>	.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)

<b>Year in School</b>	<b>SOCPROB</b>	<b>FEMPROB</b>	<b>FAMPROB</b>	<b>(n)</b>
<b>First Year</b>	.410	.384	.251	(20)
<b>Sophomore</b>	-.351	-.291	-.386	(18)
<b>Junior</b>	-.349	-.354	-.111	(14)
<b>Senior</b>	.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)**

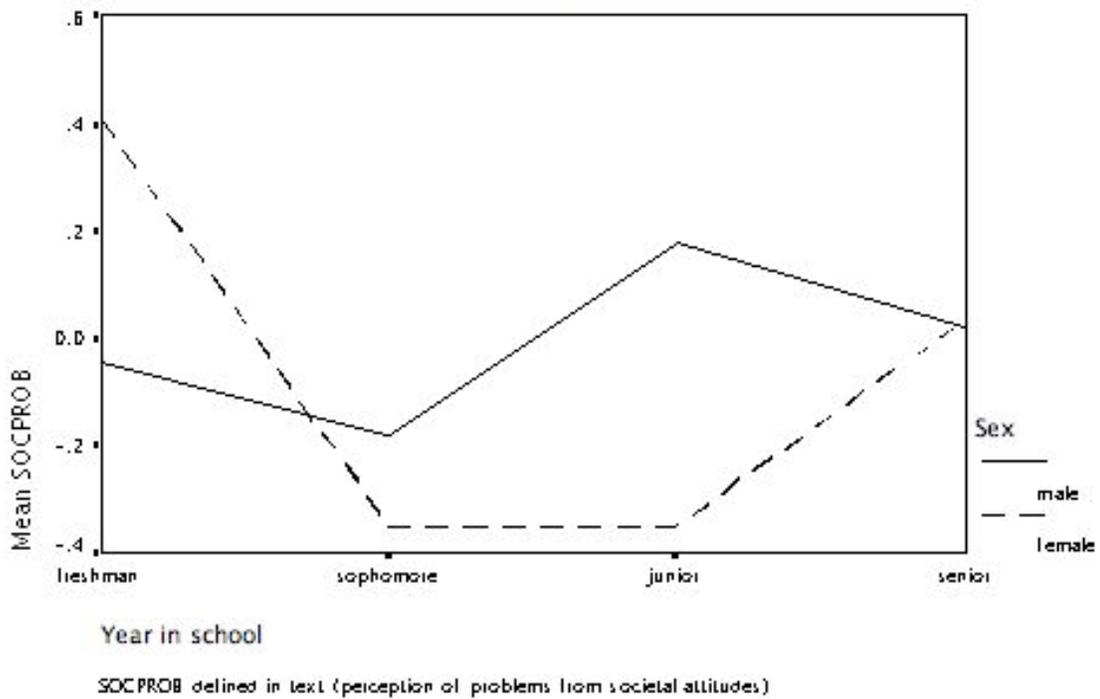
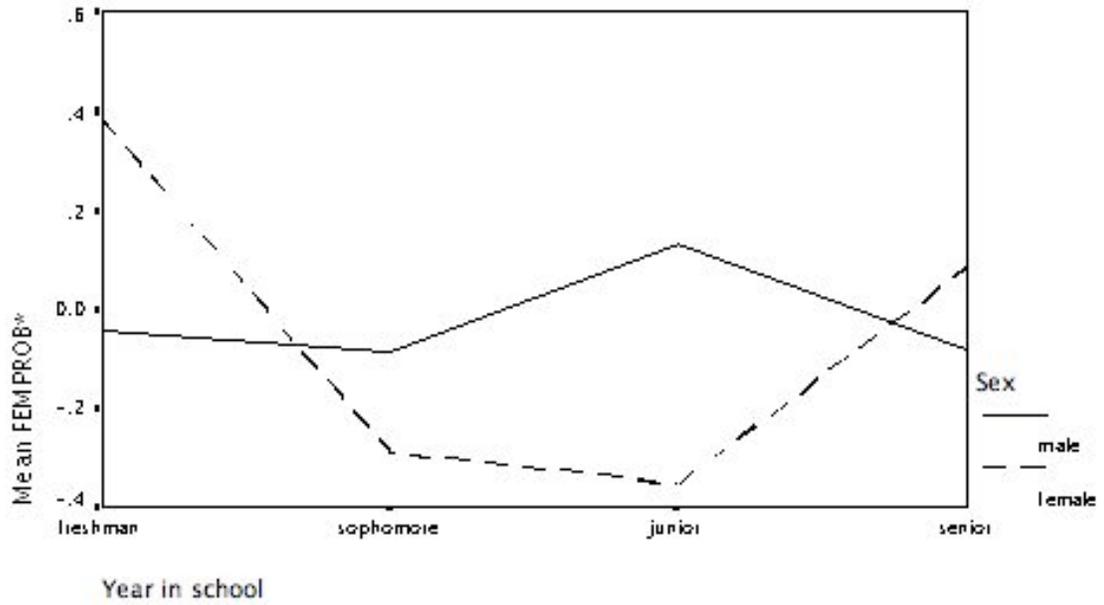
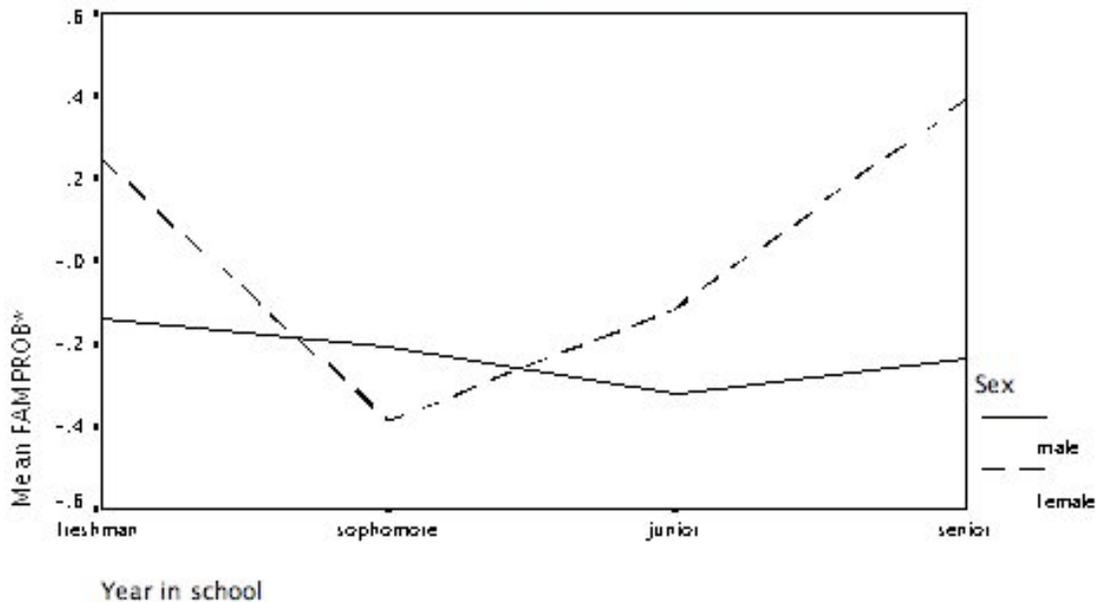


FIGURE IIG-2  
PERCEPTION OF PROBLEMS FOR WOMEN IN SEM  
BY GENDER AND YEAR IN SCHOOL (Mean FEMPROB)



\*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)

<b>Issue:</b>	<b>% Decreased Perception of Problems</b>	<b>% Increased Perception of Problems</b>
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 <sup>a</sup>	23.0	24.7
Lack of encouragement from family or friends <sup>a</sup>	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)		

<sup>a</sup>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)**

Issue	% Decreased Perception of Problems		% Increased Perception of Problems	
	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)
Issue	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
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 Problem for women?	Discrimination		Female role models		Family-career conflict	
	No	Yes	No	Yes	No	Yes
Engineering Outcome						
<b>Engineering Self-Confidence</b>						
CONF STAY ENGIN	<b>-.334</b>	-.616	<b>-.408</b>	-.443	-.537	-.394
CONF ENGIN ABIL	<b>.152</b>	-.252	<b>.133</b>	-.114	<b>.163</b>	-.030
<b>Satisfaction with Engineering Program</b> (Mean factor scores)						
SATCHOIC	.222	.285	<b>.417</b>	.057	<b>.466</b>	.177
SATCLASS	<b>.278</b>	.032	<b>.253</b>	.138	<b>.105</b>	.225
SATCLIN	.136	.263	<b>.209</b>	.152	.103	.205
SATLAB	<b>.148</b>	-.146	<b>.181</b>	-.027	.073	.082
SATTEAM	<b>.246</b>	.151	.048	.374	.029	.258
SATFAC	<b>.147</b>	-.342	<b>.061</b>	-.070	-.528	.166
SATPEERS	<b>.501</b>	-.198	<b>.307</b>	.223	<b>.592</b>	.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<sup>43</sup>, 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-

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<sup>43</sup> 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 III-1**  
**ENGINEERING SELF-CONFIDENCE FOR ROWAN AND UNIVERSITY OF**  
**WASHINGTON (“UWA”) STUDENTS BY GENDER**

(Means)

<u>University</u>	<u>University of Washington</u>			<u>Rowan University</u>		
<u>Gender</u> <u>Item</u>	<b>Total</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>	<b>Male</b>	<b>Female</b>
<b>Confident that engineering is right major for you</b>	3.27	3.52	3.02	4.09	4.11	4.02
<b>Confident in abilities in college engineering courses</b>	3.61	3.81	3.44	4.18	4.22	3.99
<b>Confident in abilities in physics</b>	3.18	3.55	2.84	4.06	4.10	3.91
<b>Confident in abilities in chemistry</b>	2.96	2.84	3.09	3.25	3.28	3.16
<b>Confident in mathematical abilities</b>	3.73	3.82	3.63	3.73	3.75	3.67
<b>Confident in overall academic ability</b>	4.01	4.10	3.93	3.81	3.82	3.80
<b>Overwhelmed by fast pace/heavy workload</b>	3.29	3.03	3.53	3.32	3.19	3.32
<b>(n)</b>	(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<sup>44</sup>.

### **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 students<sup>45</sup>. 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).

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<sup>44</sup> The discrepancy may be that 5% were considering changing majors within engineering.

<sup>45</sup> 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 IIIH-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 IIIH-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"<sup>46</sup>, as compared with the 18% of Rowan females who did not have a faculty member particularly supportive of them.

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<sup>46</sup> 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 III-2**  
**% ENGAGING IN ENRICHMENT AND HELP ACTIVITIES BY YEAR IN**  
**SCHOOL**  
 (Rowan Female Engineering Students and National WECE Sample of Female Engineering Students)<sup>a</sup>

<b>Activity</b>	<b>Rowan Females</b>	<b>WECE</b>
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

<sup>a</sup>As reported in Goodman, et. al., 2002.

**TABLE III-3**

**PARTICIPATION IN SELECTED ENGINEERING-RELATED ACTIVITIES BY  
GENDER AND UNIVERSITY  
(University of Washington, Rowan)  
(%’s)**

<b>Activity</b>	<b>University</b>	<b>University of Washington</b>			<b>Rowan University</b>		
	<b>Gender</b>	<b>Total</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>	<b>Male</b>	<b>Female</b>
% Having any contact with a mentor <sup>a</sup>		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 <sup>b</sup>		62.5	62.9	62.7	63.6	60.9	74.6
(n)		(132)	(62)	(68)	(331)	(263)	(68)

<sup>a</sup> At Rowan, the question read: “During this academic year, have there been any particular faculty who encouraged you or were personally supportive of you?”

<sup>b</sup> 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 IIIH-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 III-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		
	Total	Male	Female	Total	Male	Female
<b>Gender</b>						
<b>Satisfaction item:</b>						
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.